Integration of Maps, Satellite Images, Camera Images and GPS Data

André Scholtz

Supervised By: Associate Professor Gary Marsden & Professor Edwin Blake

Department of Computer Science

Plagiarism Declaration:

1. I know that plagiarism is wrong. Plagiarism is to use another’s work and pretend that it is ones own.

2. I have used the Computer Science convention for citation and referencing. Each contribution to, and quotation in, this practical from the work(s) of other people has been attributed, and has been cited and referenced.

3. I have not allowed, and will not allow, anyone to copy my work with the intention of passing it off as his or her own work.

4. I acknowledge that copying someone else’s assignment or essay, or part of it, is wrong, and declare that this report is my own work.

André Scholtz [19/10/2007]
Abstract
The evolution of technology has changed the way in which people share their travel experiences. This report looks at how travel sharing practices have changed and the development of Virtual Postcard. The system will allow users to share their travel experiences on the internet, and gives the ability to integrate various media forms. The system’s interface will be map-based and utilizes a journey metaphor. An iterative User-centered design process is used, each consisting of design, implementation and evaluation. Results of a final qualitative experiment are presented as well as scores from the QUIS questionnaire. A number of positive results are presented, which suggest the system has met its design goals of providing an effective and efficient user interface.

Keywords:
User-Centered Design, Photo sharing, Map-Based interface, Social networking, SenseCam.

Subject Descriptions:
H.5.2 [User Interfaces] Graphical user interfaces, Screen design, Prototyping, Interaction styles, Evaluation/methodology
Contents

Contents ........................................................................................................................................................ 3

1. Introduction .......................................................................................................................................... 7
   1.1. Problem outline ............................................................................................................................ 7
   1.1. Proposed Solution and division of work ..................................................................................... 7
   1.2. Report outline .............................................................................................................................. 7

2. Background ........................................................................................................................................... 8
   2.1. Introduction ................................................................................................................................. 8
   2.2. Evolution of the technology ........................................................................................................ 8
      Printed photographs ............................................................................................................................. 8
      Digital photography ............................................................................................................................ 8
      Self authored websites ......................................................................................................................... 9
      Social networking websites ................................................................................................................. 10
      Current Systems ................................................................................................................................. 11
      Virtual Postcards ................................................................................................................................. 15
   2.3. Conclusion ................................................................................................................................. 15

Design chapter ............................................................................................................................................ 16
   2.4. Introduction: .............................................................................................................................. 16
   2.5. The design question and considerations: .................................................................................. 16
   2.6. Understanding the users: .......................................................................................................... 17
      Personas .............................................................................................................................................. 17
   2.7. Developing prototypes .............................................................................................................. 19
   2.8. Evaluations ................................................................................................................................ 19

3. Iteration one: Paper Prototype ........................................................................................................... 21
   3.1. Introduction ............................................................................................................................... 21
   3.2. Design ........................................................................................................................................ 21
      Session 1.............................................................................................................................................. 22
      Session 2.............................................................................................................................................. 23
      Session 3.............................................................................................................................................. 24
   3.3. Implementation ......................................................................................................................... 25
   3.4. Evaluation .................................................................................................................................. 28
<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.5</td>
<td>Lessons learned</td>
<td>28</td>
</tr>
<tr>
<td>4.</td>
<td>Iteration two: High Fidelity Prototype Version 1</td>
<td>29</td>
</tr>
<tr>
<td>4.1</td>
<td>Introduction</td>
<td>29</td>
</tr>
<tr>
<td>4.2</td>
<td>Design</td>
<td>29</td>
</tr>
<tr>
<td>4.3</td>
<td>Implementation</td>
<td>30</td>
</tr>
<tr>
<td>4.4</td>
<td>Evaluation</td>
<td>31</td>
</tr>
<tr>
<td>4.5</td>
<td>Lessons learned</td>
<td>32</td>
</tr>
<tr>
<td>5.</td>
<td>Iteration three: High Fidelity Prototype Version 2</td>
<td>33</td>
</tr>
<tr>
<td>5.1</td>
<td>Introduction</td>
<td>33</td>
</tr>
<tr>
<td>5.2</td>
<td>Design</td>
<td>33</td>
</tr>
<tr>
<td>5.3</td>
<td>Implementation</td>
<td>35</td>
</tr>
<tr>
<td>5.4</td>
<td>Evaluation</td>
<td>37</td>
</tr>
<tr>
<td>5.5</td>
<td>Lessons learned</td>
<td>38</td>
</tr>
<tr>
<td>6.</td>
<td>Iteration four: High Fidelity Prototype Version 3</td>
<td>39</td>
</tr>
<tr>
<td>6.1</td>
<td>Introduction</td>
<td>39</td>
</tr>
<tr>
<td>6.2</td>
<td>Design</td>
<td>39</td>
</tr>
<tr>
<td>6.3</td>
<td>Implementation</td>
<td>44</td>
</tr>
<tr>
<td>6.4</td>
<td>Evaluation</td>
<td>50</td>
</tr>
<tr>
<td>6.5</td>
<td>Lessons learned</td>
<td>50</td>
</tr>
<tr>
<td>7.</td>
<td>Iteration five: Final Prototype</td>
<td>53</td>
</tr>
<tr>
<td>7.1</td>
<td>Introduction</td>
<td>53</td>
</tr>
<tr>
<td>7.2</td>
<td>Design</td>
<td>53</td>
</tr>
<tr>
<td>7.3</td>
<td>Implementation</td>
<td>54</td>
</tr>
<tr>
<td>7.4</td>
<td>Evaluation</td>
<td>58</td>
</tr>
<tr>
<td>7.5</td>
<td>Lessons learned</td>
<td>58</td>
</tr>
<tr>
<td>8.</td>
<td>Final Experiment</td>
<td>58</td>
</tr>
<tr>
<td>8.1</td>
<td>Introduction</td>
<td>58</td>
</tr>
<tr>
<td>8.2</td>
<td>Method</td>
<td>59</td>
</tr>
<tr>
<td></td>
<td>Sample</td>
<td>59</td>
</tr>
<tr>
<td></td>
<td>Equipment and tests used</td>
<td>59</td>
</tr>
<tr>
<td></td>
<td>Evaluation procedure</td>
<td>59</td>
</tr>
<tr>
<td>8.3</td>
<td>Results</td>
<td>60</td>
</tr>
</tbody>
</table>
Understanding and comprehension ................................................................. 60
Browsing and navigation .............................................................................. 61
User Opinion ............................................................................................... 62
The QUIS results ......................................................................................... 62
8.4. Discussion ............................................................................................ 62
9. Conclusion ............................................................................................... 64
10. References ............................................................................................. 65
11. Appendix A: QUIS Questionnaire .............................................................. 67
OVERALL REACTION TO THE SOFTWARE ...................................................... 67
SCREEN ........................................................................................................... 67
TERMINOLOGY AND SYSTEM INFORMATION ............................................. 67
LEARNING ...................................................................................................... 68
SYSTEM CAPABILITIES .................................................................................. 68
List the most negative aspect(s): ................................................................. 69
List the most positive aspect(s): ................................................................. 69
List of illustrations

Figure 1. LocoBlog ........................................................................................................................................ 12
Figure 2. VirtualTour ................................................................................................................................... 13
Figure 3. WWMX Browser ........................................................................................................................ 14
Figure 4. Main display paper prototype ................................................................................................... 25
Figure 5. Zoomed-in view of main display ................................................................................................. 26
Figure 6. Submenu ......................................................................................................................................... 26
Figure 7. Photo Browser ............................................................................................................................ 27
Figure 8. Journey Browser .......................................................................................................................... 30
Figure 9. Explorer ......................................................................................................................................... 35
Figure 10. Explorer interface after zooming in .......................................................................................... 36
Figure 11. Journey entry overlay ................................................................................................................ 36
Figure 12. Index Page ................................................................................................................................. 45
Figure 13. Home page of logged-in user ..................................................................................................... 46
Figure 14. Home page of another user ........................................................................................................ 46
Figure 15. Journey Editor ............................................................................................................................ 47
Figure 16. Journey Viewer .......................................................................................................................... 48
Figure 17. Explorer entry overlay ................................................................................................................ 48
Figure 18. Photo Browser ............................................................................................................................ 49
Figure 19. Photo Browser details ................................................................................................................ 50
Figure 20. Index Page ................................................................................................................................... 54
Figure 21. Loading Screen ........................................................................................................................... 55
Figure 22. Photo Browser ............................................................................................................................ 56
Figure 23. Explorer entry overlay ................................................................................................................ 57
Figure 24. Registration Page ....................................................................................................................... 57
1. Introduction

1.1. Problem outline
A large majority of people have been on some kind of travel journey or trip in their life time. When returning from the journey, they often want to share their travel experiences with friends and family. These travel experiences are expressed as stories and often include photographs [2]. Over time, the methods for sharing these travel stories has evolved and become more technologically advanced. The forms of media used to express the travel experiences have also evolved. The introduction of mobile camera phones has changed how people take photographs. GPS systems have also provided a means of precisely mapping a journey. The most current system for sharing of travel experiences does not support the integration of these modern media forms. Our system will provide the user with this ability.

The design question posed for this project was to develop a system which allows people to share their travel experiences on the internet, and gives them the ability to integrate satellite imagery, camera images and GPS information. The main focus will be on the design and development of the user interface for browsing the uploaded travel data.

1.1. Proposed Solution and division of work
We propose to develop a system which allows people to easily capture and share travel experiences with others. The system will take the form of a social networking style website. The site will contain a number of map-based interfaces.

The work load will be divided into two sections: design and evaluation, and implementation. This report is concerned with the design and evaluation of the system. The implementation details are covered in the report by Anton Eicher.

1.2. Report outline
In the next section, previous and related work in the fields of photo sharing and social networking are discussed. This section is followed by a design chapter which explains the design approaches and methodology which was used.

Sections 4 through 8 look at each of the development iteration which took place. Each iteration consists of a design, implementation and evaluation stage. Lessons learned during each of the iteration are also presented.

Section 9 looks at the final experiment which was performed.

The final section provides a conclusion and mentions possible future work.
2. Background

2.1. Introduction
Almost everyone has had some kind of travel experience on which they have taken photos to show friends and family. According to [1], these travels are expressed in the form of a story, which often includes photos. Over time the way in which these stories have been expressed has changed and evolved, partly due to the technology used when telling them.

We propose to develop a system which allows people to easily capture and share travel experiences with others. In order to understand what our system needs, we look at the previous systems that are used to present travel experiences to others.

We are going to examine the evolution which has occurred and look at the benefits and short falls of the previous methods. Our main interests are in the interaction between the users and the system, and sharing of travel experiences with others over a long distance.

2.2. Evolution of the technology
In the following section we are going to examine how the means by which we capture and share travel experiences has evolved. Our aim is to determine which attributes from previous systems are seen as positive aspects which should be implemented in future systems.

Printed photographs
The traditional printed photographs captured using analogue cameras was one of the first means which people could use to capture and share their travel experiences. People would tell stories about their travels to their friends and families by showing them photos of the trip. The audience to which these photos were shown was usually very small, and it was often a very personal and social event.

According to [2], two scenarios of story telling with photos exist, namely sharing stories remotely and sharing stories locally. The sharing of stories locally was very simple, but there was no effective means for one to share their travel stories to others far away. The only means at the time was for the photos to be posted, usually accompanied by a letter. Due to the material and development of photographs, making duplicates and sending them to others was very expensive. The storage of these photographs made it very difficult to search for specific images. Other forms of context information, such as descriptions, time and location, were often not available. Even though it was expensive to share travel experience remotely, many people would still did it. This suggests that our system should provide a cheap and effective means of sharing travel experiences to other people without having to be there in person.

With the introduction of the affordable, high quality digital camera, people began to move away from printed photos and move towards digital photography.

Digital photography
After the introduction of digital cameras many people began to use digital instead of analogue photography. One of the biggest benefits of digital photos over analogue was the fact that digital photos
could be stored on one’s personal computer. This made it far easier for the storage and archiving of large photo collections. With the nature of the digital medium, other metadata such as date capture and tags could easily be associated with the photos. Browsing of digital photos is also easier. Interfaces, such as that used in [2], allow for browsing to be done using low resolution thumbnail images, and high resolution to only be displayed after selecting an image. It is also suggested that interfaces be modeless due to the constant changing between editing, viewing and tagging images.

The sharing of photos to people remotely had become easier due to email; however the sharing of photos locally became a negative aspect of digital photos. People would present their travel photos on personal computer screens, which was not as social as showing printed photos [2]. According to the study by [7], “It was found that looking at printed photos in person is far more interesting than sitting in front of a display looking at them”.

In summary, the storage and searching of digital photos is far easier than printed photos. The old method of showing printed photos is preferred by many people over the viewing of digital slide shows. Application interfaces for digital photo browsers require that varied levels of detail be provided and the interface need be modeless. These findings would also suggest that our system would need to handle large photograph archives.

Later, people want an even easier way to share their travel experiences. They thus began to create web pages which included photos and stories of their travels.

**Self authored websites**

People want to share travel experiences with others, telling them the ‘story’ of their travels. They also wanted to tell these stories in an uncensored format, where they can openly express both the positive and negative experiences [1]. Computers and the internet gave the users possibilities for creating new practices, not possible with print photos [8].

People began to create their own simple web pages. These web pages acted as travel logs. The process of web logging became known as blogging. The new travel blogging technology gave people the opportunity to share their travel experiences with a much larger audience. They were also able to openly express their experiences with no restrictions. Research has even suggested that people are likely to use photo sharing as a means to improve individual relationships over distance and time.

The largest problem with this new website approach was that it is very difficult for one to create a website, and most people are not able to do so. The other issue with travel blogs was that the author had no simple means of controlling who read their blog entries. Our system would need to provide user friendly functionality to allow users to easily create and edit their travel blogs.

The issue of privacy was not a concern with the previous technologies, but it now became a concern for some. According to [9], in general, bloggers are fairly unconcerned about privacy. This new form of technology now provides a means for users to share their travel experiences on an enormous scale. The only issue is the difficulty of creating personal blog pages. With the interest of social networking
increasing, new web 2.0 technology began to develop, and blogging and photo sharing became a lot simpler for the user to do.

**Social networking websites**

With the new interest in community-driven online content, the popularity and size of social networks grew dramatically. These websites allowed for the users to easily publish their travel content, such as photos and blog entries.

All of the commenting and tagging of images and other travel content is handled by the system itself. In a study by Van House [14], a number of participants had given up on blogging because it was too much work. These social networking systems also overcome the privacy issue discussed above by allowing the user to set access control. They allow various user set access control levels on the posted contents, which are often achieved by creating access groups.

A study by [12] suggests that the social networking aspect of photo sharing is a turn-based interaction. The user will post an image, after which it is commented on by a viewer and the user will then reply to the comment. This cycle of comment – reply can continue for a number of posts. The study also suggests the importance of notifying those involved with the current “conversation” when a new comment is posted. Such functionality already exists with systems such as Facebook. The interfaces of many social networking sites also have a clear indicator of what content is new, such as bold or bright colour fonts for those newly posted messages. Even though the bloggers often appreciate the viewers’ opinions and comments, according to [9] the blogger needs to have a choice to hide the comments from direct view or to even disallow them entirely. This turn-based interaction would have to be considered in the design of the Virtual Postcards system. A means of commenting and replying to other comments would be required. The study by Nardi [9] also suggests that bloggers are interested in the stats of their blog, such as how many viewers they have. The introduction of high quality mobile camera phones has had a dramatic effect on the phenomena of social networking. Image posting sites such as flickr were also affected.

**Introduction of camera phones**

The introduction of the high quality camera phone armed the social network users with a ubiquitous camera, giving them the chance to take photos almost anywhere. This led to a change in photo taking practices, and dramatically increased the number photos that people were taking.

It is believed that the 2-4 megapixel camera phones will replace the traditional digital camera in everyday life [12]. The combination of mobile phone technology and camera also means that travel photos can be posted to social network sites almost immediately. Camera phones also lead to a dramatic change in the types of photos which were being posted [14]. People were found to be capturing mundane images which reflect their daily lives. One of the major uses for mobile social networks is the sharing of travel experiences [12].

In summary, the social networking systems allowed users to easily publish their travel experiences. The system also provides simple access control mechanisms. In some instances, the biggest benefit was the ability to publicly exhibit what you had posted. The only clear short fall of the social network systems
were that the interfaces were not sufficiently equipped for travel experiences and context information specific to travel posts, such as the geographic location of where that photo was taken. The next step in the evolution occurred when multiple technologies were merged together.

Later developers began to realize that they could combine multiple technologies together to provide their viewers with an even richer “story” of their travels. The next logical step was to add location specific metadata, such as location tags and even GPS coordinates.

Current Systems
There are currently a small number of systems which integrate many different new technologies, such as satellite images, maps, GPS location data, photographs and textual data. According to [13], geographic location and timestamp data where the photograph was taken provide critical context, as it turns an annotated slideshow into an interesting travel story. A number of previous GIS systems have been concerned with the integration of maps and images which are just map overlays of another type of map, such as aerial photographs. The latest systems aim to integrate maps with non-map images, such as vacation photographs. According to a study by [6], “Geographic location, however, is arguably the single most valuable index that is still absent from existing photo-based applications”. The reasons given for this were that location is universal, it scales well, and the most import in terms of user interface is that browsing by location is well understood and intuitive to users. In the follow section, we are going to look at three of the current systems. We are going to look primarily at the user interface and its positive and negative aspects.
LocoBlog is a mobile phone application and web site which supports location-based mobile photo blogging. The system displays travel entries linearly as well as spatially. According to [3], this allows the viewer to get a greater sense of the journey in addition to the individual places. The system is powered by Google Maps. One of the criticisms that need to be made about the system is that its hierarchical structure for the representation of journeys is possibly too strict. The user should have more freedom in the way they arrange their travel data. Another aspect of the system which could be reconsidered is the representation of trips by means of single map icons to represent the first and most recent post made for the specific journey. This representation could be confusing in cases where a round trip was made; i.e. where the first and last posts are in the same place. In spite of these criticism, the study by [3] found that the posting of messages became very personal, “In the case of holidays, many users felt it was like sending personalized postcards with the hassle”. The study also suggests that blogging and tagging of photos was negatively affected by time constraints. Therefore, the tagging and blogging facilities in future systems must be made as quick and simple as possible.
In terms of privacy and security, [3] found that in their study participants seemed to have adopted the sense of openness common amongst traditional bloggers.

**VirtualTour**

This system is interested in providing the user with resources to help plan a trip, and later allow users to share their travel experience [5]. The image resources for the VirtualTour system are acquired through both users’ posts, and through crawling images forums. VirtualTour utilizes a map based interface for browsing location tagged images. This is achieved through the Microsoft Virtual Earth platform. The user interface consists of a number of smaller panels, surrounding a large main panel. All of the smaller panels can be hidden to give a non-obscured view of the map in the main panel. The system implements a number of query methods, such as query by location, path and maps. These make it easier for the user to find the travel information they are looking for. A key attribute of the system is that the panels and map interaction is completely reflective. For example, the selection of images can be done by clicking the thumbnail on the map or in the other smaller panels. To give the viewer a simple means of viewing the entire journey, the travel entries can be viewed in a slide show manner. An animated trip can also be played by moving an icon along the journey’s path.

*Figure 2. VirtualTour*
The WWMX browser

The World Wide Media eXchange (WWMX)[13] browser is a system designed for browsing and viewing images and photographs which have geographic location tags. Like Virtual tour, the WWMX browser also implements a reflective multipanel user interface. The system also implements constraint panels which allow for the user to specify what is displayed by the interface. This constraint function is very important, given that the number of travel blogs for popular tourist venues could become very large and thus messy to display. To ensure that the map display does not become too cluttered with travel entries, a concept called ‘media dots’ was used. Media dots are circle icons on the map which indicate the position of photos. The size of the media dots are determined by the number of photos that are taking in that area. This makes the display more manageable to the user and removes the clutter of many icons being displayed in very close proximity. Other media dot attributes, such as colour, could also be used to indicate other information about the location.

The results of most of these studies found that, in ethnomethodological terms, people are using such systems as a means of communicating their greeting messages and postcards to their friends and family. In summary, these systems have successfully integrated interactive mapping systems such as Microsoft Virtual Earth and Google Maps with location tagged images and photographs. These systems have
shown that a multipanel, together with some constraint mechanism, is required to make browsing easier for the user. One of the shortfalls of the system is that emphasis is place more on the single entries apposed to the entire travel journey.

In the next section, we look at the proposed ideas for our new Virtual Postcards system.

**Virtual Postcards**
When designing the Virtual Postcards system, we aim to include those positive attributes from past systems, and remove those negative attributes from the more recent systems. The largest difference between the previously discussed methods of sharing travel and Virtual Postcards system is the mean in which photos will be captured. Virtual Postcards will be designed for use with the Microsoft SenseCam.

The SenseCam is a truly ubiquitous camera. It will be worn by the user and takes photographs automatically. No user interaction is required, besides turning the camera on.

It will capture a plethora of travel images, which could be filtered by the user at a later stage. The Virtual Postcards system will be aimed specifically at journey information, and not just single travel entries. The interface for the system will be based on the Microsoft Virtual Earth framework. In order to provide an intuitive, easy to use interface, multiple panels will be used and constraint mechanisms will be provided.

In terms of social networking, the Virtual Postcards system will be heavily aimed at providing social network facilities, such as viewer commenting. The system will also provide a means to link travel blogs of different users.

**2.3. Conclusion**
We have looked at the evolution of technologies for the sharing of travel experiences. By identifying those positive and negative attributes of past systems, we understand what needs to be implemented when developing the Virtual Postcard system.

In summary, the evolution of technology has shown that users are becoming more interested in contextual information associated with images, such as location. There is a growing interest in the sharing of travel experiences to a larger audience. Users are also interested in the opinion and comments made by those who they share their travel blogs with.

In terms of user interfaces, the visualization of such large amounts of data is difficult to achieve. Detail on demand, the ability to query as well set constraints are all required to make the interface as intuitive as possible for the user.
Design chapter

2.4. Introduction:
An interaction design approach was used for the development of this system. The reason for using this approach was that it ensures that all the aspects of interaction between the user and the system are considered [6].

A User-centered design (UCD) [6] method was used in the development of this system. UCD is a tool used in participatory design. This process involves an iterative development in which the user is involved from initial design to final release. This is done in an attempt to create an interface based on the users’ requirements rather than forcing the user to adapt to our interface.

According to Jones & Marsden [6], effective interaction design requires 3 main types of activity:

- Understanding the users
- Developing prototypes
- Evaluations

We will start by looking at the design question and considerations, we will then look at each of the three above-mentioned activities in more detail.

2.5. The design question and considerations:
The design question posed was to develop a system which allows people to share their travel experiences on the internet, and gives them the ability to integrate maps, satellite imagery, camera images and GPS information.

A number of initial design considerations existed and are presented below:

The amount of information being represented

The amount of the data that needs to be represented could potentially be enormous. The data needs to be presented in a simple way. Users need to navigate and sift through all the presented information in order to find what they are looking for. Features would also need to be implemented which prevent the display becoming cluttered with too much information.

Hardware requirements

The system is intended to be used with the Microsoft SenseCam. This hardware is not yet commercially available to the public. This means that no information is yet available about how the camera is used in the field, and field studies can not be performed to evaluate final system in a real world environment.

Technological literacy requirements
The system requires the integration of data from a number of different sources, namely SenseCam, GPS and internet based resources. At present this limits the full use of the system to users which are particularly technologically literate. It is believed though, that with technology evolving, next generation camera’s will be equipped with GPS receivers, and this type of integrated data will be simple for regular users to use.

Web based interface

Due to the system being web based, consideration must be made about what design elements are possible. The complexity of the system must also not be too great, to create long download times.

2.6. Understanding the users:
One of the most vital aspects of UCD is understanding the users as much as possible.

Early investigations looked at users of systems which provide a subset of what our system aims to provide. The goal was to understand what the users liked in those other systems, as well as what they disliked.

A population of 23 people, between the ages of 16 and 31 with varied levels of technological literacy was used. A majority of the participants had used current social networking systems, and had used Microsoft Virtual Earth or similar mapping systems.

From discussions held with the users, the following themes were inferred:

- Many users enjoy browsing community driven content, and would check the sites many times a day to check for new content
- A large number of people are sharing their travel experiences on the internet through social network sites or blogs
- Some of the participants stated that they find current community driven sites easier to navigate than other traditional sites
- The younger participants found the communication functionality very appealing, and some even used these sites as their primary form of communication with their friends

This definitely suggests that there are a number of people that would post or read other travel experiences which are presented with our system.

Personas
To make full use of our knowledge gained through user discussions, personas were developed. The aim of the personas is to provide the designer with a better understanding of the needs of real world users. Scenarios were also developed based on the expected use of the system by the various personas.
There are a number of praises and criticisms made for the use of personas [4]. The most mentionable benefit is that a “face” is provided to focus designs on. Personas allow the developers to design for more than just statistics of the target user group. Developers can have a specific persona in mind when developing certain features. Another benefit of personas is that scenarios of typical usage can be created. These scenarios allow for far more context information than conventional use cases.

A single criticism of personas is that they are fictional [11]. There is therefore no way of determining how many real world users are being represented by the given persona. In the case of this system, this was not seen as a major problem. The reason for this not being considered a major problem is that exact numbers of users being represented would not impact the success of the system.

The personas which were developed are listed below, together with a brief description.

**Arnold**

21 years old, university student currently in 3rd year business science. He enjoys going out for some drinks on the weekends with his friend, and often goes camping. Arnold enjoys posting pictures of his parties and camping trips on Facebook. Most of his posted photos are only interesting to those people who know him well. For Arnold, posting fun pictures for his friends to see is more important than documenting his trip for complete strangers.

Quote: “We should really take a trip up the coast this weekend”

**Martha**

Martha is a 30 year old house wife. He husband is 40 years old and works as an accountant. She has two children which are both in primary school. She has lots of time on her hands, and recently received her nephew’s old computer as a gift. She has below average computer literacy, but she is willing to learn new things. She has recently learned to browse for cooking recipes. As a young lady, she dreamt of going to Paris to see the Eiffel tower.

Quote: “Are you sure you don’t want to stay for a cup of coffee?”

**Bruce**

Bruce is a very successful business man. At age 31, Bruce has worked very hard to get to where he is today. He has a typical family with a house wife, and two daughters, aged 3 and 7. He has been around the world on business trips. He is now starting to relax a bit more, and starting to spend more time with his family. A typical day in Bruce’s life involves getting up at 05:45, getting ready for work, getting in his Lexus and driving to the
office. He spends the rest of the day in meetings until 18:45, when he returns home again to find supper ready for him.

Quote: “I can’t understand why it is taking you so long to get this job done”

2.7. Developing prototypes
After understanding the user, developing of prototype is the next activity required. Due to the iterative nature of UCD, a number of prototypes will be developed.

The initial prototype will take the form of a low fidelity paper prototype. This prototype will be developed using participatory design [6]. Details of the sessions are given in the chapter concerning iteration 1. The reason for using the participatory design method is that users are placed on equal footing to the designers. Participatory design also allows for users to clearly express what they want the interface to look like and how they want it to function [6]. The dependence of the user for design is both the primary benefit and drawback of participatory design sessions.

After the development of the low fidelity prototype, a high fidelity version will be developed. At this stage the design changes are based on the evaluation results of the previous iterations prototype.

2.8. Evaluations
The final procedure of any development iteration is the evaluation of the prototype. As with the design, the users are involved with evaluations as much as possible. After the implementation of the prototype, evaluation sessions will be held. The aim of these sessions is to determine how the various interface features are interpreted by the users. In many cases, a post-evaluation interview will also be held to better understand the users’ opinions of the system.

The two evaluation techniques that will be used are conceptual model extraction and observation of task performance [6].

Conceptual model extraction is aimed at understanding how users interpret various interface components given their current cognitive model. This allows us to better understand what the user is thinking about the interface, how they expect it to work and how they want it to work. The method is performed by displaying static versions of the interface components to the user and asking them questions about it. Such questions include “What do you think it is used for?” and “What do you think will happen if you use it?” A benefit of this method is that it provides a simple means of understanding the user’s ideas and ‘seeing the interface through the eyes of the user. A major drawback of conceptual model extraction is that it can only consider the user’s initial ideas of the interface. Learning effects are not taken into consideration. This makes conceptual model extraction an excellent evaluation method when used in conjunction with other methods, but a terrible method when used on its own.

Observation of task performance is simply the observation of participants while completing a series of tasks. These tasks can vary, but they are mostly aimed at testing of the newest features or those features which are considered to be problematic. During these evaluations, users are urged to talk aloud about what they are doing and thinking. This form of evaluation is known as cognitive walkthrough [6].
The observer will try to understand which areas of the interface are being misunderstood by the user and which are being praised for ease of use. This, like the participatory design sessions, has very heavy dependence on the users’ knowledge and willingness to participate.

The result of these evaluations is a list of problem areas which need to be redesigned, new features which need to be included and existing features which need to be removed. These requirements are then dealt with in the design of the next iterations.
3. **Iteration one: Paper Prototype**

3.1. **Introduction**

The aim of this first iteration was to create a low fidelity paper prototype. This was a horizontal prototype, which means that most of the features were considered, but the functionality was ignored. Low fidelity materials such as post-it notes and cardboard were used to represent the interface. This provided a simple, cheap and efficient means to develop the user interfaces. By creating the initial paper prototype, we were able to identify the major interfaces which needed to be implemented. This iteration is considered to be the most important, as it has a huge impact on the development of the system later on. Because of its importance, much detail has been used in describing the steps taken in the design and evaluation.

3.2. **Design**

The paper prototype was designed to create user interfaces which meet the users’ expectations and needs. Participatory design methods were used for the design of this prototype. This allows for end-users to become active members of the design team, rather than just spectators to the design process.

In our case, the participatory design method was used. Three design sessions were held, each consisting of 4 participants. The participants were chosen based on the following criteria: computer literacy, sharing or viewing of travels experiences and social networking experience. Each design group contained one user which had above average experience in one of the criteria. The fourth participant was chosen based on a lack of experience in all three criteria. By selecting participants with varying level of experience in difference fields, diverse design groups were formed. The aim of this was to ensure that all features would be considered equally during the design sessions.

For each of these sessions, the participants were first introduced to each other. They were then given some background information about the purpose of the session and the technology to be used, such as GPS, Microsoft Virtual Earth and social networking. The subjects were only given a very basic overview of what the system is required to do. Each of these sessions consisted of a 10 minute introduction, and 60 minute participatory design session.

The first two groups were given very little specifics about what the interface should look like and very little detail about what it needs to do. This was done in an attempt to allow as much creativity and freedom as possible for the design participants. After the first two design sessions, clear patterns were visible. To prevent the same designs being created by the final group, they were provided with the designs of the first two groups. By providing the final design group with the designs of the previous groups, they had a chance to consider these designs in more detail than the previous groups. This also gave the final group the opportunity to think of other areas which the previous groups did not have time to consider.
A summary of the decisions made, the reason for the decision, and any rejected options for each of the design sessions is given below. Note that all the decisions were made by the design subject during the design sessions, and not by the system developers.

Session 1

**Photo metadata**
The photos should have associated metadata which allow for searching or filtering. This metadata should consist of a timestamp, a GPS tag, a list of people in the photo, and possibly a trip which it is associated with.

*Reason:* There needs to be a way of searching photos based on time, locations, trip or the people in the photo.

**Displaying routes on the map**
The route that was taken should be displayed on the map to give the viewer a clear indication of where the trip started and ended, and where it went.

*Reason:* There needs to be an easy way of seeing what route a person took.

**Indicating a photo count for a given route**
An iconic display at the bottom of the screen needs to indicate the names of the places where the route starts, what places the route went through, and the end point. Above each of these places, a photo count must be displayed.

*Reason:* The user needs to easily see how many photos have been taking at different places along the route.

*Rejected Options:* Display a photo count above each of the places on the map. This was rejected because the map could possibly become cluttered which all the photo counts.

**Viewing of the photos for a given route**
When clicking on a route, an image browsing window is opened which displays a thumbnail view of all the images along that route. When selecting one of the thumbnail images, another display window is opened with the full size version of the selected photo.

*Reason:* The users need an easy way of viewing the photos taken on a given route.

*Question raised from this:* Indicating the geographic location of the photos when viewing the photos in the photo browser

**Indicating the geographic location of the photos in the photo browser**
A simplified map and route is displayed in the corner of the display. The current photo’s location is highlighted on the map. This provides an unobtrusive view of the photos, and provides the geographic information.
Reason: The user needs to see the geographic location of the various photos in the photo browser.

Hierarchical menu of locations
A hierarchical menu arranged by continent, country, state/province. Each route is contained under the various hierarchy elements. This allows routes to be selected via menu, and not just on the map

Reason: Some users are not as geographically adept as others. These users will need a means of finding locations which they don’t know the geographic location of.

Session 2

Highlight routes when selecting them
All routes on the map should be indicated in a grayed out way, this would still make them visible, but less prominent. When hovering over a route, that route should become highlighted. This indicates where that particular route goes, and doesn’t cause confusion with overlapping routes

Reason: It is possible that a large number of routes of will have different starting and ending destinations, but they all intersect the same place along their route. This could become confusing when trying to find a route which is tangled with a number of other routes

Rejected Options: Display the routes in different colours. This could still cause confusion because there are only a limited number of colours which are clearly distinguishable from each other.

Menu system
A menu system similar to the one in session 1 was agreed upon. An addition to this was that the menu and map routes be reflective. This means that when hovering over a menu item, the route on the map should high-light, and when hovering over the map, the menu icon should also highlight.

Reason: This form of menu allows for a combination of browsing based on the map, or browsing based on the location hierarchy.

2D/3D system
The option should exist so one may switch between 2D and 3D mode.

Reason: Viewing of routes on a 3-dimensional globe is confusing for some users who are comfortable with a 2-dimensional map.

Indicating the photo location on the map
The location of photos on the map is indicated through the use of media dots, the size of the media dots is based on the number of images in that area.
**Reason:** Photos need to be indicated on the map, but it is not possible for every photo to be represented as a dot. The map would get too cluttered.

**Rejected Options:** Displaying the photo’s locations on the map using different colour dots. The colour will be based on the number of photos. This was not possible because there is not a simple means of conceptually linking the colour spectrum with a representation of the number of photos.

**Rejected Options:** Displaying of the photo locations in a single style and indicate the number of images as a tool tip when the cursor hovers over that point. This is not possible because the user would have to move the cursor along the entire path in order to check how many photos where taken at each point.

**Session 3**

**Search facility must exist**
The user must be able to search for a trip or photo using various different fields, such as place name, keyword, people in the photo, time, and based on a rating system. Using wildcard searches should also be possible.

**Reason:** Users need a way of finding a single photo in a huge corpus of data. Many different users will remember different things about the photo or trip they are search for, therefore different search methods must be available.

**Limit search results returned**
The amount of search results returned should be limited, as to prevent unmanageable amounts of data being presented to the user. The number of search results that can be returned is then limited to a set amount, which can be determined after fully implementing the system.

**Reason:** It would not be possible for the interface to handle abnormally large amounts of data to be displayed. Requesting of huge amounts of data could potentially cause resources issues later in the implementation stage

**Rejected Options:** Limit the amount of searches based on a time interval. This is not possible because the number of information between different time intervals is not uniform.

**Time line filter**
*This feature was not finalized during the design session. Many of the design participants had conflicting ideas about this feature.*

It should be possible for the user to select the starting date and ending date on a time line. The trips and photos which fall outside of the selected dates are not displayed.

**Reason:** This provides the users with an intuitive means to limit the results which they want to be displayed, based on time.
**Social networking**
It should be possible to comment on other people photos and trips, as well as rate them.

**Reason:** Users enjoy community driven content and social networking systems. They required a means of commenting on the photos and trips posted by other users of the system.

### 3.3. Implementation
In this iteration, no high fidelity implementation was required. Images of the final paper prototype are displayed below, together with a description of the various interface components.

![Figure 4. Main display paper prototype](image)
The main display (figure 1) consists of a large map display, with a menu panel on the left side. The map display indicates all the routes and media dots. This can be seen more clearly in the zoomed-in display (figure 2).

The menu panel contains four submenu options: My trips, places, search and filter. The prototype of these submenus can be seen in figure 3.
My trips:

This option displays all the trips that you have uploaded, and they are arranged hierarchically based on continent, country, and province/state.

Places:

This option displays all the trips that you and others have uploaded, and they are arranged in the same hierarchical way as “My trips”

Search:

This allows the user to search for a trip or photo based on any of the above discussed metadata, such as time or location.

Filter:

The filter menu allows for only specified trips and photos to be displayed. The filter is selected based on time only.

Figure 7. Photo Browser

A photo browser interface was also designed (figure 4). This was displayed when selecting a route on the map, or selecting a media dot on the map. A film strip style thumbnail browsers is displayed at the bottom of the window. A large version of the selected image is displayed above the film strip. A small, simplified map is displayed in the top right of the display. A comments window is displayed on the right side, below the simplified map.
3.4. Evaluation
The aim of this evaluation was to provide rapid feedback of the design ideas and ensure that no user requirements had been overlooked. Due to the participator nature of the design of this prototype, a non-user based evaluation was used. The evaluation was performed by testing the interface functionality against scenarios based on personas. The personas used are described in the design chapter. A scenario was created for each of the personas. These scenarios represented the typical activities of that the persona was expected to perform with the system.

Evaluations found that the interface was satisfactory and all the expected user requirements had been catered for.

3.5. Lessons learned
A great deal of knowledge about participatory design was gained during this iteration. The benefits of user-centered design were also made very clear. By involving the users in the initial design phase of the interface, many features were identified which would have otherwise been overlooked. It was also clear the user of low-fidelity materials provided an effective and efficient means of expressing ideas between design participants.
4. Iteration two: High Fidelity Prototype Version 1

4.1. Introduction
The aim of this prototype was to produce a high fidelity prototype based the previous low fidelity prototype. This iteration was the first of our high fidelity prototypes. A high fidelity prototype is a prototype which resembles the final product [2]. In this iteration, the first of the three interfaces was to be developed.

4.2. Design
Due to no implementation constraints being considered during the initial paper prototype design, the requirements were greater than what could be implemented within the allotted development time. Because of this, a subset of the requirements would be implemented. The decision of what functionality would not be implemented was based on how central the function was to the system’s overall use. The following features were removed from the requirements:

- Hierarchical menu of locations: this feature was not vital to the functioning of the system. The removal of this feature was not expected to impede the user.
- Searching and filtering of images: this feature was seen as a non-vital component which is left for future development. However, searching of entries based on users will be developed.

It was also decided that the system would be an internet based interface. This would allow for users to gain easy access using existing web browsers. No additional software installation would be required.

Analysis of the paper prototype identified three major interfaces which were required:

1. An interface which allowed for browsing of photographs and their metadata.
2. A map based interface which indicated where photos were taken on a map.
3. A map based interface to display where a sequence of photos were taken for a single journey.

The viewing of journeys was the most novel and unexplored of the three interfaces, it was therefore prototyped first. The key design goal for this interface was to provide the user with a clear indication of the journey that was taken. This goal drew from two of the requirements identified in the previous iteration: displaying routes on the map and indicating the geographic location of the photos. Both of these were required in order to communicate the metaphor of a journey and not just a group of geo-tagged images.

The journey viewer would display a single journey at a time. This decision was based on concerns that the display would become too cluttered.

The layout of the journey viewer was the same as the paper prototypes main display. This consisted of a large interactive map covering the entire interface. There was a collapsible menu sidebar which would overlay the left side of the map. Due to the removal of the searching, filtering and location menus, the menu was designed to contain only those journey entries which are part of the journey. Each of the
journey entries consisted of the photograph and its associate title and description. These metadata were decided on in the previous iteration. The journey entries would also have an associated “Go to this location” link, which would align the entry’s associated media dot in the centre of the display.

The reflection between menu items and the map was identified as an important interface design. This feature was stressed by the previous iterations’ participants. It was required that when a photo location, represented by a media dot, was hovered over, the associated journey entry would highlight and visa versa. The highlighting of the media dots was done by turning the dots from a dark red to an animated glowing bright red. The highlighting of the journey entries in the sidebar was achieved by changing the photo and text from translucent, through which you could see the map, to opaque. This ensured that the conceptual link between the menu and the media dots on the map was made clear.

The design of the map controls for the interface was not changed. The controls remained the default Microsoft Virtual Earth controls, besides the ability to click on the media dots overlaid on the map. When clicking on a media dot, the associated photo is displayed in the photo viewing interface.

4.3. Implementation
This prototype was created purely to look like the final product. It was fully client-side, and had no server requirements other than the Virtual Earth server. All of the journey data was hardcoded into the prototype. A screenshot of the prototype can be seen below.

![Journey Browser](image.png)

Figure 8. Journey Browser
Figure 1 clearly shows the layout of the interface with the large map and the collapsible menu on the left. The media dots indicating the location of photos are shown as red dots on the map. The path showing the route followed is indicated by a blue line between the media dots.

The photo viewer had not yet been implemented. When the user selected either an image from the menu sidebar or a media dot on the map, a popup window would be displayed to indicate that a journey entry was selected. Another feature which was not implemented as planned was the 3D functionality. The 3D view did not support the event driven functionality which was vital to the implementation of Virtual Postcards. This problem may be due to Microsoft Virtual Earth SDK being a beta version. The problem of the 3D view did not negatively impact the system and will not impact future evaluations.

4.4. Evaluation

The aim of this evaluation was to determine how users would interpret the interface, given their existing ideas of how interfaces should work. In order to get an understanding of this, conceptual model extraction was used. This involved showing the user an image of the interface. They were then asked what they thought the interface components various were used for. The users were asked questions such as “What do you think the red dots on the map are for?”, “What do you think will happen if you hover over or click on them?”

After the conceptual model extraction, the users were given the interface and asked to perform a number of tasks. During this task based evaluation, the participants were asked to verbalize what they are thinking. The tasks which were performed were designed to get the user to interact with as much of the interface as possible. The tasks included finding the geographic location of a photograph which was described to the user, and describing the first and last photograph of the journey.

From these evaluations, a number of problems were found with the interface. These problems are described below:

- The participants found that there was no way of identifying where the journey started or ended. All of the media dots were the same. The only way to determine where the journey started or finished was to hover over the first or last journey entry in the side bar, and find the associated highlighted media dot.

- Participants became confused and frustrated when hovering over a media dot representing a travel entry which was not currently being displayed by the sidebar. The sidebar can only display three full travel entries at a time. When hovering over a media dot representing one of those travel entries currently in the display, the entry would become highlighted. This can be seen in figure 1 where the first entry is highlighted. When hovering over the media dot representing a travel entry which is not being displayed, no highlighting is seen. This makes it unclear as to which entry the media dot is associated with. Users would have to alternately scroll down the list of journey entries and hover over the media dot in order to find the dots’ associated entry.

- The highlighting of the media dots was not initially clear to the participants. Most of the participants stated the highlighting was not gripping enough.
During the conceptual model extraction, users were interested in temporal information of the journey entries. This was not displayed on the interface.

The “go to this location” link was confusing to the users. They were unsure of its function. This link was located under each of the journey entries on the menu sidebar. When clicking on it, the map would pan so that the media dot associated to that entry would be displayed in the centre of the map.

During the conceptual model extraction, a number of participants did not notice the collapse/expand button on the sidebar. A large majority of the users correctly identified the buttons function. They also stated that they would have preferred if it was less subtle.

When performing the task based evaluations, the participants stated that the display was not very welcoming. They suggested that a context or welcome message be displayed.

Users were confused by the “Journey browser” title for the interface. Many of the participants mentioned that the title suggested that they were browsing through a number of journeys, rather than viewing a single journey.

An effort to solve these problems will be made in the design of the next iteration.

4.5. Lessons learned
Many lessons were learned about the importance of user evaluation. The inclusion of users in the evaluation process allowed for realistic feedback. A major lesson learned was that conceptual model extraction gives very effective feedback on those features which are easily taken for granted. A practical lesson which was also learned was the skill of observing users – it was difficult to encourage the users to think aloud during the evaluations and to say what they are doing.
5. **Iteration three: High Fidelity Prototype Version 2**

5.1. **Introduction**
The aim of the third iteration was to resolve some of the problems with the journey browser interface and to develop the second of the three required interfaces. The second interface was also a Virtual Earth map-based interface.

5.2. **Design**
The design phase for this iteration consisted of two parts: refining of the journey browser interface and designing the second map-based interface.

To prevent the propagation of design errors from the journey browser to the new interfaces, the journey browser interface was refined before designing the second interface. The design changes made to the journey browser were based on the evaluation of the previous iteration. These changes are described below:

In order to clearly indicate where the journey started and ended, it was decided that icons be used. These icons would be positioned next to the first and last media dots of the journey. The design of these icons was left for the next iteration.

One of the major design issues with the previous iteration was the highlighting of the travel entries in the menu sidebar. This problem occurred whenever a user hovered over a media dot associated to a journey entry which wasn’t in the display area of the sidebar. To prevent this problem, the sidebar would need to scroll to the appropriate journey entry when hovering over the associate media dot. This would allow for the correct journey entry to be displayed when ever hovering over its associated media dot.

The highlighting of both the media dots and the journey entries needed to be changed as to be more noticeable. The journey entry highlighting was altered such that a white boarder was placed around the photo. This boarder would turn dark red when hovering over the photo. The “go to this location” link was also altered to have a red background when hovering over it. It was undecided at this time about what should be done to improve the highlighting of the media dots.

The journey entries were also altered such that they contained more than just the title and description. Date, time and geographic position details were also added to these entries.

The “go to this location” link was changed to “center map on this location”. This was done with the aim of making its function more obvious to the user. The collapse/expand button on the edge of the sidebar was also altered. This was changed to be a red colour. The aim of this change was to make it more noticeable to the user.

The Journey browser was renamed to Journey viewer. This was done as “Journey viewer” is more indicative of its function.
Based on the requirements determined during the second iteration, a map based interface which indicates where photos were taken on a map was required. This interface is similar to the journey viewer in that they are both map-based interfaces. The major difference between the interfaces is that the second interface will be used for exploring or browsing of journey entries only. These entries will not be joined to other entries of the same journeys. The interface will also display all the entries of all the journeys, not only those entries from a single journey. Due to the explorative function of the interface, it was called the “Explorer”.

The single most important design concern for the Explorer was that it was required to represent potentially enormous quantities of data. In order to make the interface as easy to use as possible, it was important that it remains uncluttered even while representing large amounts of data.

The design for the explorer was based on the decisions made during the initial paper prototyping. The Explorer was designed as a full screen map-based interface which allowed users to explore the world journey entries.

Media dots were used to represent journey entries in a similar way to the Journey Viewer. To prevent clutter and confusion, the media dots were hidden from the user until they zoomed to within a reasonable distance of them. This ensured that too many media dots are displayed at once. Hardware resources also limited the number of media dots which could be displayed at once.

The media dots used in the Explorer had added functionality over those used in the Journey viewer. The explorer media dots were able to represent more than one journey entry at a time. This is done by using varying size media dots to represent a number of journey entries posted at a certain location. Large media dots were used to represent a large number of entries at one location, whilst the smallest media dots were used to represent a single entry. The media dot designs were originally conceived during the paper prototyping of iteration one.

Media dots are considered to indicate the number of entries which are located under it. When zooming out, the resolution of the map would result in the media dots moving towards each other. When the dots moved close enough, they would need to merge to form a single larger media dot. The opposite would occur when zooming in. When zooming in, the media dots would move further apart. In the case of a large media dot representing a large number of entries, they would separate into multiple smaller media dots when zooming in on it. When hovering over a media dot, the number of entries represented is displayed in a tooltip-like display above it.

When clicking on one of the media dots, a translucent overlay is displayed which contains a thumbnail view of all the travel entries. The entries are displayed in the form of a thumbnail image, entry title and a description. A “View Journey” link is also displayed under each of the journey entries.

When hovering over the thumbnail image, the border would change to a red colour and the cursor would change. This is the same behavior as hovering over images in the Journey Browser thumbnails. When clicking on the image, as with the clicking of images in the Journey Browser, the user would be taken to a photograph browsing interface. This interface is the last of the three interface and still needs
to be designed and developed. The “View Journey” link would open the associated journey in the Journey Viewer. This would facilitate the interaction between the two interfaces.

5.3. Implementation
Due to the time constraint for the implementation of this iteration, only a small portion of the design changes were made to the Journey Viewer. However, the Explorer prototype was implemented in its entirety according to the above mentioned design specifications.

Like the Journey Viewer, the Explorer was a client-side application with no server back-end. Again the prototype was designed to look like the final product, but very little of the final system technologies were used. All of the journey entries were hardcoded into the system.

An image of the initial screen of the Explorer can be seen below (Figure 1)

![Explorer](image)

*Figure 9. Explorer*

Figure 1 indicates how none of the media dots are displayed until zooming in on the desired area. In this implementation all the data was hard coded into the system. Only a small amount of sample data was used, which was positioned in the Cape Town area.

When zooming in, the media dots are clearly visible. In the case below (Figure 2), 6 entries are located under the larger media dot, and a single entry under the other smaller media dot. The media dots were implemented such that three sizes were used.
When selecting one the media dots, the translucent journey entry viewing overlay is displayed. As mention in the design section, this overlay displays a thumbnail view of the journey entry images along with the entry title and description. A screenshot of the overlay is displayed below (Figure 3)
By clicking on the View journey button in the entry overlay, the associated journey would be opened in the journey browser. When hovering over the image thumbnails the white image border would become red. At this stage the photo browser interface had not yet been developed. When clicking on the photo thumbnail a simple message popup would be displayed indicated that this feature is still under development.

This implementation also proved that the design of variable sized media dots was feasible.

5.4. Evaluation
Two major goals were set for this evaluation. The first was to evaluate the users’ reactions and understanding of the novel variable size media dot concept. The second was to evaluate how the users would interact with the intertwined use of both the Explorer and Journey Viewer. Hard coded test data was used for these evaluations. The test data was all situated near the Cape Town area.

Even though the concept of map-based interfaces is novel, the cognitive model of navigating using a map is well understood and intuitive to the user. This is what makes the map interface so simple for the user to understand and use.

Media dots are a completely new concept and users have no previous cognitive model to base the concept on. Because of this, the benefit of media dots needs to be weighed against the effort required to learn how to use them. This balance is essential in the design of a usable interface which also provides strong functionality.

To understand how users first interpreted media dots, conceptual model extraction was utilized. Users were shown a screenshot of the Explorer interface where two different size media dots were being displayed. This was very similar to that shown in figure 2, but without the tool tip indicating the number of photos. The users were asked to explain what they thought the dots were for, and why they were different sizes. A large majority of the participants understood that more journey entries were located under the larger media dot. The participants were then asked what they thought should happen when zooming in or out. A large majority of the participants stated that the media dots would remain visible, and their size would remain relative to the zoom level. The other participants agreed that size of the media dots would stay relative to the zoom level when zooming in. When zooming out, they believed that the media dots would no longer be visible. These results suggest that for a large majority of users, the merging and separating behavior of the media is unexpected.

The next step of the media dot evaluation was to allow the users to interact with the system. A task based evaluation was used once again. The aim of this evaluation was to determine how the users grasped the concept of media dots while interacting with them. The participants where given the interface at its initial state (Figure 1). It was explained to them that some journey entries were located in the Cape Town area. They were then asked to perform tasks which required them to interact with the interface. These tasks included determining how many entries were located in the entire Cape Town area and describing where each of the entries was located. It must be noted that none of the users had trouble using the map controls to zoom. During this evaluation, it was clear the users where having a moment of realization about how the media dots function. This was made clear by their comments, such
as “Ah, that makes sense!” and “...I see what’s happening”. To verify that these observations were correct, very short post-evaluation interviews were held with the participants. They were asked what they thought of the media dot concept. They were also asked to explain in their own words how the media dots function. These interviews further confirmed that the concept was understood.

The last part of this evaluation was to determine how the users would interact with and understand the intertwined use of both the Explorer and Journey Viewer. This was done simply to check if the logical connection between the Explorer and Journey Viewer made sense to the user. A continuation of the previous task based evaluation was used. After finding the requested journey entry in the Explorer, the user was asked question about the associate journey. Questions such as “Where did the journey start”, “How far into the journey was this entry made” and “Describe the route followed on this journey” were asked. A problem was noticed once again with the “Center on map” link. Many of the users were not noticing or using the link, rather navigating the map and hovering over different media dots until finding the correct one. Users were asked about this behavior as part of the post-evaluation interview. Most of the participants claimed that they did not notice the link. Those participants who did see the link stated that they thought it was static text and not a link.

The results of this evaluation found that users were easily able to move from the Explorer to the Journey Viewer. However it was not possible to return from the Journey Viewer to Explorer. This is a serious design concern which will be resolved in the future iterations. A design concern was also noticed with the Explorers journey entry overlay (Figure 3). Many users stated that they would have preferred it if the journey title was displayed with the journey entries.

A surprising result was also noticed with the collapsing and expanding of the menu side bar in the Journey Viewer interface. Many of the users did not use the feature even though it was made more visible. When asked about it, many stated that it was not needed.

5.5. Lessons learned

From the iteration, it was learned that some design concepts cannot be evaluated until they are fully implemented. This was the case with media dots. The evaluation of these components can only be done when the users are able to fully interact with them. A key lesson was also learned about reusing design ideas through out the system. This can provide a good means of standardizing the various interfaces. This may also result in major design issues if the component being reused is found to be flawed. In the case of the map controls used in both interfaces, this means that the controls need only be learned once. If the controls were not designed correctly, the design issue would have propagated through out the system. A final lesson learned was that some features, such as the “center map on this location” link, require a number of refinements before adequately functioning.
6. Iteration four: High Fidelity Prototype Version 3

6.1. Introduction
The aim of the fourth iteration was to create a prototype of the entire Virtual Postcards system. This would include all three of the interfaces. The technology used would be the same as that intended for the final system. All of the design decisions made in the previous iterations would also be implemented in this prototype. This made the fourth iteration the largest iteration for implementation and the second largest for design.

6.2. Design
The design goals for this iteration were to resolve all of the remaining design flaws from the previous iterations as well as the design of the third interface. A means of linking all three of the interfaces was also needed.

The first goal was to resolve the design issues discovered in the previous iterations. Refinements to the Journey Viewer were dealt with first.

In order for the user to clearly identify the starting and finishing locations of a journey, easily recognizable icons were designed. A green icon of a flag with an “S” on it was used to indicate the starting position. A similar red flag icon with an “F” was used to indicate the finishing position. In order to not confuse the users about the starting and finishing points of the journey containing journey entries, the icons are placed adjacent to the appropriate media dot. This was done opposed to replacing the first and last media dots with the icons. The decision of giving the icons different colours was made, as this makes it easier to differentiate between them.

As noted in an earlier evaluation, the highlighting of the media dots was found to be too subtle. The normal media dots were represented by static red media dots. The highlighted media dots were represented by an animated glowing between red and black. In order to make to the highlighting more noticeable, the difference in colour between the non-highlighted and highlighted media dots needed to be more severe. An initial design idea was made to change the non-highlighted colour to green, the opposite colour to red according to the colour wheel. This choice was quickly rejected as a large portion of the map interface is green. This would have made it very difficult to view the green media dots. A choice of light blue was made as it is clearly different from red and not found on the map interface.

A reoccurring problem found in two previous iterations was the “centre on map” feature found under the journey entries. It was found that users did not see the link as clickable. In order to make the affordance clearly to the user, the link was altered to resemble a clickable button.

A number of design refinements were also made to the Explorer interface. These are given below.

The collapse/expand feature for the menu sidebar was removed. This was removed due to the function not being required by the users. This feature also had a negative impact on the performance of the interface. It was decided that the menu remain static, but in the same location on the interface.
As a result of the previous evaluation, the Explorer’s journey entry overlay was redesigned. Participants of the previous iteration expressed the desire for more Journey context information to be displayed for each of the journey entries. The reason for this was that they were interested in which journey entries were from the same journeys. The photo description for each entry was therefore replaced with information indicating which journey the entry was from.

After refining the previously implemented interfaces, the third and final interface was designed. The purpose of this interface is to allow for users to browse various journey photos and their associated metadata. This was a non-map based interface which provides a means of viewing large versions of the photographs taken on a specific journey. Most of the designs for this interface were decided during the initial iterations. The paper prototype for the interface can be seen in Figure 4 of iteration 1. Due to the viewing and browsing function of this interface, it was labeled the “Photo Browser”.

The key use of Photo Browser is the ability to view large scale versions of the current journey entry photographs. Due to this, the large scale photographs are placed in the centre of the interface. Besides the viewing of large scale journey photographs, the interface required controls to move to the other entries of that journey, view the other metadata associated with the entry and comment on the entry. The designs for these features are explained below. Due to the large amount of display space being taken by the large scale photographs, much effort was made to utilize space efficiently.

During the initial paper prototyping, it was identified that there need be a method of traversing the journey entries in chronological order. It was also decided that a thumbnail image of the previous and next entry images be displayed. This provides context for the current entry. This design was adapted from the film-reel design of the paper prototype. The film-reel thumbnail display was not possible as it would occupy too much screen space. The previous and next entry thumbnails would be displayed on left and right side of the main photograph. A left facing arrow will be placed between the main photograph and the previous entry thumbnail. The same is done with a right facing arrow on the right side with a thumbnail of the forth coming photograph. When displaying the first journey entry, nothing will be displayed to the left of the main image, and the opposite will occur with the last entry. When hovering over any of the main photograph, a tool tip containing the entry title is displayed. When hovering over the thumbnails, a tool tip containing “previous photo:” or “next photo:” followed by the entry title will be shown. When clicking on the thumbnail images, the previous or next journey entry is displayed in the Photo Browser.

The second requirement of the Photo Browser interface was the presentation of metadata. It is required that metadata such as the entry title, description, geographical location, temporal information and comments be displayed. The layout of the metadata was also based on the designs of the paper prototype. The metadata is displayed in a table below the main photograph. The title of the journey entry is displayed below the main photograph. In order to be more noticeable, the title is displayed in a bold font and centered horizontally. This was also done to prevent users from associating the title with the thumbnail on the left of the interface. A sentence describing where and when the photograph was taken is given next. The position is given in the form of latitude and longitude, and the time is given as a
time followed by a date. A “Description” heading is placed below the context information. This is followed by the description of the journey entry.

The final requirement of the Photo browser is the ability to view and post comments for the various journey entries. In the paper prototype designs, the comments panel was placed to the right of the interface. Due to the limited display space, this was not possible. During the paper prototyping stage, issues such as display space are not considered. Designs therefore need be altered to accommodate for the display size. The comments panel was therefore shifted to be displayed under the description. Each of the user comments were framed separately. This was done to clearly distinguish between different comments made by different people. The comment box and “Add comment” button were placed below the list of comments. The facilities to read and add comments were placed close together as to prevent confusion for users wishing to add to previously made comments.

A means of navigating between the three interfaces was also needed. Due to the system being internet based, a website was designed. Both of the map-based interfaces were placed in individual web pages. The Photo Browser interface was also designed as an individual page. Besides the three main interfaces, the site was also required to facilitate social networking.

The goals for the website were to be as simplistic and user friendly as possible. To achieve this simplicity a minimalistic approach was taken. Only those pages which were required for core functioning of the system were added. The site was designed to be viewed at a resolution of 1024x768 pixels. This resolution was chosen as it provided a balance between optimal display space and expected system resources of users.

The first page to be designed was the index page. This page would be presented when opening the Virtual Postcards website. The primary aim of the page was to serve as an introduction to the system. A bold welcome message was placed at the top of the page. This was done to make the system more user-friendly and less intimidating to new users. An introductory paragraph was placed below the welcome message. This stated what the system allows users to do, what is needed to use it and what the user needs to do in order to start using it. To facilitate the social networking features, hyperlinks to register a new user and login were placed in the introduction text. The index page also serves as a starting point for navigating through the system and all the journeys. To make it easy for users to start exploring the various journey entries, a section was added explaining the Explorer. This section also contained a hyperlink to the Explorer. This made it simple for the user to navigate to it. The final section, placed at the bottom of the display, was the “Start now” section. The aim of this section was to allow for users to quickly and easily start using the system. A search facility was placed in this section. This allowed for users to search for other system users in order to view the journeys they have posted. A short explanation of how to use the search was given above the search panel. The search panel took the form of a grey cell with a black border. The grey colouring made the panel more noticeable. The words “Start typing a user name…” followed by a textbox and a “Go” button were placed in the panel. An auto completion feature was also designed to make searching easier for the user. When the user started to enter a username in the textbox a dropdown list would be displayed under the textbox containing a list of possible potential usernames. For example, when entering the letter “A”, all usernames beginning with
the letter “A” would be displayed in the dropdown list. The user could then select the username from the list rather than having to type the entire name. When selecting a username, the selected user’s homepage is displayed. The design of the user homepage is discussed below. The index page is only displayed if the user is not logged in. If a user did not logout from the previous session, when returning to the site, they are presented with their home page.

The social networking aspect of the system was designed such that each user has a personal home page. Two situations exist for viewing home pages: viewing one’s own home page when logged in, and viewing someone else’s homepage. When viewing someone else’s homepage, the foremost purpose is to display the various journeys posted by that user. When viewing your own home page a number of additional administrative features are available. These features allows for the addition of new journeys, editing of current journeys, password administration and sending of invites to friends.

The design of the home page when viewed by other users was as follows. The page consisted of only two sections: Journeys and the Search tool. A two column layout was used with the Journeys section on the left and Search tool on the right. This layout was chosen because of its efficient use of space. The Journey section was placed on the left because of its similarity to the Journey Viewer sidebar, also positioned on the left. The Search tool consisted of a description of the user search mechanism followed by the user search panel. This panel is the same as that used on the index page. The Journeys section contained a short description followed by a list of all the journeys posted by the user. The description states that the journeys listed below were posted by the user and they could be viewed in the journey viewer. If the user has no journeys, a message stating that is displayed.

Each journey listed on the home page is represented with a journey summary. The journey summary consisted of the journey title, start time, start point, end time, end point, a description and a “View journey” link. This was displayed in a way similar to the journey entries in the Journey Viewer sidebar. When clicking on the View journey link, the journey was opened in the Journey Browser.

When viewing one’s own home page, a superset of the components found when viewing other users’ homepages is displayed. The Search tool is the same for both pages. A Password Changer is also displayed on the right of the display, under the Search tool. This consisted of three password boxes, labeled “Old password”, “New password” and “Re-type password”. A button labeled “Change password” was located under the three boxes. A description of the tool was given above it. “Tell a friend” was a feature located below the Password Changer. This allowed users to enter a friend’s email address and they would be invited to use the system. A short description of this feature was displayed above it.

Journey summaries for both home page views are similar, however, owners of the homepage have the option to edit or delete the journey entries. An Edit journey and Delete journey link was placed beneath each of the journey entries. A Journey manager section with an Add journey link was also placed at the bottom of the page. The description below the Journeys section was also altered to indicate that journeys can be deleted or edited. When clicking on Delete journey, a popup was displayed to verify the delete. If verified, the entry was removed. If delete was canceled, the popup would close and no action would be made. This verification window was designed to ensure that no journeys are removed by
accident. When clicking the edit journey or add journey link, the Journey Editor is displayed. This page has the same two column layout as the previous pages. An “Edit your journey” section is placed on the left and “Photo Manager Tool” on the right. The aim of this page was to allow users to edit their existing journeys or to add new ones. If the Edit journey link was selected in home page the page is populated with the existing journey details. If the add journey link was selected in the home page the page contain a blank form.

The “Edit your journey” section allows for users to edit the journey details, such as the journey title and description. The section contains an explanation of what it is for and instructions for how to save changes which are made. It also contains a link to return to the user’s home page. Below this, a simple form containing a text field for the journey title, a text field for the journey description and a “Save details” button. The form elements are all placed in a grey cell with black border, as with other forms in the system.

The “Photo Manager tool” allows for users to edit or add entries to the current journey. This section contains a number of journey entry forms. These forms allow for entry details to be entered. These details are the entry image, the title, latitude, longitude, date, time and description. The form elements are also placed in the cell as with other system forms. If a journey is being edited, a number of these forms are displayed each populated with the details of the current journey entries. A non-populated form is displayed about these forms. This form is labeled “Add a new photo”. It is used for the addition of new entries to the journey. When adding a new entry or editing existing entries, the entries are reordered in descending chronological order.

Besides the addition of new pages, the existing interfaces were placed on web pages. The Journey Viewer interface was placed on a web page. A context message was displayed above the interface. This message added to give the users an indication of the title of the current journey being viewed as well as the journey owner. The title of the journey was displayed in bold font to make it clear to the user. As mentioned in previous iterations, users required a means of returning to the Explorer from the Journey Viewer. A simple instruction to click the photo to view it was also added.

A similar design was used for the Explorer page. The Explorer interface was placed on a web page. A single line message was displayed about the interface. This message stated what the interface was used for. An instruction to zoom in on an area to see the photographs was also added. The user name of the journey owners were also added to the Explorer’s entry overlay. This was done to standardize the entry summary to look like entry summaries of other pages in the system.

The Photo Brower interface was not modified in order to be placed in the website. The only addition made was a single like message similar to the Explorer. This message indicated the name of the current journey being viewed. Links to the Journey Viewer and Explorer interfaces were also added to the message. Due to the addition of the social network facility, the commenting function at the bottom of the Photo Browser was only active if logged in. If not logged in, a message was displayed at the bottom of the interface to indicate that users are required to login before commenting. To make it easier for existing users to login and new users to register, a link was added to the register and login pages.
The penultimate design made during this iteration was the design of common error and success notification messages. The reason for this is the requirement for user feedback. Whenever a user requests a task to be performed, feedback is required. If a request is made by the user, such as the update of entry details or a search, a notification message is displayed at the top of the webpage. The messages are displayed at the top of the page as this is the most clearly visible part of the page. It was also decided that the messages should be colour coded. The success message is green and the fail is red. This was done to allow for very fast interpretation of the message.

The final design decision made for this iteration was the inclusion of a common title bar and colour scheme throughout the system. It was ensured that various page elements throughout the system had the same visual styling and appearance. This was done to prevent the user from being surprised. An effort to make the page layouts as similar as possible was also made. The aim of the title bar was to provide an interface component which remains static throughout the system. The title bar contained a large heading, home link, Explorer link and login components. The heading was the only part which changed regularly, as this would display the title of the current page being viewed. By doing this, it is clear to the user where they are at all times. The Home and Explorer links were added because these pages would be used most often by the users. A link to the Journey Viewer is not possible since a specific journey must be selected to be viewed. The title bar also contained login components. If a user is logged in, the username would be displayed together with a Logout link. This provides a simple means of viewing your login status quickly no matter which page is viewed. If no user is logged in, a login link and register link are displayed. This also provides a simple means to Login or Register no matter where on the system.

One of the major design goals of this system is to make it as easy to use as possible. By attempting to make all the system pages as similar as possible and standardizing the interface components, users are not required to learn a large number of different features. After learning a few of the features, many of the other features should seem simple to use. Common interface layouts also allow for the user to predict where specific functions will be located.

6.3. Implementation
All the design changes mentioned above were implemented. Screen shots of the implementation can be seen below. The resulting prototype for the implementation took the form of a fully functioning website. It contained all the previously designed and prototyped interfaces as well as the administrative pages discussed in the design section. Unlike the previous iterations, this prototype was not completely server independent. A number of servers were required. These included database, application and web servers. Screen shots and descriptions of the implemented system are given below.
The first page displayed when opening the Virtual Postcards system is the index page (Figure 1). Title bar containing the page title is clearly visible in this figure. No one is logged in at this stage, as the login or register links are visible. These are replaced with the username and logout links when someone logs in. A red failure message can be seen at the top of the screenshot. This is the result of searching for a username which does not exist. The username search feature is also visible in this figure. In this instance the letter “a” has been entered, as a result all the usernames starting with that letter are being displayed.

The two screenshots which follow (Figure 2 and 3) illustrate the difference between the home page of the logged-in user and that of another user. The difference in the number of interface features is clear. Figure 2 shows all the administrative tools such as password changing and telling a friend. The links below the journey entries are also evident in figure 2. Even though the interfaces are different, a number of features are the same. The title bar remained the same. Journey listings, search tools and the overall layout do not change.
Figure 13. Home page of logged-in user

Figure 14. Home page of another user
The Journey Editor was one of the more complicated webpages to implement due to the complicated forms. The same two column layout as with the previous pages was used. This form allowed users to upload photographs. Files were selected using a traditional file browsing popup. Input of invalid date and time data was prevented by using dropdown boxes. Data validation was also performed on the latitude and longitude values before storing the data. If the data failed the validation, an error message similar to that in figure 1 is displayed. If the data is added or altered successfully, a green confirmation message is displayed.

The Journey Viewer interface underwent the largest amount of changes since its initial implementation. A screenshot of the interface can be seen in figure 5. The most noticeable is that the interface was placed on a webpage. Another noticeable change is that made to the media dots colour. The start and finish icons were also added. The sidebar was changed to be static. Affordance of the “center on map button” was increased by using buttons rather than hyperlinks. A number of design decisions from previous iterations were also implemented.
The Explorer is the second of the map-based interfaces. Very few implementation changes were made. This interface was also placed on a webpage. Those changes which were made occurred with the
Journey entry overlay (figure 6). The journey entry summaries were changed to display the journey title and owner. In terms of interaction, clicking on the view journey link would open the associated journey in the Journey Viewer. When clicking the entry image, the image and journey would be presented in the Photo Browser.

The Photo Browser (figure 7) was newest of the interfaces, and the only non map-based interface. As can be seen from the screenshot, space was very limited due to the large image display. The current image is displayed as a large image in the centre, with the previous and next images displayed as thumbnails to the sides of the image respectively.

*Figure 18. Photo Browser*

The details of the journey entry (figure 8) were displayed below the main image. As shown, the details section included a commenting feature. This allowed for users to comment on the journey entry when logged in.
6.4. Evaluation

The aim of this evaluation was to evaluate the system in its entirety. A task based evaluation was used. As with the previous iterations the users were asked to think aloud during the evaluation. A simplified form of conceptual model extraction was also used to determine initial reactions to the interface components. The tasks to be performed by the user were geared at evaluating all the interface components and features. When changing between the system’s web pages, the participants were asked to stop and explain what they think the purpose of the page is and whether anything does not make sense to them.

The first task the participants were asked to perform was to read the index page and to explain what they thought the purpose of the system was, and what they should do next in order to use it.

They where then asked register themselves. After receiving the registration email containing their temporary passwords, the users where requested to login. After login, the participants were asked to explain the home page that was being presented to them.

The participants were then told that a friend of theirs, with the user name of Andre, had posted a trip. They were then asked to navigate to Andre’s homepage and find his list of posted journeys. After locating the posted journeys, the participants were asked to open the journey in Journey Viewer. As with the previous pages, a simple conceptual model extraction was performed.

Question related to the journey, such as start and end times and position, were then asked. The participants were then asked to open one of the journey entries in the Photo Browser. Participants were
then asked how they thought one should interact with the interface. Questions such as “How would you move to the next photo?” were asked. When the participants were finished browsing the journey in the Photo Browser, they were asked to open the Explorer. Tasks were then given to find the number of journey posts in a given area.

The evaluation was completed with a post-evaluation interview. Questions were asked to clarify some of the odd interaction behavior noted during the evaluation. The participants were also asked if they found any of the interface features confusing or nonsensical.

The results of the evaluation suggest that the system was well understood and easy to use, however, some minor design refinements were required. The problems encountered are given below:

Many of the users mentioned that the wording of the help messages and tool tips was confusing. They stated that too much ‘technology terminology’ was used.

During the loading time of the map-based pages, users were unsure of what was happening. This was a major interface issue. The user should always be provided with feedback and be aware of what is happening.

When navigating to the Photo Browser and Journey Viewer, participants were unclear of how to return to the previously viewed interfaces.

In terms of the index page, a majority of the participants were unsure of the purpose of the system. When asked about this in the interviews, they mentioned that they did not read the entire page but rather just scanned to get a quick understanding. The index page was also said to be very plain and uninteresting. Some of the participants were initially unsure about the user search function. They interpreted it a location or keyword search.

Minor issues were also identified with the Photo Browser. Entry titles were not being noticed by the participants. The arrows between the main image and the thumbnails were thought to be links to the previous and next entries. When asking the participants to find the description of a journey entry, some of them were not aware that the entry details were located at the bottom of the page. The representation of the entry position was also confusing for some participants.

Only a single problem was identified with the Explorer interface. This problem was found with the journey entry overlay. It was not clear as to which journey entries were part of the same journey and which were posted by the same user.

The final issue discovered involved the new user registration. When a user registered, they are required to enter their email address. A temporary password is then sent to them. During the evaluation, many of the participants stated that they did no feel comfortable entering their address.
6.5. Lessons learned
The first lesson learned from this iteration was that constant refinement and iterative development does lead to a better system. This became clear as the problems found in the evaluation were far less than in previous ones, and were smaller. It was also learned that problems will be found during the evaluation, even when you think the system has been perfectly refined from previous iterations. Redesign time still needs to be allotted even if you think the system is perfect. The importance of having a standardized interface was also made clear. By having a design which is reused throughout the system, the usability and aesthetics are greatly improved.

The final lesson learned was a more negative one. A buffer period should always be planned. This allows for the project to remain on schedule even if something does go wrong. The implementation for this iteration was originally planned at four days. Due to unforeseen problems, it took eight days to complete. Without the buffer period being added early on in the planning, this could have created serious problems.
7. Iteration five: Final Prototype

7.1. Introduction
This was the fifth and final iteration in the development of the Virtual Postcards system. The aim of this iteration was to develop the forth and last high fidelity prototype. No formative evaluation was performed. After this implementation, a large scale experiment and qualitative evaluation will be performed.

7.2. Design
Due to the near flawless designs achieved in the previous iterations, the design phase of this iteration was the shortest. Although fewer design problems were identified in the previous iteration, the refinement of these issues is not as simple or obvious as those in the previous iterations. Most of the design changes made were purely superficial.

The first redesign which was performed was to reword most of the tooltips and help messages. The wording was changed to use almost no technical jargon. Rephrasing was also done so that the use of the interfaces rather than the interface name was used. For example, instead of a tooltip referring to the Explorer, the tooltip would refer to the page which allows you to explore the world map to find other interesting photographs. This change was made with the hope of making the interface more understandable to new users.

To ensure that the users were constantly aware of what was happening with the system, a loading display would be added. This would be presented to user whenever data would load for an extended period of time such as when opening the map-based interfaces. The loading screen would occupy most of the interface, except for the title bar. This was done to prevent users from clicking on other links while another page was loading. The title bar was not covered by the loading screen. Leaving the title bar visible ensured that the loading screen still conformed to the style of the system. The loading screen also needed to be animated. Animation provided feedback to the user that something was still happening and that the system has not frozen.

Besides the rewording of the index page messages, keywords were changed to a bold face font. The layout of this page was also changed. The aim of these changes was to make it easier for the users to identify the key features of the system. The layout was changed to be more compact. A screenshot of the Explorer interface was also added to the page. This was done to make the interface more visually attractive. The user search panel was also changed. The text was changed to display “user name” in bold. The purpose of this change was to make it clearer to the user that a username need be entered.

The Photo Browser interface underwent a number of layout changes. The title of the journey entry was moved to be displayed above the main image. This was done in an attempt to make the title more noticeable. A “Details” link was also placed next to the image title. When the Details link is clicked, the page scrolls down to display the entry details. This link was added with the objective of making clear that further details can be viewed. A change was also made with respect to the user interaction of the
The arrows between the main image and the thumbnails were changed to act as links. This was done because some participants in the previous evaluation presumed they were links to the previous and next journey entries. The arrows would expand when hovering over them and the cursor would become a hand icon. This was done to make the affordance clearer. The last change made to the Photo Browser was the representation of journey entry positions. The location details were changed to make it clear that latitude and longitude values were being represented.

The Explorer overlay required redesign again. Previous evaluations found that users were unclear of which journey entries were part of the same journey and which had the same owner. To make this clearer to the user, the owner’s username was displayed in bold face.

The final design change of the system was made to the registration interface. As mentioned in the previous iteration, users expressed concern when entering their email address. An anti-spam message was thus added to the foot of the interface. This message stated that only a single email will be sent, and that email addresses will be kept confidential.

### 7.3. Implementation

This was the final implementation of the project. All of the above mentioned design changes were made. Screenshots of the implemented interfaces and a description of the changes made are given below.

The first screenshot (figure 1) illustrates newly implemented index page.

![Virtual Postcards](image1)

**Figure 20. Index Page**
The layout is evidently different from the previous iterations index page. The simplified instructions and bold keywords are also evident. The minimized Explorer screenshot was placed in the Explorer section of the page.

Figure 2 illustrates the loading screen which was implemented. An animated “spinner” was used to indicate the system was busy, and it had not become stuck.

![Your Home Page](image)

*Figure 21. Loading Screen*

The interface which underwent the most design changes was the Photo Browser (Figure 3). The entry heading was placed above the main image, together with a link to the details section. The arrows were also changed to have hyperlink functionality. Details of the entry were displayed in a more verbose and simplified way. This can be seen at the bottom of the screenshot. In this figure the page has been scrolled down, and the title bar is not visible. The comments section at the bottom of the page has also been cropped off.
Figure 22. Photo Browser

Minor implementation changes were made to the Explorer interface (figure 4). The journey entry overlay was altered to display the usernames in bold.
The last implementation change was to the user registration page (Figure 5). An Anti-spam message was added to the bottom of the page.

Note: We will only send you one email, containing your username and password. We will not send you any spam whatsoever, and we will keep your email address strictly confidential.
A number of changes were also made to the server side of the system. These are looked at in the report by Anton Eicher.

7.4. Evaluation
No evaluation was performed on this final iteration. A qualitative user experiment was performed which is discussed in the final experiment section of this report.

7.5. Lessons learned
At this stage of development, a number of lessons were learned about the process of iterative development. The first lesson learned was that iterative development is a process which starts at a coarse grain and becomes finer as the processes continues. This is evident by comparing the design changes made in the early iterations and those made towards the final iteration. It was also learned that design problems found in the later iterations are far more subtle than those found in early iterations. The solutions to later problems were found to be equally difficult to identify, but far more challenging to solve.

8. Final Experiment

8.1. Introduction
The design question posed for this project was to develop a system which allows people to share their travel experiences on the internet, and gives them the ability to integrate satellite imagery, camera images and GPS information. Our primary focus was to design and develop an effective, efficient and user friendly interface for browsing of these travel experiences. The aim of the final experiment is to evaluate the final completed system based on these requirements. Due to the system providing such novel functionality, no other available system could be used as a comparison. For this reason, a qualitative approach was taken.

Quantitative research is largely conclusive, while qualitative is explorative. The deliverables for such an exploratory experiment are rich descriptions of the interaction patterns observed. Suggestions are also included as to why these patterns exist. These suggestions are relevant only to the interactions being observed: they are not to be generalized to entire populations.

The experiment which was conducted consisted of a short tutorial of the system. Participants were then asked to answer a series of task based questions. Questions related to the participants’ views of the system were then asked. The experiment was concluded with the administration of the Questionnaire for User Interface Satisfaction [10]. The QUIS is an established questionnaire which provides a recognized scale for the system.

The sections which follow discuss the method used for the experiment, the results and a discussion of the results.
8.2. Method
Details of the method used for the experiment are given below. The participants used are discussed in the sample section. Questionnaires used are discussed under “Equipment and tests used”. Details of how the experiment was conducted are looked at in the evaluation procedure section.

Sample
A population sample representative of the target user group was chosen. The sample consisted of 10 subjects. The age of the subject ranged from 17 to 47 years. Males and females were equally represented. Subject had varied levels of computing, travel and social networking experience. Majority of the participants were students and had regular internet access. In order to make the user evaluations as effective as possible, the users involved in the evaluation were representative of the users expected to use the final system.

Equipment and tests used
A standard desktop personal computer was used. The system was presented using the Firefox internet browser. During the experiment all users were voice recorded. Software was also used to video record the interaction with the interface. The test data used for the final experiment consisted of 103 journey entries grouped into 4 journeys. Three of the journeys were created from real travel data, while the fourth was a fabricated journey. The fabricated journey was used as test data for the early iterations, and used as a tutorial set during the final experiment. Due to the journey entries being fabricated, the users were urged to concentrate on the interface rather than the actual entries. All three of the real journeys posted were very similar. They all started in the Cape Town area. The duration, distance and number of entries made varied between the journeys.

A short form of the Questionnaire for User Interface Satisfaction was used. This questionnaire contained 27 questions separated into 5 sections: Overall reaction to the software, screen, terminology and system information, learning and system capabilities.

Evaluation procedure
A tasked based experiment was used. Participants were trained before performing the tasks. After completing the tasks, users underwent a short interview. Due to the qualitative nature of the experiment, the users were observed while completing the tasks and any interesting behavior was noted. The experiment is concluded with the administration of the QUIS questionnaire.

Before the experiment was started, the purpose of the study was made clear to the users. They were also informed about what information is being collected and that a voice and screen recording would be made. Freedom to withdraw from the experiment was also mentioned.

A brief training tutorial was presented to the participants. During this tutorial, the users would login with a guest account. This was done so that the login procedure could be evaluated during the next part of the experiment. The tutorial lasted for between 7 and 14 minutes. In the time the users were told about the aim of the system and what features it aims to provide. Users were familiarized with the various interfaces by browsing the fabricated journey. As mentioned above, by using fabricated journey
entries which were not realistic the participants could concentrate on the interface rather than the entry
details.

After the tutorial session, the users were asked to register themselves. One of the three available
journeys was randomly selected. These journeys were selected at random to decrease the possibility
that the participant could have gathered information about the journey from previous participants. The
participants were given the username of the user who posted the journey and an identifying description
of the journey. They were then asked to find the trip on the user’s home page. Participants were told
that they may use any of the interfaces or function available to them in order to answer the questions.

9 task based questions were asked in random order. The random order was to decrease any learning
effect. Most of the questions could be answered by using a number of different approaches and
interfaces. All 9 questions are considered to be typical travel related questions and are not aimed at
favoring the interface.

2 interface opinion questions were then asked. These questions were aimed at identifying what features
the users were unclear about or missing. They also aimed to identify which features the subjects felt
were unnecessary or uninteresting.

The final 2 questions of the questionnaire were aimed at understanding the users’ interpretation and
opinion of the journey metaphor used throughout the Virtual Postcards system. The first question asked
the user to describe their overall interpretation of the journey they just viewed. The last question asked
the users to express how our system compares to other methods of sharing travel experiences.

The session was concluded with the subjects completing the 27 item QUIS questionnaire. 4 of the 27
QUIS questions were omitted as the majority of subjects stated the questions were not applicable to the
interface. The QUIS questionnaire can be found in appendix A.

8.3. Results
The behavior and interaction patterns observed during the experiment are given below. These results
have been categorized into major three areas: Understanding and comprehension, Browsing and
navigation, and User opinions.

Understanding and comprehension
One of the most surprising observations made was how much understanding and
comprehension the participants were gaining in such short periods of time. When first opening
the journeys in the Journey Viewer, participants were asked to browser the journey for 5
minutes. After the 5 minutes of browsing, they were asked the 9 travel questions. In most
cases, the participants were able to answer the questions purely from memory. For those
questions which could not be answered from memory, the participants were easily able to
search for the correct answers. This finding could suggest that users are able to get a very clear
understanding of the journeys presented to them in a short period of time.
Another observation which could suggest the system provides a good understanding of the journey is the results of the final 2 opinion questions. All of the participants gave positive responses and stated that they had a clear understanding of the journey which was presented to them. Some participants even stated they felt more understanding then if they travel experience had been presented verbally.

**Browsing and navigation**

A number of interesting observations were made with regards to how users navigate and browser the travel experiences using Virtual Postcards.

One browsing behavior noted was that some participants used the map to navigate journey entries, while other users the entry list in the sidebar. This was observed using the Journey Viewer. Some of the users would navigate the journey by panning the map from one media dot to the next. Once panned to the media dot, the user would hover over it and look at the highlighted journey entry. Some other users would navigate in the completely opposite way. They would select the journey entry from the sidebar and then click the “center on map” button. The same outcome would result from both means of navigating. Very few instances were noted of participants employing a hybrid of navigation styles. These observations could suggest that some users are more comfortable navigating maps than others. A suggestion could then also be made that the interface accommodates for both map and non-map users.

An expected pattern was noticed with regards to the order in which journey entries were viewed. All of the users would start at the beginning of the journey and sequentially explore the entries. This was noticed for both map navigation and non-map navigation.

Another behavior pattern which surprisingly emerged during the experiments was that of people wanting to navigate to points of interest on the map. This occurred during the initial tutorial in which users were introduced to the map based interfaces. When the user had become comfortable with the navigation controls of the system, they would often browse to other points of interest. These other points of interest, such as the house, did not have any journey entries associated with them. The aspect which made this behavior so noteworthy was that when being asked to return to the tutorial journey entries, participants were all easily able to navigate back. This finding could imply that once comfortable with the map interface controls, navigating can be very simple to achieve.

When viewing journeys using the Virtual Postcards system, the same entry details can be viewed in a number of different interfaces. While observing the participants, it was noted that a large majority of the participants would primarily use the Journey Viewer. Even when changing to the Explorer to view other entries in the area or the Photo Browser to view a large scale image, users would continuously utilize the Journey Viewer as their primary interface. These results could suggest that the Journey Browser is a better means of viewing a journey than the other interfaces.
**User Opinion**

Results of the user opinion questions also suggest the interface has met its design goals. The participants were asked to compare traditional methods for sharing travel experiences and the Virtual Postcards system. A number of participants responded to this by commenting on the ability Virtual Postcards has to share the data remotely. Another positive response was that the viewing is controlled by the user and not by the person who traveled. An example of controlled sharing is that of being shown photographs by someone else. You do not have control over how the photographs are viewed.

**The QUIS results**

The purpose of administering the QUIS was to provide scores on a recognized scale. The aim of providing these score was to provide a benchmark for comparison with future systems. Due to the data only providing a benchmark, no significant statistical analysis was done with the results. The results of the questionnaire are presented below (Graph 1). The graph indicates the mean values for each of the sections as well as the standard deviation range of the scores.

![Graph 1. The QUIS Scores](image)

**8.4.Discussion**

The results presented from this experiment were explorative. Although no conclusive evidence can be drawn, a number of observations could suggest that the design goals of developing an effective, efficient and user friendly interface for browsing of these travel experiences have been met.
Besides the positive aspects of the results, potential experimental flaws should also be mentioned. One potential area of dispute is that of sample size. The sample size of 10 is too small to make any generalized comments. These results suggest that future research with a larger sample could be worthwhile. Also the nature of qualitative studies is that results can only be applied to the sample, they can not be generalized to apply to a global population.

Another area of potential argument is that of introspection and self reporting needed by the participants. In the case of the opinion questions, participants were expected to report on their own understanding. This could lead to skewed results as users believe they have a better understanding than they truly do.

In spite of the potential experiment flaws, this experiment was considered a success. This success was based on the following factors:

- The system provided a means of posting travel experiences using photograph, GPS data, satellite imagery and text data.

- The integration of the various forms of data achieved. When the users were presented with the combined data, it was understood and considered to be intuitive.

- Evaluations suggest that all typical travel experience tasks can be achieved with the system.
9. Conclusion

In conclusion, a number of lessons were learned during the development of the Virtual Postcards system. Besides those lessons noted in each of the iteration chapters, the full development of a system on this scale provided the perfect platform to practice many design and evaluation techniques.

In terms of the methodologies used for the system development, the results were surprisingly good. The UCD approach provided for a firm foundation for the iterative process. By involving the users throughout the development, constant evaluation and thus constant system refinement was made possible. The inclusion of users in the evaluation process also provided a means of getting diverse feedback from a number of different users. Without this diversity, it is possible that some problem areas would have been overlooked or other areas would have been over emphasized.

The decision to have five iterations was seen as having a large impact on the design quality of the final system. The large number of iterations allowed for initial iterations to be focused on the overall system details, while later iterations were used for the design of lower level fine system details. This behavior of increasing design granularity was not initially expected, but was considered to indicate design progression.

Many lessons were learned about time and resource management. Initial time estimates allowed for a buffer period in case of unforeseen circumstances. This buffer period had to be used later due to implementation issues which arose in the penultimate iteration.

Another surprise feature emerged during the participatory design sessions. Initial concerns were had that users would not have the inclination to design such a novel system. This concern was removed after the first design session. The users are able to produce far higher quality designs than were expected.

The design question posed for this project was to develop a system which allows people to share their travel experiences on the internet, and gives them the ability to integrate satellite imagery, camera images and GPS information. It is believed this goal was achieved. The experiment results given in section 9 are suggestive that the system developed is easy to learn, user friendly and sufficiently powerful.

Possible future work could be the implementation of a full scale system. This requires more server-side resources and possible optimization of the implementation.

Experimentation could also be continued to further explore how users interact with the system. The results presented in this report are promising, however, due to the small sample size, further research is required before the results may be generalised.
10. References


11. Appendix A: QUIS Questionnaire

OVERALL REACTION TO THE SOFTWARE

<table>
<thead>
<tr>
<th>Rating</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Terrible</td>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>wonderful</td>
</tr>
<tr>
<td>Difficult</td>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>easy</td>
</tr>
<tr>
<td>Frustrating</td>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>satisfying</td>
</tr>
<tr>
<td>Inadequate</td>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>adequate power</td>
</tr>
<tr>
<td>Dull</td>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>stimulating</td>
</tr>
<tr>
<td>Rigid</td>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>flexible</td>
</tr>
</tbody>
</table>

SCREEN

Reading characters on the screen

easy             |   | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | hard           |

Highlighting simplifies task

very much |   | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | not at all      |

Organization of information

very clear |   | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | confusing      |

Sequence of screens

very clear |   | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | confusing      |

TERMINOLOGY AND SYSTEM INFORMATION

Use of terms throughout system

consistent |   | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | inconsistent |

Terminology related to task

always     |   | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | never          |

Position of messages on screen

consistent |   | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | inconsistent   |

Prompts for input

clear      |   | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | confusing      |
Computer informs about its progress
always 0 1 2 3 4 5 6 7 8 9 never NA

Error messages
helpful 0 1 2 3 4 5 6 7 8 9 unhelpful NA

LEARNING
Learning to operate the system
easy 0 1 2 3 4 5 6 7 8 9 difficult NA

Exploring new features by trial and error
easy 0 1 2 3 4 5 6 7 8 9 difficult NA

Remembering names and use of commands
easy 0 1 2 3 4 5 6 7 8 9 difficult NA

Performing tasks is straightforward
always 0 1 2 3 4 5 6 7 8 9 never NA

Help messages on the screen
helpful 0 1 2 3 4 5 6 7 8 9 unhelpful NA

Supplemental reference materials
clear 0 1 2 3 4 5 6 7 8 9 confusing NA

SYSTEM CAPABILITIES
System speed
fast enough 0 1 2 3 4 5 6 7 8 9 too slow NA

System reliability
reliable 0 1 2 3 4 5 6 7 8 9 unreliable NA

System tends to be
quiet 0 1 2 3 4 5 6 7 8 9 noisy NA

Correcting your mistakes
easy 0 1 2 3 4 5 6 7 8 9 difficult NA
Designed for all levels of users

| always | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | never | NA |

List the most negative aspect(s):
1.
2.
3.

List the most positive aspect(s):
1.
2.
3.