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Augmenting the city

- digital context creation

Søren Thorup
Michael Vestergaard
Glen W. Nielsen

Supervisor:
Jesper Kjeldskov

Aalborg University
Department of Computer Science
Selma Lagerlöfs Vej 300
DK-9220 Aalborg Øst
Phone (+45) 96 35 80 80
Fax (+45) 98 35 97 98
http://www.cs.aau.dk/

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Group members:
Glen Würtz Nielsen
Michael Vestergaard
Søren Thorup

Supervisor:
Jesper Kjeldskov

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CHAPTER

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RESUME

This Master Thesis revolves around the theme: “Augmenting the city” and focus on digitally presenting context. The Thesis primarily consists of two papers, the first paper is mainly technical and the second paper takes origin in the experience gained from the first paper and introduces the concept Digital Urban Ambience.

In the first paper we report on how emerging technology in Smartphones can be used to present photos in context, inspired by the spatial information they hold. An application running on an Android Smartphone was created. The application was called PhotoWorld and uses 3D accelerated graphics to explore the possibilities of presenting photos related to the surroundings. A user study was conducted, which were followed by a Grounded Analysis to investigate and concretize any themes or concerns. Our findings show that a presentation of temporal data in context can add a lot to the user experience, but that spatial information can be ambiguous and not necessarily easily understandable. We identified several presentational and conceptional problems. This increased user satisfaction mixed with the identified problems propose interesting challenges for presenting photos in context.

In the second paper we present the term Digital Urban Ambience, directed at context-aware mobile systems in an urban environment, facilitating a user-driven context creation by digitally presenting context rather than trying to adapt to it. An application, called AalborgLive, based on Digital Urban Ambience is implemented and a field evaluation with 58 participants is conducted. We find that AalborgLive is used in a quite spontaneous pattern, which makes for a fast “finger on the pulse” of the surrounding environment, and that interactive dynamic content plays an important role in the user experience. Finally we discuss our experiences with Digital Urban Ambience.

The main contribution of this Thesis is the Digital Urban Ambience concept that can be used to present context by Augmenting the City with digital context creation. An approach to Augmenting the City that in our evaluation received good feedback and

puts more attention on the idea of presenting the context, instead of adapting to it. We find that an understanding of the urban environment as an ever-changing entity is important when using the concept of Digital Urban Ambience, as live data and having interactive means of tuning into the ever-changing content, lays the foundation for a good user experience.

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PREFACE

This Master Thesis has been carried out at the Department of Computer Science, Aalborg University, by a group consisting of three members. Two from Software construction, Glen and Søren, and one from Informatics, Michael. This Thesis contains two papers, the first is mainly a technical paper, which has beeen revised and rewritten. The second paper introduces a new term with basis in the experiences gained in the first paper.

Both papers are written in the SIGCHI conference Publication Format [4], which has been an exciting and challenging task.

We would like to thank our supervisor Jesper Kjeldskov for putting his expertise in this research area at our disposal. Also we would like to thank Mikael B. Skov for reviewing our papers. Additionally we would like to thank all participants involved in our evaluations.

CHAPTER

3

INTRODUCTION

In previous semesters we have been working with the concept of "Augmenting the City", presented by Kjeldskov and Paay [1], with focus on augmenting the city with fiction. A work that e.g. resulted in a paper by Kjeldskov et al. [3], which evaluates a system that is based on location-based storytelling in the urban environment. In our Master Thesis we explore how Augmenting the City can be combined with the features of modern Smartphones like the iPhone and the Android phone. In this regard many interesting aspects can be examined, like: What can the built-in GPS, compass and camera do for the user experience? Does this technology support new possibilities within digital city exploration? Can Augmented Reality empower the experience? There are already a lot of mobile guides found on the market and most of them are primarily made for tourists. We take advantage of the technology that today´s smartphones has to offer and create a concept that is not only interesting to tourists but also locals. Inspired by the constructivistic approach to context, presented by Oulasvirta et al. [2], we strive to present the context, rather than having the system trying to adapt to the context.

Our work primarily consists of two papers, which are based on work done from September 2009 to June 2010. The first paper, "PhotoWorld: Presenting Photos in Context", about presenting photos in context. The second and main paper, "A Finger on the Pulse: Digital Urban Ambience", uses the knowledge gained from the first paper, and introduces the concept Digital Urban Ambience implemented in the application AalborgLive. The two papers both has basis in the term "Augmenting the City", as they are working with enhancing the experience of exploring the city.

The first paper is mainly the foundation for the technical implementation and interaction techniques used in the second paper. The use of 3D graphics and interaction by motion is introduced and evaluated with a mobile application called PhotoWorld, that presents photos to the user in the physical context the photos were taken. The evaluation finds that the users are capable of creating their own interpretation of the

on-screen information and that they find it interesting to explore the urban environment. The second paper builds upon these findings, in the creation and evaluation of the concept "Digital Urban Ambience", by implementing a mobile application called AalborgLive based on Digital Urban Ambience. The application is able to show digital information about the context the user is located in, in the categories places, people and public transportation, inspired by the way PhotoWorld works.

In this paper we present a summary of the two papers, followed by a conclusion of the papers in regards to Augmenting the City. Afterwards each paper in full length is included. In the Appendix we present design and implementation notes, the interview guide and evaluation data. We now introduce the research questions that the two papers seek to answer.

3.1 Research questions

Within the scope of Augmenting the City we have asked two research questions, which are presented below.

3.1.1 Research question 1

The first research question mainly adresses the technical possibilities within the smartphones, which are becoming increasingly popular. There are many examples of systems in HCI that facilitates context exploration, though they are often build on hardware where you have to combine e.g. a PDA and a GPS. As the smartphones are becomming obtainable by more and more people, it is interesting to examine what possibilities there are regarding context exploration when taking advantage of the technology in smartphones.

> How can we use the technology provided in today's smartphones to facilitate context exploration?

3.1.2 Research question 2

Based on the experienced gained and the findings from the first research question, we examine how context exploration, by presenting context, can be applied to Augmenting the City. This research question focuses on a more conceptual understanding of context presentation.

> How can we apply the concept of presenting context to Augmenting the City?

The first question is adressed by the first paper and the second question by the second paper.

CHAPTER

4 ARTICLES

Following are two summaries of the two papers mentioned earlier; “PhotoWorld: Presenting Photos in Context” and “A Finger on the Pulse: Digital Urban Ambience”.

4.1 PhotoWorld: Presenting Photos in Context

This paper introduces a different way of browsing photos in context. There exists several approaches to presenting photos on a mobile screen, and some of the newest involves the phones’ built-in GPS to show photos captured in the same area by other users. By using the spatial information of a photo and the coordinates of the user´s current position, it should be possible to create a visible link between the photo and the context. In this study a mobile application called PhotoWorld was developed, striving to present photos to the user that are taken in the area he is positioned in.

Figure 4.1: Two screenshots of the mobile application PhotoWorld. In the right screenshot the phone is held horizontally. In the left it is held vertically.

PhotoWorld was developed for an Android phone (HTC Hero) and makes use of the phone’s camera, GPS, compass and motion sensor. Screenshots of PhotoWorld can be seen in Figure 4.1 When using the application the phone can be held in two ways. The phone can lay down flat in a hand with the screen facing upwards. This is when the phone is held horizontally. Holding the phone vertically means that the phone is held

like a digital camera in front of the user's face. When the phone is held horizontally a top down view of photos spread out on a black background like a deck of cards is shown on the screen. A red dot is displayed in the center of the screen indicating the user's current position in relation to the photos around him. The photos are located according to where they were originally captured, i.e. the photos surrounding the red dot on the screen are photos taken in the area of the user's current position. When the phone is held vertically all photos will "stand up" and are placed around the user like posters. Instead of looking down at the red dot, the user will now *be* the red dot, looking at the pictures surrounding him. By physically turning around the user can survey the pictures around him. At last the user can take a photo using the built-in camera and watch it being placed among all the other photos in PhotoWorld. To make PhotoWorld work properly the application made use of the phone's GPU to create 3D accelerated graphics. It was necessary to use this technology to create the illusion of rotated photos being placed in a virtual world.

A field study involving 11 participants showed that most of the participants had a hard time grasping the concept of moving in a 3D world of photos. Also the study showed problems when having multiple photos at the same location, as it was hard to distinguish each photo from each other. But despite some user experience problems, the study showed that the participants were able to interpret what they saw in some interesting ways. For instance, because many of the photos in the system were taken along roads and paths, some participants followed these paths of photos as they generated a kind of map. Also some participants decided to contribute to the system by filling out the blank areas, i.e. take photos in the places no photos existed. Additionally the study showed that the participants favored the photos showing something that was not visible all the time. For instance they were impressed by a place where they could "look inside" a closed shop, as a photo was taken at the time the shop was open.

4.2 A Finger on the Pulse: Creating Digital Urban Ambience

The paper introduces the term Digital Urban Ambience, which references the concept of creating an ambience with a digital aspect of the user's context in an urban environment, that facilitates a user driven context creation. The concept is build on a constructivist approach to context where the goal is to present the context instead of adapting to it. To evaluate Digital Urban Ambience a mobile application called AalborgLive was developed. Screenshots from the application can be seen in Figure 4.2. The application was designed to run on all Android phones, and makes use of GPS, compass, motion sensor and camera. AalborgLive attempts to let the user create urban ambience by "applying different lenses" to the city. The lenses can be interpreted as content-filters and will present the user to various aspects of the living city. In AalborgLive three different lenses was implemented. One that shows Places in Aalborg. That is restaurants, cafés and bars. Another shows the bus stops in Aalborg. The last one makes it possible for the user to see the location of his friends. All three lenses can be applied to a map showing the location of the different content. Additionally the user can hold the phone in front of his face like holding a camera using the lenses to present the content on top of the camera input from the phone using Augmented

Reality.

Figure 4.2: Two screenshots of the mobile application AalborgLive. In the right screenshot the phone is held horizontally. In the left it is held vertically.

The application was evaluated with a total number of 58 participants in a field evaluation conducted with a triangulation of three different field studies. One study involved 10 participants who used the phone for half an hour accompanied by a researcher taking notes and asking question. Afterwards the 10 participants were interviewed. The second study involved six participants who lent a phone in a week and were interviewed at the end of the week. The last study involved 42 participants who downloaded the application from Android Market. This study ran in one month. We had contact with four of the 42, as we interviewed each of them twice during this study. Log data was gathered from the phones in the week and month studies.

The field evaluation showed that the application was best suited for users who mostly made spontaneous decisions, as the map shown in the application always shows the surroundings of the user's current position. It showed that dynamic content was important for creating a digital urban ambience, as the lens showing live updates on the busses was very popular. The participants were very satisfied with a rating functionality that was implemented to let them express their opinion of a place. The lens showing the friends received very mixed feedback, but the evaluation showed that it is possible to create something very interesting using a feature like this, because the participants were very good at interpreting what their friends were up to based on the friends' location. During the one hour study Augmented Reality was not used that much. A lot of the participants said that it was cool, but many also pointed out that it was most for fun and not very useful. However the people from the month study used Augmented Reality about a third of the time using the application, which indicates that there is a certain interest for this feature.

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CONCLUSION

This project evolves around the idea of Augmenting the City using digital context creation, which we approached from two different angles. One is from a primarily technical view and the other is a more conceptual view.

Developing PhotoWorld we learned how the technology of today's smartphone could be used to create a virtual world consisting of photos taken by users. The purpose of this study was to become familiar with the technology and see how the interaction forms developed affected the user experience. The evaluation of PhotoWorld spawned interesting findings. One of them showed that most of the participants really did not care for the content of the photos, except for the photos showing something that was not visible at the current time. Some did also interpret the locations of the photos as a pathway, as the photos were taken along a street. The interaction worked well, despite the content was not that interesting to all participants, they liked the combination with the 3D view and top down view, though they would have liked a map such that they could easier find their way around the area.

These findings let us to explore the idea of city exploration by presenting context in greater detail, which created the term Digital Urban Ambience, which was the reasoning for developing AalborgLive. The idea behind AalborgLive was to take the concept of PhotoWorld and make it applicable in an urban context, instead of simply showing photos. AalborgLive consists of a lot more content than PhotoWorld and it was therefore required to implement some kind of content filtering. As we still wanted to keep the idea of the context being presented and not adapted, we did not want automatic content filtering, which is why we invented the lenses metaphor. The field evaluation of AalborgLive showed that the participants was very much into the idea of the lenses, and learned fast how to tune in on the desired content. Combining the possibilities of today's technologies with the concept of presenting data for augmenting the city turned out to be a good approach for creating Digital Urban Ambience, as the field evaluation showed that the participants found the information presented

useful and interesting. Some even said that they would have liked to keep the phone with AalborgLive.

The main contribution of this Thesis is the Digital Urban Ambience concept, that can be used to present context by Augmenting the City with digital context creation. An approach to Augmenting the City that in our evaluation received good feedback and puts more attention on the idea of presenting the context, instead of adapting to it.

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CHAPTER

6

PHOTOWORLD: PRESENTING PHOTOS IN CONTEXT

PhotoWorld: Presenting Photos in Context

Glen Würtz Nielsen
glenwn@cs.aau.dk

Søren Thorup
sthorup@cs.aau.dk

Michael Vestergaard
michalv@cs.aau.dk

Dept. of Computer Science, University of Aalborg
Aalborg, Denmark

ABSTRACT

Using Smartphones to present context in form of user generated photos is a rather unexplored field. We report on how emerging technology in Smartphones can be used to present photos in context, inspired by the spatial information they hold. An application running on an Android Smartphone was created. The application was called *PhotoWorld* and uses 3D accelerated graphics to explore the possibilities of presenting photos related to the surroundings. A user study was conducted, which were followed by a Grounded Analysis to investigate and concretize any themes or concerns. Our findings show that a presentation of temporal data in context can add a lot to the user experience, but that spatial information can be ambiguous and not necessarily easily understandable. We identified several presentational and conceptional problems. This increased user satisfaction mixed with the identified problems propose interesting challenges for presenting photos in context.

Author Keywords

Presenting context, Mobile interaction, Photos in context, Smartphone, GPS, Digital compass

INTRODUCTION

As mobile devices become more technically advanced, several new opportunities for the users to experience new functionality and interaction forms arises. A feature like a built-in camera has in the last 10 years improved to a point where users actually use it as their primary camera. This has been noticed by developers of mobile hardware and mobile applications, and they are at an increasing rate trying to synergize the photo capabilities with the enormous popularity, which services like Facebook and Flickr has seen lately. We are seeing new and improved ways of getting a user's photos posted on these websites, and also new ways of presenting the photos. One of Flickr's main goals for their services is:

> *We want to enable new ways of organizing photos and video.* [9]

This paper is based upon the premise that an increasing number of users are using their mobile phone to take photos of their surroundings. As mentioned by Yoon et al. mobile phones enable people to capture important moments at the right time and place [20]. When it comes to showing these photos on a mobile screen several issues arise. For instance Yoon et al. argue that new sorting algorithms are needed to limit clutter on the screen. We introduce a way of sorting based upon the user's location in context. When a lot of people captures photos in an area, these photos will be a part of the context in this area. By showing the photos captured in the nearby area of the user, we let the mobile phone present context as photos. So contrary to the suggestions given by Yoon et al. about using a sorting algorithm, that intelligently decides what the user should see, we allow the user to decide and explore for him self which pictures that should be shown.

The mapping between what the user sees on the screen and what is happening around him is an intriguing aspect, and is something we delve deeper into. The fact that many photos should be presented, leads to considerations regarding which photos should be displayed. Spatial information about the surroundings in which the photo was captured, can be used as a parameter for choosing which photos to display. We strive to emphasize this in our application. User generated content is an interesting aspect for this application, but it would be very ambiguous, and the application could be just as useful in other situations like Mobile Guides or Historical Walkthrough concepts.

User generated photos all have a unique story in the way they capture a unique moment in time. Even though it might not be something normally considered, latent questions about why, how and when the photographer took the photo is always there. When introducing this perspective into the element of context aware Smartphone's we have a new angle in regards to presenting photos, which to our knowledge, has not been covered in prior research.

This paper introduces an application called *PhotoWorld*, aiming at creating a presentation form that, by using spatial information about each photo, reproduces the visual link between the photo and its context. This may add to the experience of browsing photos in context, compared to browsing photos at home on a desktop computer. The temporal aspects of photos are in this way able to make something invisible visible, for instance photos captured at another day.

The application was tested in a User Study with 11 participants using half an hour strolling around the city of Aalborg. Through interview, questioner and log data, the *PhotoWorld* concept was evaluated regarding how photos can be mapped to the surroundings and how this mapping was perceived by the user.

The remainder of this paper is organized as follows. First we give an account of related work, with description of relevant research literature. Then the implementation is presented before the User Study is described. Consequently the results are described, followed by a discussion. Finally, the conclusions and future work are presented.

RELATED WORK

When creating a mobile application for presenting photos in context, there are important aspects to examine. Following three important aspects are presented: 1) showing and browsing data on a small screen, 2) understanding of context and 3) interaction with a mobile device.

Showing and browsing photos on a mobile device has been subject to several studies. On laptops and home PC's browsing photos is usually done in a grid of thumbnails or a similar way of showing many photos. By selecting a thumbnail the user can see it in a high resolution [2]. This way of browsing photos has been adapted to mobile devices and the small display is one of the biggest hurdles when displaying many photos on a mobile device. Xie et al. observe that browsing photos on a mobile device requires more zooming and scrolling actions to view photos than desktop browsing [19].

When it comes to presenting the photos in context, sorting of the photos is crucial, to prevent flooding of the screen. This sorting can be done by using the information a mobile device can get about the user's location. Several ideas has been evolved by using the GPS location to sort the photos [14, 12]. For instance Effrat et al. developed GeoFoto, which is a mobile system showing the user photos taken at the user's current location [8]. In this way the nearest photos are shown, but the problem with showing all the nearest photos on the small display remains, because location tagged photos are often clumped in areas, like popular places for tourists. GeoFoto lets the user choose a direction, either north, south, east or west, and then only shows the photos in the chosen direction according to the user's current location [8]. This concept has been developed further in a recent poster session [14], where the user chooses between the same four directions, but instead of tapping on the display to choose one direction, the system uses a digital compass to determine the user's orientation.

When presenting photos in context there are mainly two different options, either the system should adapt to the context and find photos that likely has an interest for the user, or the system should present the context. Oulasvirta et al. [15] divides these two approaches into a constructivism and realism based approach to context interpretation. A realism based approach to context tries to interpret and adapt the system to the context and a constructivism based approach presents context, such that the user can create his own interpretation of the context, also reffered to as context-creation. Just-for-us [13] is an example of a system going towards the construcvistic understanding of context and evaluates the idea of making the invisible visible. An idea based on digitally presenting information that is not visible otherwise.

Interacting with a mobile device in context can be done in a number of different ways. In recent years interaction methods using sensors has been developed [1, 4], examples are the touch screen and the accelerometer. These can be used to improve the user experience of the interface, but some interactions may be too complex or ambiguous to solve using these sensors, as can be seen on the prototype developed by Hinckley et al. [11]. It is important to consider which types of interactions are viable by using sensors. In 3D games the interaction has been improved by using the accelerometer on mobile devices. This has for instance been done in a 3D multiplayer space game developed by Chehimi et al. [4]. This has been accomplished by mapping the physical actions of the user, and the way the mobile device interprets these actions. When you play the game and tilt the mobile device to the right the spaceship turns right. Their evaluation showed a contribution to the user experience in a very positive way [4]. Creating a relation between the physical actions of the user and the way the system interprets and reacts according to these actions, can hereby have a positive effect on the mapping between the user's actions and an application.

PRESENTING PHOTOS IN CONTEXT: PHOTOWORLD

PhotoWorld strives to present the context in the form of photos, by using the spatial information of the photos. The application focuses on creating a clear mapping between the surroundings and the photos in the system, by using position and orientation of the photos. A working prototype was implemented, which later made it possible to test the perception and understanding of this mapping. Furthermore we would be able to test how the user would react towards this new way of browsing photos.

Preliminary brainstorming sessions lead to two different photo representations for the application. The application therefore consists of two different presentation views, which are referenced: "Panorama View" and "Compass View". The two presentation views have different ways of presenting photos seen on Figure 1 found on the next page. When the user holds the device in front of him like a camera the Panorama View is activated and will let the user look into a 3D world where the photos are placed around him like posters. When the user holds the device flat down in his hands the Compass View is shown and presents the user to a top-down view of the photos, scattered like a deck of cards on a table. The Panorama View and Compass View will be presented in greater detail in the following sections.

The application was implemented on a HTC Hero Smartphone using the Android 1.5 platform. The device has a screen with a resolution of 320x480 and hardware accelerated 3D graphics using OpenGL ES. Interaction with the device mainly takes place via a capacitive touch screen and a

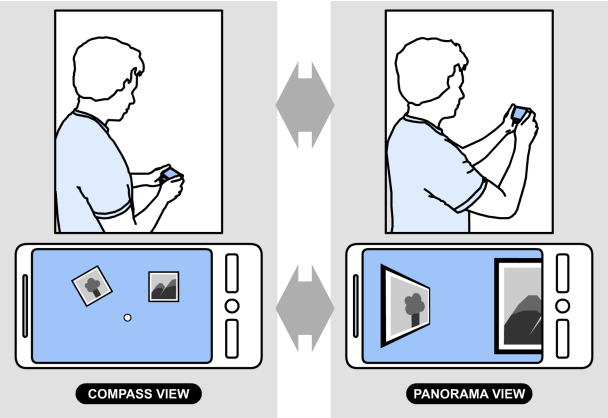

Figure 1. The user can switch between Panorama View and Compass View by moving the device from a horizontal position to vertical a position.

series of hardware buttons at the bottom. Furthermore it features a GPS, accelerometer, 5MP camera and digital compass. Programming for the device was done in Java by using Eclipse IDE paired with the official Android API and plugins.

Panorama View

In this view the user can watch the photos up close. A concept drawing of this view can be seen on Figure 2, which illustrates how the photos are displayed, corresponding to his facing direction. This is inspired by elements from 3D gaming, which implies an implementation of standard 3D camera rules with perspective projection. Perspective projection makes distant photos smaller than photos only a few meters away, and it gives a perception of depth on the screen by skewing the elements.

As seen in Figure 2 the photo of a tree is skewed inwards. This is done to simulate the fact that the photo is taken from a different angle than the user is facing. The user will have to walk more to the right to look straight at the photo. Another photo is represented smaller in the Panorama View, since its real world placement is further away. In the bottom of Figure 2 the user has made a 90 degree turn to the right. He is now seeing the house photo un-skewed, since he is standing right in front of its original creation direction. The other photos have disappeared, which is caused by another element inspired by 3D gaming, the Frustum [17]. It is often used in 3D graphic engines to determine what needs to be drawn and what can be culled. Therefore the user has to turn around himself when using the Panorama View, to see all photos around him. This view will create a virtual illusion of posters placed around the user.

To show the photos in the same direction as they were taken, rotation in 3D was chosen to simulate the angle from the user's position to the angle the photo was taken in. This spawned new issues, like the consideration of what should be done with photos that were taken from the opposite direction of the user. A figure sketching this concern can be

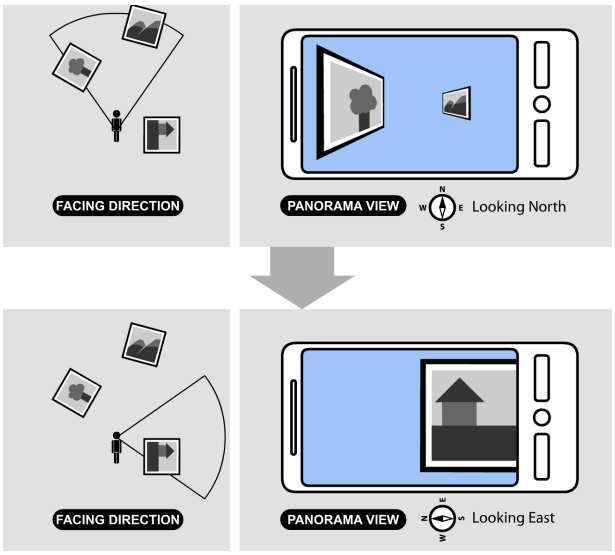

Figure 2. Concept drawing of the Panorama View which illustrates a change in screen content based on the direction the user is looking.

seen in Figure 3. In the figure we can see how the middle photo of a house is not shown in Panorama View, because the photo of the house is taken from the opposite direction of the viewer. When viewing the photo of the house in 3D, the user would see the backside of the photo. A possible solution could be to make the back side white as a paper photo would be, but that solution could potentially block the user's view. Therefore, if the angle between the user and the photo becomes too great it will simply be removed. Users are therefore only able to see photos taken in approximately the same direction they are facing.

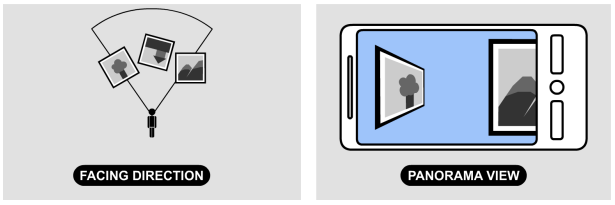

Figure 3. Concept drawing of photos disappearing when switching between Compass View and Panorama View.

The Panorama View is implemented by placing the photos in a 3D space with positions and relative directions, resembling how the photos were taken, as seen in Figure 4. The maximum view depth is set to what corresponds to 200 meters, so that photos taken more than 200 meters from the user's location will not be visible. Furthermore, only photos taken within a 40 degree angle from the direction the user is looking will be fully visible.When the angle is between 40 degrees and 60 degrees, the photos are gradually fading more and more out, until they finally become completely invisible. This sorting is needed to ensure fluent performance on the limited hardware of the Smartphone.

Figure 4. Screenshot of the Panorama View showing three photos from central Aalborg.

Compass View

This view would hopefully be familiar to the user, since it was inspired by Google Maps and other top-down 2D maps. Another incentive for making this view was based upon the need of a better overview of the photos, in contrast to the Panorama View. It was found that large amounts of photos required some sort of presentation that could guide the user to the right photo and location.

This analogy to a compass is illustrated on Figure 5, where a rotation from North to East is shown. The drawing shows how we represent the user's position in the center of the screen, illustrated by a small circle. The photos are then placed around the center, based on their individual geographical position in proportion to the user. The center circle is always fixed on the screen, but the photos will move around this fixed point and get closer as the user moves towards their position. The lower part of Figure 5 illustrates a person looking due North who is then turning 90 degrees to his right, just as we showed in the prior section about the Panorama View. As can be seen in the figure, the photos would turn around the person to represent their position in the plane according to his new orientation. The photo of a tree that was in front of him when looking North is now on his left.

Like the Panorama View, the photo direction also needs to be represented, so it is possible for the user to understand the direction in which the photo is taken when searching for a photo. This feature can also be seen in Figure 5, where the bottom of the tree photo is still pointing towards the user even after the user turned East. While implementing the Compass view, it became obvious that the photos could get very small, so a zoom feature was designed, which zooms in directly at the center point and the user's location.

In the implementation of the Compass view, the planes with the photos are made orthogonal and placed on a plane, and rotated to match the direction in which the photos were taken, as seen in Figure 6. This makes the compass view look two-dimensional like a map, even though 3D was used.

Interaction

It was important to make the user interaction simple and intuitive. This meant finding a way to move away from standard button pushing, as more smooth seamless interaction

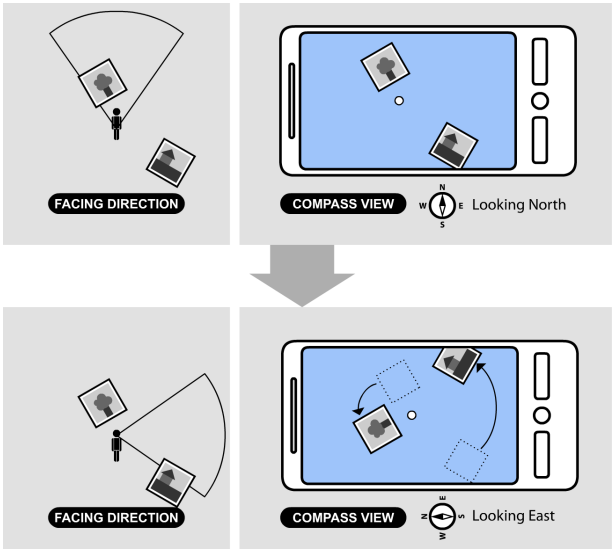

Figure 5. Concept drawing of the Compass View showing the user making a 90 degree turn.

Figure 6. Screenshot of the Compass View showing a series of photos from central Aalborg.

would fit the concept better. For that reason we chose to use the user's positioning of the device and movement as the main interaction form and thereby relieving the user from a any GUI interaction. The main interaction form for the user will be the transition between the two views. Inspired by Cho et al. where they use a tilting phone to browse photos [6], it was decided to use tilting to switch from Compass to Panorama view. This is done by the user by raising his arm and moving the phone up in front of him. A drawing of this interaction can be seen in Figure 1. The Compass View is shown as long as the phone is held horizontally, as it can be seen on the drawing. When the user moves the phone to the vertical position the view will automatically change without any further input from the user, which is done by registering input from the device's accelerometer. The goal is that this form of interaction will be intuitive and not obstruct the user in his use of the two views.

The application makes it possible for the user to take photos of places they feel is important and wants others to see. A way to instantly create content to the system would create a nice synergy to the general concept of user-generated con-

tent. Furthermore the zoom feature for the Compass view was designed and implemented, as prior mentioned, and is done by sliding the finger up and down on the touch sensitive screen of the device, just like zooming normally works on newer touchscreen phones.

Technical Issues

To technically solve the issue of presenting photos as a part of the context, data about where each photo was taken and in which direction, was saved by our application in an XML file. By using the device's GPS and compass data, the photos' direction and distance from the user at any given time could then be calculated, and translated to relative positions on the screen of the device.

The compass was however rather sensitive to magnetic materials, like a pair of keys and metal buttons on a coat, which would cause inaccuracy. To compensate for this, smoothing the input by using interpolation and by calculating an average value from 10 measurements was implemented. It makes reaction time to directional changes a little slower, but more smooth with less flickering caused by inaccurate measures. Quite some time was spend tweaking variables and code for the compass to create a good user experience.

To display the photos on the screen, OpenGL ES graphics API was used for both the Compass and Panorama View, by mapping the photos as textures on 3D planes. The application is designed to work when the device is held sideways in order to make as many photos as possible viewable in the Panorama View.

The result of the implementation described in this section, was a fully functional application, which made it possible to test and evaluate the ideas in the same way they are described here. The user can use and interact with the system in the way it was designed, without having to imagine the feel and functionality of the application, like if it was faked by using for example mockups, sketches or a wizard of oz system.

USER STUDY

The purpose of this study was to understand and explore the possibilities of presenting context in the form of photos, via *PhotoWorld*. As suggested by Göger and Myrhaug [10], it is essential to ensure a context match between the study and the application use. This includes things like documenting results in the situation and the context at the specific moment. Göger and Myrhaug also suggest that relevant tasks are given to the user, but since the application is focused on presentation of data in a free roaming environment, it was not found relevant for the test of *PhotoWorld* to do such tasks. Furthermore the test would focus on use patterns, so dictating tasks to the participants use would contradict the purpose. The inspiration came from the approach presented by Chin and Salomaa [5], where an open ended User Study, allowing the users to walk around freely and experience the device, is used.

Göger and Myrhaug [10] stress how important choosing the right participants is. Based on the stage of the development different participants could be relevant. During early development "Expert Walkthoughs" would be a valid approach since this early prototype would be very unstable. These Walkthroughs were conducted by ourselves, since we constantly made iterative builds of the application and tested it.

Before starting the actual User Study, two pilot studies were conducted to evaluate the testing frame, improve any obvious errors, and get some experience as testers. This lead us to identify and correct a critical error in the application, that could make it close unexpectedly. Furthermore the wordings of the questioner questions were improved to remove some ambiguity that was found.

Setting

A large amount of user generated photos for our User Study was needed, and considering our in-depth knowledge of the system, we decided to recruit external people to take photos. Four people were recruited to take a series of photos within a designated area of the city. The area selected can be seen in Figure 7, and covers most of the center of Aalborg.

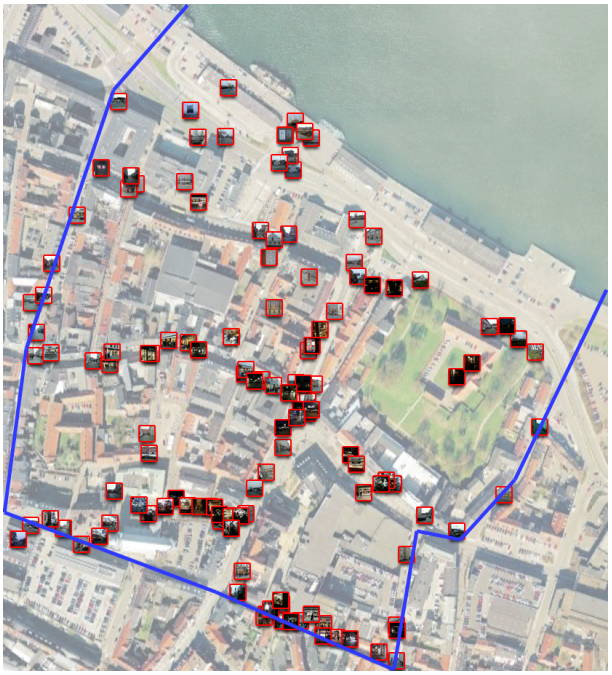

Figure 7. Map of our test area including photos taken by our recruits.

Photos from Facebook or something similar could have been used, but since photos holding information of direction and position were needed, it was necessary to take new photos. These four photographers were given their own starting point and was asked to take 40 to 50 photos of the area. They received no further instruction besides a guide on how to take a photo. 150 photos from central Aalborg were taken by our four recruits. After the photos were taken, all duplicates or out-of-focus photos were removed, as handling such photos is beyond the scope of this study. In total 135 photos were used in the User Study. After each test the photos taken by the participant were saved and then removed from the phone

to ensure that all participants experienced *PhotoWorld* in the same way.

Participants

Eleven people with limited prior knowledge of Aalborg city participated in our study - four females and seven males. Three of them were exchange students who just moved to Aalborg from Iran two months earlier, two of them were visitors from southern Denmark, and the rest were students who just started at the University. About half of these students were still living outside Aalborg. The participants were between 19 and 50 years of age, with the major part in the early twenties. Their experience with using a phone with touch screen and using the built-in camera was very mixed. The younger male participants in general had a greater experience with the Smartphone elements than the females had.

Procedure

The User Study itself consisted of several elements. First the participants was given a textual introduction, which described the setting and what was expected of them. Following this general introduction they were introduced to the application running on the Smartphone, by the test leader. The participants were shown the different views, how to switch between them, how to zoom, and a short explanation on how the photos would appear as they walked around. The participants were then encouraged to just freely walk around and explore the possibilities of the program. During the test each participant were followed by a test leader and an observer. The observer was in charge of taking notes of relevant events while the test leader was in charge of trying to make the participant think aloud and help if there was a problem. The participant constantly interacted with the test leader, who asked questions and probed the participant to "think aloud". After the test, which took approximately 30 minutes, the participant was asked to fill out a questioner. Lastly, the test leader conducted a semi-structured interview, and the observer asked questions to clarify any interesting behavior he had noticed.

Data Collection

During the test the phone logged GPS positions and interactions with the device. This information was written to a preformatted log file, which then could be analyzed by a parser we created for this specific purpose. The parser made it possible to transform the logs to drawings on a map and groupings in a graph. Furthermore notes were taken on site by an observer walking around with the participant and the test leader. The user were asked to fill out a Likert Scale questioner [18] consisting of 17 questions grouped in two sections named: "Your Experience" and "Views". The answers from the Semi-Structured Interview were written down by both observer and test leader as the interview progressed.

Data Analysis

Grounded Analysis was used to identify and classify identities and relations in our User Study [16, 7]. Grounded Theory provides a framework to organize and structure collected data. Themes were generated by systematic use of techniques and procedures to split qualitative data into controllable elements before using this foundation to create higher level concepts. First open coding was used to discover 243 different properties from the interviews, questionnaires and observations. These properties identified 57 phenomenons. Following the open coding, axial coding was used to create structure in the data and make categories based on the phenomenons. Eight categories was created from the phenomenons. Selective coding was used to relate the categories to each other, with the purpose of gaining an understanding of how the categories are interrelated and hereby finding the main themes. This resulted in four themes listed below.

- Perception of the surroundings
- Mapping between the real world and the photo world
- Use patterns
- Photos within the system

This series of themes was then compared to answers from the Likert scale questioner. Furthermore relevant categories were examined against automatic logged data. For example a category about misplaced photos would be checked with the questioner to see if the user actually noticed this problem. It was then taken a step further, by examining GPS data through the test, to see where and when the GPS signal was inaccurate and what impact it had on the phones perception of placement.

FINDINGS

The User Study led to a series of findings related to the four themes mentioned above, which will be elaborated in this section.

Perception of the surroundings

Almost half of the participants found it difficult to get an overview of which photos were to be found in the nearby area. They often had difficulties creating a link between the photo on the screen and its physical location, e.i. to understand where a photo is located according to its position on the screen. There were several reasons for that, which will be elaborated on below.

To gain a better overview of the photos, the participants often zoomed out in the Compass View, which in turn made the photos smaller. This action spawned lots of reactions related to the size of the photos in the Compass view. In general all participants wanted to see the photos in a bigger format, and thought it was possible to click on a photo to see it in full screen. As they discovered that this was not possible, some participants instead held the device rather close to their face to have a closer look at the small photos. Figure 8 on the next page, shows how a user is using Compass View to get a perception of the surroundings.

A strategy attempted by the participants when wanting to see distant photos in a larger format, was trying to zoom by tapping on them in the Compass view. This was not possible because of the zoom implementation, which only made it possible to zoom in on the current location so only the photos

Figure 8. Picture of Compass View in use.

nearby was shown in a larger scale. Some of the participants wanted to pan around to see photos further away, and they wanted to be able to zoom in on other photos than the photos close to them. One of the participants asked directly if he was not able to see distant photos.

A number of participants requested a map underneath the photos, to help determine which route would lead them to a photo, and to help create the relation between the real world and the photo world. In contrast to this, some participants discovered that the position of photos actually created a map showing possible paths they could use when walking around the city. One of the participants remarked, that now when she did not know Aalborg that well, she had a hard time finding her way from her current location to the location of the desired photo.

Some of these findings do however reveal some kind of contradiction, as almost every participant agreed that *PhotoWorld* created a good overview of the photos in their surroundings, even though some of the observations imply something else.

Mapping between the physical world and the virtual world

The implementation choices of *PhotoWorld* regarding the different views, lead to some interesting findings. The navigation through the photos requires the participants to comprehend the mapping between what they saw on the screen and the surroundings they were in. Each movement by the participant, being either directional or orientational, would spawn a reaction in the application that would re-arrange the photos based on the participant's positioning.

It became clear that not all participants understood this relation. Some of the participants would for instance not realize, that if they walked "through" a photo in Panorama view and wanted to see it again, it would require them to walk backwards while still facing the same direction, and not simply look behind them. Doing so would only show the backside of the photo, and thereby nothing. There was a connection between the GPS coverage and the participants understanding of the mapping between virtual and the physical world, which was discovered by comparing questionnaire replies and automated log data. This showed a connection between good GPS coverage and understanding of the mapping. Participants who did not believe the photos were positioned in correlation to their own real world position were also the participants who experienced the worst GPS coverage.

When there was good GPS coverage, the participants were astonished by how well the photos were positioned in correlation to their context. Figure 9 is an example of good GPS coverage matching the photo position. In this regard one participant said:

> *Wow it is pretty amazing how the photos match their real position!*

Figure 9. Picture of Panorama View in use.

Contrary to this, some of the participants experienced the GPS reciever losing its signal, and thereby stopped updating the content on the screen. This made it impossible to perceive that ones movement affects the representation. When situations like these occurred it spawned different responses from the participants. Some figured out that the GPS or compass did not update properly, while others, mainly the ones with lesser understanding of the technology, would get confused and stop moving trying to see if it was possible to relate the physical world to the virtual world.

It was essential that *PhotoWorld* should be able to show in which direction a photo was captured, to reconstruct the connection between the participant's perspective and the perspective of the photographer of the photo. Therefore in the Panorama view, it was like walking in a 3D world mapped to the physical world with photos standing around like big posters. The rotation of these photos in Panorama view was the feature that got the most mixed feedback. Some participants quickly understood and liked the fact that they could see in which direction the photographer had captured the

photo, and used this to see if they could get the same perspective as the photographer. Others understood the rotated photo in Panorama view as an arrow pointing in the direction they had to walk to see the photo. This relates to the problem where the participants have not realized that the display works like a window to a virtual world. One participant thought that the rotation of the photos was quite amusing, but not especially useful.

In the previous mentioned situations, some participants got even more confused when they used the Compass view to find the photo. It made them believe that, if they from their current location could see the photo in the Compass View, they would also be able to see the photo in the Panorama View. E.g. the user sees three photos in Compass View, but only two in Panorama View and does not discover that one of the photos is taken in the opposite direction. Some participants found it confusing that certain photos just disappeared when switching views.

Interesting use patterns

During the test the participants could roughly be divided into two groups. The first group never walked away from areas with photos, unless they had a specific location they wanted to go to. Most of the time they found a photo in the Compass view and walked towards it. When they got close to where they thought it was captured, they tried to locate the photo in the Panorama View. The other group tried to fill out some of the empty areas where there were no photos, by taking a photo at this location. During the interview one of the participants stated that he tried to find "black spots" in the system and fill them out.

In general, participants used the Compass View while moving. When they arrived at a place of interest they stopped walking, and started using the Panorama View to explore the surroundings. When using the Panorama view, the participants often only moved short distances. This became very clear when analyzing the log files from the phones. Figure 10 show that the participants on average walked 67 % of their total distance while using the Compass View.

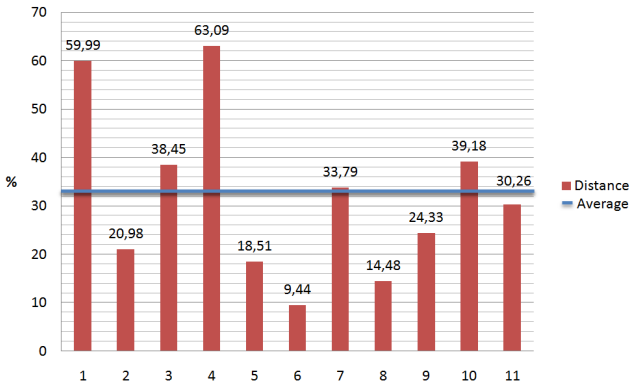

Figure 10. Graph showing how many percent of the distance was walked while using the Panorama view.

As it can be seen on Figure 10, two of the participants stood particularly out in their use of the system. Analyzing their use patterns showed that they did the opposite of the rest of the participants, and walked around using primarily the Panorama view.

All of the participants expressed that it made sense for them to change between the two different views. When asked the question: *It made sense to switch between Compass and Panorama view by tilting the phone up and down?*, they all agreed with an average score of 4.55, where 5 is strongly agree. This hereby shows that the interaction when going from Compass view to Panorama view was easy to understand and use.

From the questioner it can also be seen that when the participants were asked if they found it natural to interact with the phone in the way *PhotoWorld* demands it, there was no clear answer. Most of the participants did not find it natural, but the people who had experience with Smartphones found it very natural to use and rated the interaction 5 in the questioner.

Photos within the system

In the survey the content of the system had a significant impact on the user experience. Some of the participants expressed a need for more photos. For instance two of the participants who walked towards a well-known church, expected to see some photos of it, but there were no photos even though it is one of the tourist attractions in the city. However, many of the participants added photos of places they felt were missing from the system, which was also the case for the church. The photos in the current system tends to be clustered around a few places, and generated a clear pattern of where the photographers mainly took photos. Some of the users followed this path and stayed in close proximity, others left the path to explore isolated photos.

Most of the participants expressed a wish to be able to experience the city in a different view with the system. For instance to be able to see the city at different times of the year, or to see how a shop would look if it was open. Since the photos were taken over a period of just two days, the temporal diversity was limited, but still showed the city at both day and night. At the time the pictures were taken, there was a christmas market in the city, and the city was decorated with christmas lights. One of the photos in the system was of a seller in his booth, which during some of the tests was closed, and other photos had captured the christmas lights during the night when they were lit. The participants who saw this were very pleased by how the system made it possible to make things visible that were currently invisible.

In general there was a wish for different types of filtering and sorting of the photos. For instance a filter to make it possible to show photos taken by friends only. Furthermore many of the participants asked if it would be possible to get information about the photos. One participant mentioned that he would like to have historic information linked to some of the old buildings in the city centre.

DISCUSSION

In this section we will discuss two central aspects of presenting photos in context using *PhotoWorld*, related to the findings of the User study.

Presenting temporal information

The photos which contained temporal information that differs compared to what the user saw outside of the system, added to user experience by making the invisible visible. This was for instance seen when users were doing a test in broad daylight and saw pictures from the evening on the Smartphone. There are possibilities regarding sorting the photos and using the temporal information of the photos, that should be examined.

PhotoWorld uses GPS, like [14, 12, 8], to choose the nearest pictures to show, which worked well when GPS accuracy was good. As suggested by Effrat et al. [8], a digital compass was used to choose in which direction the user wanted to see photos. This created an intuitive way of choosing a direction, but turning the photos according to the direction they are taken in, was sometimes hard to understand and would be interesting to investigate further.

The findings indicates that participants who knew the area well, are more likely to take pictures of places that are not yet in the system. This is likely due to the fact that people who know the area well, has a better understanding of what is happening in the area and which things might be interesting for others to see. This is different compared to people who are new to the area, and thereby does not have the same knowledge. The idea of having a local person contributing to a system for e.g. tourists has been studied before in the alternate mobile-guide system Anywhere [3].

As *PhotoWorld* digitally presents the context in the form of photos without any intelligent filter algorithm, it supports the idea behind a constructivistic approach. When presenting context instead of adapting to it, it allows the user to interpreted the context in his own way. This was for instance seen in the observations about users creating an understanding of a street map based on where the photos were shown, by mapping the "photo-paths" on screen to real streets. An interesting observation, that supports the idea of using the user's ability to create their own context.

Understanding of a virtual world

In Cho et al. they developed a tilt-controlled photo browser [6], where browsing photos was done by tilting the device either left or right. In their user study, they find that the participants did not have any problems understanding and using the tilt-controlled browser, even though it is a rather unconventional way of browsing photos. In *PhotoWorld* the users also browse photos by tilting and moving the device, but also by moving around with the device themselves. However, as can be seen in the findings, some participants had difficulties understanding the interaction concept of walking around in a virtual world and watching photos. Throughout the development process, this problem was not foreseen, and it was quite interesting to observe that not everyone was capable of grasping the technique of navigating in a virtual world by moving around in the physical world.

From our point of view it seemed logical to map the physical world with the virtual world of photos. That said, almost everyone of us has become acquainted with 3D programming and grown accustomed to navigating in a virtual world. It was interesting to notice that three participants had no problems understanding the concepts of the Panorama view. These three participants were male and around 20 years old. They had all tried some kind of first-person-shooter 3D game (FPS), e.g. Counter-Strike. So playing 3D games might help understand the concepts of moving around in a virtual world like *PhotoWorld*. Also in FPS games, walking sideways is a crucial part of playing the game, so that might be why the three participants quickly figured out how they were supposed to move to see rotated photos straight on. Of course, there are other reasons why only a few participants walked sideways. Two participants read the rotated photos as arrows "pointing" in the direction of the location of the photo. Another reason could be that walking sideways is a very unnatural way of moving in a crowded street.

Cho et al. discusses if the tilt-controlled browser will work even better if the user had used it for some time [6]. We believe this is very likely when you are testing out new interaction forms. Therefore it could be interesting to see if *PhotoWorld* is easier to use the second or third time a participant uses it.

CONCLUSIONS & FUTURE WORK

In this study we have created a mobile application called *PhotoWorld*, which presents photos in context. The application allowed us to evaluate a new way of exploring photos in context. Most of the participants understood the concept of *PhotoWorld*, in terms of how to interact with it and how photos were presented according to their location. They were especially impressed by the recreation of the spatial information in the application. The temporal aspect of the photos in the system received better feedback than we expected, which could be investigated further in future studies. During the User Study, Some accuracy issues were encountered with the device's built-in GPS and compass, which influenced the experience and ability to understand the application for some users. This was something that was impossible to control, but it revealed some relevant issues if functionality like this was to be implemented in a commercial application. The User Study also shows that all but two participants preferred to use the Compass View when walking around in search for places of interest, and then use the Panorama View for seeing the photos up close, which matched our expectations from when we designed the application.

As future work it would be interesting to use the experience gained about interacting and presenting photos on a mobile device in context, for developing and evaluating a concept for presenting photos in context combined with other online photo sharing services, like Facebook. Several users requested a social aspect of the system, which could be an interesting aspect of a system like *PhotoWorld*. Maybe the

users would be able to interact with each other through photos when walking around the city. Facebook's galleries with both private and public albums, incorporating tagging of people, could be moved to *PhotoWorld* if just the photos complied with the technical requirements of the system.

We see possibilities in the concept of presenting information based on the user's context, which can create a versatile system that takes advantage of the user's ability to create their own understanding of the context. An interesting concept that can be further examined in a future work.

A long-term study could be applied, to test how the concept would be received as more content is added. When the amount of photos in the system increases a study of how a further sorting of which photos that are shown would be interesting, for instance the sorting could be done by seasons or friends photos. Finally an evaluation of the user's experience during a longer period of time would be really relevant when evaluating this concept as a way of presenting photos in context. The temporal aspect of the content would be more profound over time, so as the system would mature one could imagine that it would increase the satisfaction for the users. *PhotoWorld* could very well be the foundation for further studies into contextual photos, social interaction and data sorting.

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CHAPTER

7

A FINGER ON THE PULSE: CREATING DIGITAL URBAN AMBIENCE

A Finger on the Pulse: Creating Digital Urban Ambience

Glen Würtz Nielsen glenwn@cs.aau.dk
Søren Thorup sthorup@cs.aau.dk
Michael Vestergaard michalv@cs.aau.dk
Dept. of Computer Science, University of Aalborg
Aalborg, Denmark

ABSTRACT
The increasing popularity of Smartphones creates new opportunities for mobile systems. We present a term called *Digital Urban Ambience*, directed at context-aware mobile systems in an urban environment, facilitating a user-driven context creation by digitally presenting context rather than trying to adapt to it. An application, called AalborgLive, based on *Digital Urban Ambience* is implemented and a field evaluation with 58 participants is conducted. We find that AalborgLive is used in a quite spontaneous pattern, which makes for a fast "finger on the pulse" of the surrounding environment, and that interactive dynamic content plays an important role in the user experience. Finally we discuss our experiences with *Digital Urban Ambience*.

Author Keywords
Digital Urban Ambience, LBS, Location-Based Services, Presentation, Context-aware, Mobile interaction, Smartphone, Constructivism, ArcZoom

INTRODUCTION
Smartphones are becoming increasingly more popular [21] hereby giving more people the opportunity to access the internet anywhere, which supports the Ubiquitous computing concept suggested by Weiser in [22]. In particular the iPhone and the Android phones have pushed the limits of what a mobile phone is capable of, and after the introduction of the Apple App Store and the Google Android Market a lot of people have directly access to thousands of applications. This gives an oppurtunity for developers and researchers to try out new concepts on a potiential vast amount of users.

The Smartphone introduces new possibilities to a widely popular market, namely the mobile phone market, with technologies like GPS, compass and high-speed internet. This has led to a substantial increase in the amount of context-aware applications, which takes advantage of these technologies. There are different approaches to how computers should act upon the context. Oulasvirta et al. [18] describes how context interpretation span from a *realism* to *constructivism* based approach, which can be applied to the area of mobile applications that guides or informs the user based on the context. Taking a realism based approach to context means that, if a computer is correctly instrumented and programmed, it can adapt its behaviour to the requirements of the context. E.g. a system that guides the user or gives recommendations. A constructivistic approach to context means that, instead of labeling contexts, computers can provide resources for people themselves to create and maintain contexts in their action. E.g. presenting information which facilitates user-driven context creation. Constructivism is about presenting context, instead of trying to adapt to it.

In this article the constructivism based approach to context is used, which is inspired by French structuralism. In this regard the French social anthropologist Claude Lévi-Strauss, who introduced the term "structuralism", has presented an interesting understanding of an urban environment as an ever-changing entity, similar to a living organism.

> By its form, as by the manner of its birth, the city has elements at once of biological procreation, organic evolution, and aesthetic creation. It is both natural object and a thing to be cultivated; individual and group; something lived and something dreamed. [11]
> *Claude Lévi-Strauss - 1968*

When considering a constructivistic context understanding and the urban environment as an ever-changing entity, it becomes important to provide ressources that support an ever-changing context and facilitate that the user hereby can create and maintain contexts. This has created a certain way of understanding context presentation in an urban environment, that we call: *Digital Urban Ambience*. The term refers to the concept of creating an ambience with a digital aspect of the users context in an urban environment, that facilitates a user-driven context creation. Urban ambience is an older term, which e.g. has been used in a sociological study from 1964 by Theodore Caplow [5]. Digital refers to creating the ambience digitally, e.g. through an application for Smartphones.

In this study an application called AalborgLive, which creates *Digital Urban Ambience*, is implemented and evaluated. AalborgLive is evaluated using a triangulation of evaluation methods, to study the usage of the application in different aspects and scenarios. The evaluation involved 58 users in total and was conducted by doing three different field studies, a one-hour video recorded study in mid-town Aalborg, a one-week study and a one-month longitudinal study.

RELATED WORK

When considering systems that present context, it becomes interesting to take a broader look at the research of mobile HCI which involves context. This type of research falls within the categroy of context-aware systems, which encapsulates computer systems that can both sense, and react based on their environment.

Within context-aware systems there are different aspects of sensing the environment, two examples of these are Sleep Cycle [20], which monitors vibrations while the user is sleeping to determine the best time to wake-up the user, and Just-For-Us [9] which facilitates sociality in public places based on the user's location. The latter example is a Location-Based Services (LBS), which is a subcategory of context-aware systems. There is a great variety of LBS, e.g. the tour guide system Cyberguide [1] and the location-based game MapLens [15]. Within the LBS systems that seek to provide users with information about the context there are mainly two different aspects, actively controlling and guiding the user, like Bedwell et al. [2], or in a more passive way facilitate the user to guide himself by using the system, as discussed by Xu et al. [23]. The first example is trying to adapt to the context and the latter example presents context.

Many LBS help the users in planning where to go and what to do, among these are Kenteris et al. [8] that implemented a tourist guide called myTileneCity. Other systems like the Magitti Mobile Leisure Guide (MMLG) developed by Bellotti et al. [3] focuses on locals instead of tourists. The MMLG is designed for young urbanites and emphasizes spontanity, with a realism based approach to context and hereby gives recommendations as to what the user could do. It is arguable whether a system like myTileneCity supports spontanity, from a tourists perspective, as well as the MMLG supports spontanity, from a local's perspective. We believe that *Digital Urban Ambience* supports spontanity for both tourists and locals, in that it is the individual context creation that creates the oppurtunity for spontaneous actions.

As new technical possibilties arises, within the mobile systems, more LBS are taking advantage of these possibilties by implementing Augmented Reality (AR), e.g. the AR Browser Layar [10] and MapLens [15]. The last-mentioned is developed by Morrison et al. and uses AR to display digital information on a mobile phone screen with a physical map mediated as background through the camera. Another example of a mobile system using AR is NearestTube [16], which utilises the compass input to augment information on-screen, about where and in which direction the nearest London tube is. It uses the camera input as background and layers information on top, hereby creating an illusion of digital signs hovering in mid-air. In regards to visualising an ambience on a mobile systems there can be advantages of using AR.

A further advancement among LBS using AR is layering 3D graphics on top of the camera ouput, which e.g. has been done by Schall et al. [19] to visualise underground infrastructure on a mobile device, and by Miyashita et al. [14] in a mobile museum guide. The latter example used virtual balloons, as 3D objects, to compensate for the lack of precision in today's technology, in regards to determining position and orientation of the mobile device, thus the balloon would seem to be floating around rather than being placed at a fixed position. Considering the amount of work done within the field of AR, and the advancement of the mobile technology, we hereby believe that there are valuable aspects of using AR, to support the creation of *Digital Urban Ambience*.

DIGITAL URBAN AMBIENCE: AALBORGLIVE

AalborgLive is an application for smartphones running the Android OS. It has been designed to run on all Android mobile phones and was developed using a HTC Hero phone. The application uses the phone's built-in GPS, compass, camera and motion sensor.

The application presents the user to a map showing the user's current position. On the map is a set of icons representing different information about the context. A screenshot of the map with icons can be seen in Figure 1. Basic interaction principles are first explained, to get a fundemental understanding of the application and the concept of AalborgLive afterwards.

Figure 1. The Places lens. Restaurants, cafés and bars are represented as icons showing logos and facades.

Interaction techniques

The two main interaction techniques in AalborgLive are Lenses and ArcZoom and will be described in the following.

Lenses

In AalborgLive lenses are the equivalent to content-filters, that determines which category of information is shown on the screen. By "changing lenses" the user can decide which information is shown on the map at any given time.

To change a lens the user has to flick a finger over the Lens Wheel in the right side of the screen, which will turn the wheel either clockwise or counterclockwise according to the user's action. The wheel consists of three slices in different colors and with different icons, where each slice represents a different lens, as seen in Figure 3 on the following page. When the lens is changed, a lens frame is animated to move over the screen, which visually indicates that another lens is now active, and the icons on the screen will change.

Figure 2. The ArcZoom shown in three stages. (A) shows the screen when the device is held horizontally. In (B) the device is tilted in a 45 degree angle, showing the map in a perspective view. (C) shows the screen when the device is held vertically. Note, that the map has disappeared and the physical world is shown as background.

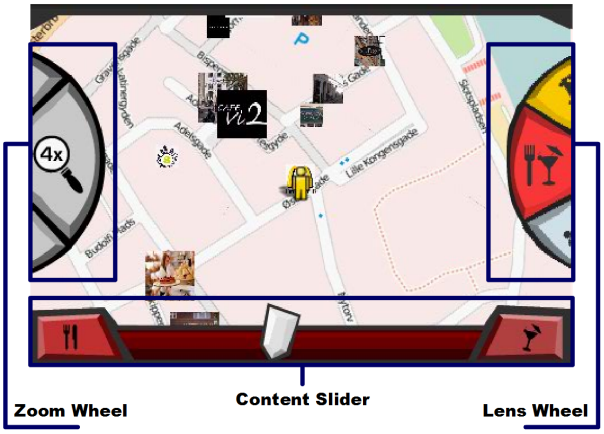

Figure 3. The touch interface of AalborgLive

Each icon on the map reveals little information on itself. Depending on what it represents, it mostly indicates where it is located and what is located there. To let the user explore it further, it is possible to tap the icon and hereby open a small window which contains more information.

ArcZoom

ArcZoom is an interaction technique developed for AalborgLive. ArcZoom is performed when making a transition from a bird-eye perspective of the map to a point-of-view perspective by tilting the phone from a horizontal to a vertical position, illustrated in Figure 2. The name of ArcZoom is inspired by the technique used by photographers when moving the camera in an arc. When the phone is held horizontally the map will be shown from above, similar to holding a paper map, as seen in Figure 2 (A). By tilting the device the map will tilt too and make it possible to look along the map in your facing direction, as seen in Figure 2 (B).

When the phone is held vertically the real physical world is shown on the screen with the icons on top of it, as seen in Figure 2 (C). This is where the concept of AR comes into play. By using the phone's built-in camera input as a background and placing icons on top of it, an illusion of the icons hovering in the air in the physical space is created.

The three lenses in AalborgLive

As AalborgLive should present context instead of adapting to it, the information shown on the screen is not intelligently filtered by an algorithm but instead manually filtered by the concept of lenses. All information is available at once and the user is in control of what is being shown on the screen and what is not. By changing lenses the user can "take the pulse" of the part of the city environment the user finds interesting.

In theory the application can hold an infinite amount of lenses showing e.g. city attractions or hotels, but in this study three specific lenses were chosen and implemented, namely the lenses:

- People
- Places
- Public Transport

These three lenses was chosen to explore diverse possibilities of facilitating user-driven context creation. The lenses are inspired by already existing location-based services, which are Loopt [13], Lonely Planet iPhone Travel Guides [12] and OneBusAway [7]. We believe that these location-based-services are interesting when creating *Digital Urban Ambience*. The three lenses are presented below.

People

The People lens focuses on sociality and makes it possible for the user to see if any of his friends is in the nearby area.

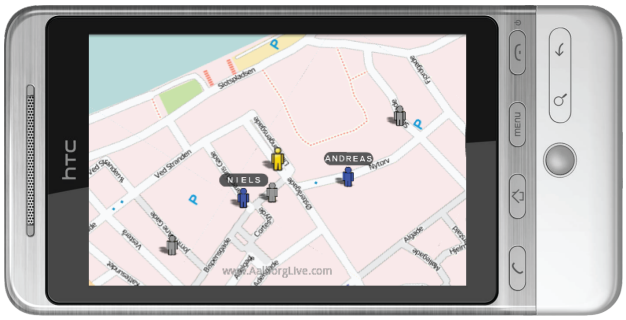

Figure 4. The People lens. Blue people are friends. Grey people are other online users.

Figure 5. The Public Transport lens. The phone is held in a vertical position allowing the user to see the bus signs hover in the air.

Each user has a friend list and each friend who is online will be shown on the map as a blue person with a name tag, as seen in Figure 4. It is also possible to see people who are not friends but are using AalborgLive. The other people who are online, but not on the user's friend list, will be shown as grey persons on the map. Each user's location is updated every 5 seconds for as long as the application is running, so it is possible to see these grey and blue persons move around on the map, according to their movement in the physical world.

If there are many online users these grey people can be used to indicate where there is a lot of social activity, if they are located close together. When holding the phone in a vertical position the user can pan around the area and scout for other online friends, who will be hovering in the air in the direction where they are located. Furthermore the user can tap on a friend and a profile page will show up. In a final version of AalborgLive there are some privacy issues that has to be addressed, regarding showing you current location to everyone else and turning this on and off.

Places

The information shown using the Places lens is mostly static information about physical places. In AalborgLive these places are restaurants, cafés and bars within Aalborg. The application provides the user with an overview of nearby places. AalborgLive has information about more than a hundred places within the city of Aalborg, which are displayed on the map as small icons, similar to thumbnails, of either a logo or a photo of the facade, see Figure 1. If the user tilts the phone into a vertical position, the icons will appear to hover in the air right outside of the places they represent, using AR, as seen in Figure 2 (C).

If the user taps on an icon, a window pops up showing information about the place, in the form of text and photos from inside of the place. The user can express his own opinion about a place by rating it from one to five stars in this window, which will be visible to other users viewing the place.

In the bottom of the screen a content slider is shown, which can be seen in Figure 3. This slider makes it possible for the user to filter the places, by emphasising either restaurants, cafés or bars. Moving the slider all the way to the left will enlarge images of places that mainly serve food. Moving it all the way to the right will enlarge places where you go to get something to drink. Placing the slider right in the middle will show places where both eating and drinking is more equally emphasized, like e.g. a café or a place which serves as a restaurant during the day and a bar at night.

Public transport

The Public Transport lens is based on temporal information about where nearby bus stops are, and when the next buses will arrive at the different bus stops. The bus stops are represented as bus icons on the map, which make them all look like each other, but when the user zooms in all bus icons will be replaced by an icon showing the next four buses arriving at this stop and in how many minutes they will arrive. The reason why the bus icons change appearance, depending on the zoom level, is that the sign with the next four arriving buses needs to be a lot bigger than the bus icon to be readable. When the user zooms out all these big signs will clutter, if not replaced with smaller icons.

By tapping the bus icon, information about the ten next buses arriving is shown in a popup window. AalborgLive contains live information of all 390 bus stops in Aalborg. The information about the buses is retrieved online via NTLive's (The local bus distributor) mobile homepage. Holding the phone in a vertical position will make the icons, showing the next four buses, hover in the air where the bus stop is located. This can, similar to the People lens, be used to determine in which direction the bus stop is located, as seen in Figure 5.

Technical implementation

The Android platform has a well-documented development environment and an API that allows for easy access to hardware sensor readings, which AalborgLive takes advantage of. Despite of this there were two comprehensive technical challenges.

3D and Augmented Reality

To create a smooth transition, when using ArcZoom, from the top-down map view to the AR view and to make the AR part of AalborgLive work, most of the GUI is build using a 3D engine based on OpenGL ES. Screen elements like the map and the icons are all 3D objects which are handled and drawn by the 3D engine. Even though the phones have hardware accelerated 3D graphics, it was necessary to limit the

number of icons on the screen to a maximum of 20, to ensure the frame rate is always above a smooth 15 frames per second, with an average of 20 frames per second. To make the 3D engine work when using dynamic content streamed from the web, a dynamic texture loader was implemented. The texture loader handles events, when waiting for textures to be downloaded, and possible delays or connection losses.

Constructing the map

The map used is similar to Google Maps, but Google Maps has a copyright license which does not allow third parties to use the map in applications such as AalborgLive. For this reason it was decided to use OpenStreetMap [17] instead, which is open map data that everyone can contribute to and use. To use this type of map provider, it was necessary to implement the logic that builds a map based on the data from OpenStreetMap, to make it work with the sensor input from the phone's GPS.

FIELD EVALUATION

The evaluation of AalborgLive was conducted using a triangulation of three different field studies, with different durations and setups. Bogdan and Biklen [4] states, that triangulation is a powerful technique that facilitates validation of data through cross verification from more than two sources. The evaluation makes use of what Denzin [6] describes as data triangulation, which involves time, space and persons. AalborgLive was tested with different sets of participants, each under different circumstances, in studies lasting an hour, a week and a month. The field studies lasting an hour and a week were evaluating user experience and use patterns, for users in a staged situation. The participants were handed a smartphone that they were not accustomed to use, whereas the one-month study only consisted of users who uses an Android smartphone as their personal phone. The evaluation will hereby, besides evaluating user experience and use patterns, give an insight into the differences in these, when evaluating user scenarios with staged Android smartphone users versus everyday users.

Length	Interview method	Data collection	Participants
1 hour	Think aloud, semi-structured user group interview	Video data, recorded interview	10
1 week	Semi-structured interview	Logging, recorded interview	6
1 month	Semi-structured phone interview	Logging, recorded phone interview	42

Participants

The evaluation of AalborgLive involved a total of 58 participants. The one-hour field study was conducted with 10 participants in the age of 22 to 28. Half of these participants were females. The participants were evaluating AalborgLive in groups of one to three persons. The persons within a group knew each other well.

The one-week field study consisted of two groups of three participants in the age of 21 to 27. Five of the six participants were males. The participants in each group knew each other well. All participants in the first two field studies had little to no experience using a smartphone.

The one-month study was conducted with participants already having an Android Phone as their personal phone, who downloaded the application from the Android Market. There were nearly 300 downloads, providing the same amount of potential participants, which were narrowed down to 42 using the following two requirements: 1) Participants must have used the application within Aalborg and 2) participants must have used the application more than once. Four of the 42 participants in the month-long study were recruited, by asking them to download the application. They were all males with age ranging from 20 to 26. Three of the four participants lived in Aalborg. We did not have any contact with the 38 other people who self-imposed downloaded it, therefore their age and gender is unknown. As the 42 participants own an Android Phone we assume that they have some experience with smartphones.

Procedure

The one-hour field study was conducted in the center of Aalborg city. The participants was given a brief introduction to the evaluation and the application. Afterwards each participant was asked to complete 11 tasks using AalborgLive. A task could be: "Using AalborgLive it is possible to point out bars instead of cafés. Use this functionality to find a bar of your choice." A researcher followed each participant helping out if any problems occurred. Completing the tasks took around 20 to 30 minutes. A picture from this study can be seen in Figure 6.

In the one-week field study a group of three participants were concurrently lend an Android phone with AalborgLive preinstalled. They were given a brief introduction to the application, but was not asked to use it in any particularly way other than what they felt for. After a weeks usage we collected the phones again. It is important to note that the phone was not able to send text messages or make any phone calls. It was anticipated that this will affect the results as the participants had to carry both their personal phone and the phone running AalborgLive. After the group of three returned the phones another group of three were lend the phone using it a week following the exact same procedure.

For the one-month field study AalborgLive was published on Android Market and was hereby publicly available. To download the application it is necessary to have an Android smartphone and a Google account which gives access to the Android Market. Hereby the application can be downloaded by searching for e.g.: "AalborgLive" or just "Aalborg". The four people we have asked to download the application were sent instructions on how to get it. Posters about the application were distributed on Aalborg University to spread the word about AalborgLive.

Data collection

The ten people from the one-hour field study, were interviewed in groups with the same people they were testing the application with. E.g. if three people were concurrently

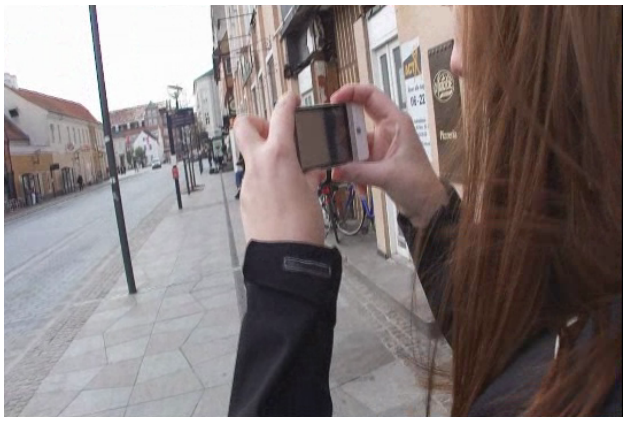

Figure 6. A picture from the recordings in the one hour study, where the participant is trying the AR view in midtown Aalborg

testing the application, they were interviewed together. During this field study every participant was followed by a researcher, who recorded the participant's actions using a camcorder. A picture from these recordings can be seen in Figure 6. In the two one-week studies, groups of three people borrowed smartphones with AalborgLive. Usage data was logged in a database and the users were subsequently interviewed. The data from the one-month study consists primarily of logged data from the 42 participants, and interviews with each of the four recruited participants, after the first and second week. All interviews were carried out using an interview guide following the procedures of semi-structured interview, and were recorded using a voice recorder. All participants were advised that usage data was sent from the phone.

Data analysis

Using Grounded Analysis we identified and classified the outcome of all three approaches. Grounded Analysis provides a framework to organize and structure collected data from e.g. an interview or a survey. We used Grounded Analysis to identify phenomenons across all collected data. We are aware that the different approaches of conducting the field study will generate various data, and that they might not all be comparable. First Open Coding was used to discover 393 different properties. Afterwards all properties were classified into 100 phenomenons. These phenomenons were hereafter narrowed down to six themes using the Selective Coding. The six themes are:

- Spontaneous planning
- Interactive content tuning
- Value of dynamic data
- Social awareness
- Exploring the city through Augmented Reality
- Contributing to the Urban Ambience

These six themes represents findings that we believe are important when creating *Digital Urban Ambience*.

FINDINGS AND DISCUSSION

In this section numbers from the log data is presented and discussed in relation to how AalborgLive works. Afterwards the qualitative data from semi-structured interviews and video recordings are presented and discussed.

Quantitative data

All graphs and circle diagrams presented in this section are produced by log data generated by the 42 participants from the one-month study. In total there were 206 sessions, a session starts when AalborgLive is started and runs until the user quits the application. During a session log data is sent from the device approximately every five second.

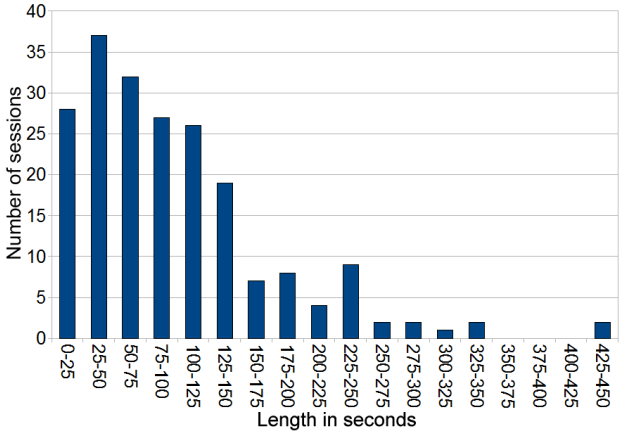

Figure 7. Diagram showing for how long the application was running at a time, based on our log data and grouped in 25 second intervals

The graph in Figure 7 shows that the participants used the applications in short bursts. The average session length was 100.8 seconds, with a clear tendency showing that the vast majority of sessions are between 0 and 150 seconds long. A few participants deviated from the the others and had the application turned on in quite a long time. Looking at the log data, it showed that some of these participants were traveling by bus while using the application.

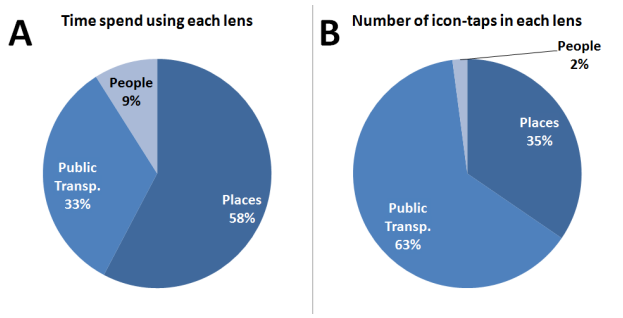

Figure 8. (A) shows the amount of time the users spend using each lens (B) shows how many times the users tapped an icon in each lens.

In Figure 8 the circle diagram A shows how much time is spend using each lens across all sessions. It turns out that over half of the time was spend using the Places lens and 33 percent was spend using the Public Transport lens. In this

regard it is important to note that the applications starts up with the Places lens as the default lens. This might explain why this lens has been used most of the time. Only 9 percent of the time was spend using the People lens, and might have something to do with the lack of activity as only very few participants were online at the same time. In the B circle diagram it can be seen that bus icons have been tapped 122 times where icons of restaurants, cafés and bars only have been tapped 66 times. Comparing diagram A and B shows that even though the users spend more time in the Places lens, they tapped on more icons in the Public transport lens.

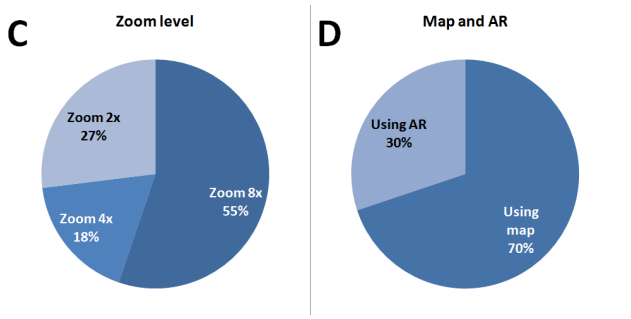

Figure 9. (C) shows the time spend in each zoom level. (D) shows how much time the users spend using AR, i.e. holding the device in a horizontal posiiton.

The time spend in each zoom level is shown in circle diagram C in Figure 9. The application starts out using 8x zoom (the closest), which can explain why 55 percent of the time is spend using this zoom level. 27 percent of the time was spend using 2x zoom, which was the zoom level furthest away. It is important to note that the user has to be in zoom level 8x to perform ArcZoom. As can be seen in circle diagram D the participants used AR 30 percent of the time. The fact that AR only can be used when using 8x zoom, might explain why the most of the time were spend using 8x zoom.

Spontaneous planning

AalborgLive was found to be good at facilitating spontaneous decisions and exploration of the nearby area. During the study, a number of comments by the participants indicated differences in how the participants preferred to make decisions about where to go. Some participants said that they would rather plan where to go before leaving home, while others wanted the opposite and preferred to be more spontaneous and exploratory.

Of those participants who were less keen on exploring, some said that they would like a system like AalborgLive, if they were visiting another city as a tourist. During one of the group interviews in the one-week study, a participant said:

> *I think I would mostly use something like this (application) if I was a tourist some place.*
> *(U3)*

Another participant explained how she would like to be able to choose a place, and have the system guide her to the location. Not only in Aalborg where she is a local, but also if she was visiting another city and was recommended to visit a specific place. In all three studies, participants expressed how AalborgLive was good for spontaneous decisions about where to go and for exploratory discovery of places nearby. E.g. when looking for a new place in the local area. As a participant in our one-month study said:

> *It could be quite funny to use it to find new places to have dinner. I used it (the application) once in town because everything was occupied.*
> *(L1)*

The use of AalborgLive for making a quick and spontaneous decision is also supported by the log data from the one-week study and one-month study. The log data clearly shows that the participants used the applications in short bursts, as can be seen on the graph in Figure 7.

The participant did however also point out how he probably would not use it to find new bars to go to, as he says he already has his favourite places to go out in Aalborg. A number of our participants in the one-hour study also searched for, and went to, a place they already knew as soon as they started the application. These findings further more indicate a connection between how the participants use the system and the participants relation to the local area.

Interactive content tuning

The field evaluation of AalborgLive showed that having interactive ways of filtering and tuning the content, can add to the user experience. A finding that especially adresses the somewhat static type of content, but is likely to be applicable for other types of content as well.

The Places lens mainly contains static information, which is possible to filter further by zooming, moving around and using the slider. As AalborgLive does not guide the user by recommendations, but by digitally presenting information that the user can create an understanding of the context from, it becomes important to have filters that allows the user to "tune in" on what is interesting and relevant. This is supported by 14 participants from the field evaluation, who suggests more content and categorisation, e.g. attractions and shops, and three who specifically suggested more sorting options in the Places lens, e.g. price and food-type filters. From these suggestions we deduce that more content, categories and filters can add to the user experience. The reasons for wanting more adjustable filters, is likely that different persons has different needs in an urban environment, which probably is the reason why the participants suggested lots of different content and filters. One of the participants gave the following example, as to why he would like a particular filter.

> *It should be possible to divide it, in such a way that you can choose all clothing shops or supermarkets. When i moved to Aalborg I for instance didn't know any nearby supermarkets.*
> *(U4)*

Looking at this quote we see that it is important that the system has a substantial amount of content, to filter and browse through, in the aspect of presenting the user with relevant information, in this case supermarkets.

Most comments related to having more content and options regarding filters, come from discussions about the Places lens. Though this might be due to that content in the two other lenses already is quite interesting, as they are based around live data. We still believe that the idea of interactively tuning the content has possibilities of improving the user experience when browsing live content, as well as static content. The importance of having interesting content, is insinuated in the following comment by a participant, which gives an example of how interesting content is important.

> *I thought it was nice to see a picture, that way you could beforehand know what kind of ambience there is in the restaurant.*
> *(U2)*

We argue that allowing the user to interactively tune the content, makes for a more interesting presentation of content, which might even give a notion of a living digital presentation of the urban environment.

Value of dynamic data

Dynamic data is an interesting type of content, that can increase the user experience. When the participants were asked which lens in AalborgLive they liked the most, almost everyone preferred the Public Transport lens over the People and Places lens. As one of the participants from the week study said:

> *Actually i used this Bus view a lot .. It is a great view as it shows delays*
> *(W2)*

The B diagram in Figure 8 also indicates that the Public Transport lens was used more than the others. One reason for this, is that many participants will probably use the bus more often than they will go to a restaurant, but this is not the only reason. One of the main difference between the Places lens and the Public transport lens is that the latter presents live data. All the information about places is static, which resulted in some participants finding the information about places unsatisfactory. A participant stated:

> *There were too diverse amounts of information under the different places.. Perhaps price level or something like that could be nice*
> *(U3)*

Apparently the live data seemed more relevant than static data. If the Places lens also presented live data it may be more interesting for the users. Several participants from the field evaluation asked for information about dinner menus in regard to the pop up window showing information about a place. Taking this thought further and combining the idea of a dinner menu from a restaurant with the idea of presenting live data, the system could e.g. show the meal of the day for a particulary restaurant. However, when harnessing the possibilities of dynamic data it is important to keep in mind that we are presenting the context and not adopting to it. I.e. the meal of the day, should be presented as the fact that it actually is the meal of the day, and not as a suggestion based on the user's preferences.

Social awareness

The participants interpreted the location and movements of their friends shown in the application to give them social awareness. Both in regards to the relation to the people they saw on the screen and the relation between the people on the screen. We see that the People lens has possibilities of creating sociality, but that it requires a certain amount of users and friends using AalborgLive at the same time.

The participants of the one-month and one-week study that we spoke with, used the People lens one or two times, just to realise that no persons were to be found on the map near them. The lack of activity meant that none of these participants used this lens more than a couple of times. As can be seen in Figure 8 (A), the users spend the shortest time using the People lens compared to the other lenses, and in Figure 8 (B) there were almost no taps done on persons in the People lens, which is very likely because there was not many people online at the same time.

Two of the participants from the week study did see some anonymous persons on the map. They wanted to communicate with these persons, but were sad to find out that they could not. To make the user experience better with the People lens, it would be necessary to have more people on the map. Another nice addition to the People lens would be to include a functionality for communicating with other users.

Most of the participants from all three studies did not see any specific use of the People lens, for mainly two reasons: They could not think of situations where it would be useful and they were very concerned about privacy issues. Nevertheless, we observed some very interesting behavior during the one-hour study. The participants expressed a certain interest in the whereabouts of their friends, as almost everyone commented on the sight of their friends when they appeared one the screen. For instance one bursted out:

> *Hey, that's [friend's name].*
> *(V4)*

It was our impression that many participants had a lot of fun tracking down their friends, and it was interesting to see some participants commenting on the movement of the people on the screen. One expressed surprise, when he saw an unnamed person walking towards him on the screen. Another participant said the following when she saw both of her friends were located close to each other on the screen.

> *Oh, there is [Friend 1] and [Friend 2]! They are gathered over there without me.*
> *(V6)*

There is no indication on the screen of the two friends communicating which each other, still this participant assumes that the friends are socializing because they appear close to each other. This shows that, despite participants saying that the People lens is not that interesting, it can encourage sociality, as well as the importance of having quite a large group of users such that the individual user will see or even meet friends in the People lens.

Exploring the city through Augmented Reality

AR provided AalborgLive with a versatile visualisation tool. Though it was found interesting by the participants, it was not found crucial for creating *Digital Urban Ambience*, as the participants were able to link the screen content to their surroundings without using AR. A lot of participants were impressed by how well it worked and some found it useful for determining the direction of an icon. They said that the map was sufficient for them and provided them with a better overview than AR did. Most of the participants found AR to be a feature that was mostly for fun. As one of the participants stated:

> *It is another way to show the content, that makes it more fun to play with.*
> *(W4)*

Despite that many participants in the interviews said that they found AR fun, but not necessary, the graph on Figure 9 (D) shows that users from the one-month study used AR 30% of the time. We hereby argue that AR adds to the user experience in an exciting way, that might not be absolutely necessary, but is an intriguing aspect of *Digital Urban Ambience*.

Contributing to the Digital Urban Ambience

We have discussed the importance of live data and seen how the static data related to the places is not very interesting for the participants in its current form. However, the rating system, which is accessible using the Places lens, received very good feedback, and a lot of participants rated one place or more. During the one-hour study, several participants without any instructions rated a place they knew based on their own experience. While rating a café a participant said:

> *I don't agree with this rating ... I'm gonna rate it lower ... they've forgot to put olives on my food twice.*
> *(V4)*

Based on the experience of a previous meal at the café, the participant gave it two stars. This was a tendency we saw among almost all participants, they found it important to see what other people rated the place and wanted to be able to apply their own opinion. The popularity of the live data in the Public Transport lens, can perhaps be compared to the rating system in the Places lens, as the participants expressed satisfaction when their vote changed the overall rating of a place.

User-based ratings are a rather directly way of contributing to the *Digital Urban Ambience* compared to the People lens, where users contribute in a more implicit way, simply by being online AalborgLive shares information about their whereabouts. In Figure 10, which shows where users from the one-month study used AalborgLive, it is shown that they were mostly online in the same areas. An observation that, in regards to the People lens, can reduce the need for a very large user base a bit, because users tends to be online in the same areas and will hereby more frequently see other users, compared to being evenly spread out.

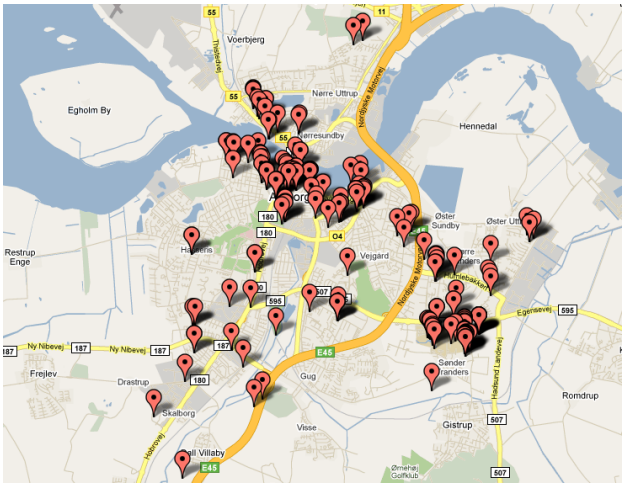

Figure 10. A map showing where in Aalborg people from the one month study used AalborgLive, indicating that it is mainly used in the same areas, around the center of Aalborg and Aalborg University campus.

CONCLUSION

In this paper we have introduced the term *Digital Urban Ambience*. We argue that it is a useful way of exploring an urban context, as AalborgLive has received good feedback in the field evaluation. It diminishes the need for adapting the system to the context, by deploying user-driven context creation.

AalborgLive consist of three diverse content-filters and an element of AR, making it possible to examine some of the many possibilities for creating *Digital Urban Ambience*. The application was evaluated using a triangulation of three different field studies involving 58 participants. It showed that the participants could find their way around Aalborg using AalborgLive, and some even used it to find new places. For some participants during the evaluation, the application even became an appreciated tool in their daily life, for checking live data about busses and exploring their nearby area. It was a tool that spawned interest in trying new things and places, as several participants said that they could imagine using AalborgLive to find places to eat or drink, and explore new areas. The social aspect of the application showed an interest in seeing where friends are located, and the frequent use of AR showed that many people might be interested in AR technology.

An understanding of the urban environment as an ever-changing entity is important when using the concept of *Digital Urban Ambience*, as live data and having interactive means of tun-

ing into the ever-changing content, lays the foundation for a good user experience.

In a future work it would be relevant to examine when the AR view is used and what it is used for. We found that AR improved the user experience, but we did not try out different implementations of AR. A further look into what exactly users are looking for when using AR and evaluating different implementations would be interesting, in the aspect of improving AR combined with *Digital Urban Ambience*.

A comprehensive evaluation of mobile systems that guides by adapting to the context compared to mobile systems presenting the context, would be interesting in regards to getting an understanding of pros and cons of the two approaches. Especially when focusing on system that addresses both tourists and locals.

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APPENDIX

A

APPENDIX

A.1 DVD

Attached is a DVD containing sound recordings of interviews and video recordings shot during our field study, in the following folders:

- “one-hour” - contains video and interviews from the one-hour study
- “one-week” - contains interviews from the one-week study
- “one-month” - contains interviews from the one-month study

A.2 Design

A.2.1 Thoughts on the GUI

It is always a great challenge to design an intuitive Graphical User Interface (GUI). What really helped the creative process was when the analogy of the lenses as content-filters was made. When thinking of the content-filters as lenses that are applied to the screen, it made us think of the interaction style like the one found on the View-Master.

Figure A.1: View-Master

The View-Master, originally invented in 1939, is a mechanical device showing 3D images created by two different images, one for each eye. To change the 3D image shown in the goggles, the user has to push a button on the side of the device making the image-disk spin. The idea of flicking a finger on the side of the device was transferred to AalborgLive allowing the user to flick a finger along the right side of the screen making a wheel spin as a new lens is applied. The “change lens”-button is presented as a wheel. This design makes interaction easy, as the wheel indicates that the user has to spin the wheel to change lens.

A.2.2 Augmented Reality

Switching from the map view to AR view is done in one seamless motion, by moving the phone from horizontal to vertical position. As can be seen in Figure A.2, the screen will show the map as background to begin with, and gradually tilt and change to the camera input with AR with 3D graphics on top, as the phone is moved upwards.

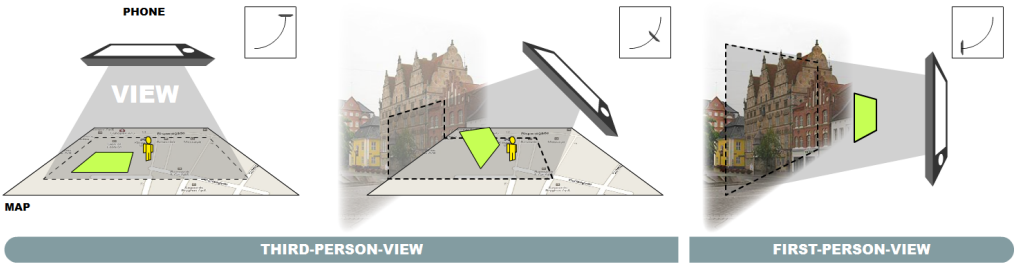

Figure A.2: ArcZoom - Switching to AR view

A.3 Implementation

A.3.1 Mobile application

The AalborgLive mobile application was writen in Java in the Ecplipse system development environment using the Google Android API. It has been designed using HTC Hero smartphones as our primary test and target devices, but is made to be able to run on any smartphone which uses the Android operating system and contains hardware GPS, compass, camera and accelerometer.

A.3.2 Android Market

To get the application out to the participants in the one-month study, we accuired a developer license for Googles Android Market. The Android Market is an online store where people upload and download Android applications. It is available to all Android users, and is build into the Android operating system, and is therefor easily accessible for eveyone who owns an Android device.

This introduced some challenges, as we had to make sure that our phone ran on different hardware with other system specifications and other versions of Android. We only had one type of device for internal testing, so before making the application live, we had to test the application firmly in virtual environments.

A.3.3 Technical design

To make our application able to support the interaction and presentation features of our design, we implemented the application around a 3D engine based on OpenGL ES. Hardware accelerated OpenGL ES is supported by a lot of Android based smartphones, including our own target device HTC Hero, which is the main reason for this choise.

The content within the application is streamed to the phone through webservices via mobile networks (3G and GPRS). The maps are hosted by a 3rd party map API provider named OpenStreetMap, and the rest of the content is hosted and maintained by ourselves (this will be discussed further in the next section). For this reason, we made extensive use of threading within the application to let the user experience as delay-free interaction as possible. When the user changes lens or in other ways trigger a content request, the application will continue to function normally, while the data is being loaded.

A.3.4 Webservice

The webservice and its administrative tools are build in PHP with a MySQL database for persistent storage. The following section describes the functionality and implementational details about the webservice.

Content handling

Content handling is performed in the way that the phone requests an XML file depending on whether the lens in use in the application is either people, places or public transportation.

For the "Places" lens it works in the following way: The phone requests the XML file containing the "Places" elements by sending the following information to the webservice:

- Unique phone ID (IMEI number)
- Users current possition (latitude and longitude)
- Maximum distance in latitude and longitude from the users current possistion, defining the geographical area in which elements are wanted
- The maximum number of elements wanted (in our application this is per default 20)
- Element selection method for obeying the maximum number of elements wanted (Nearest elements or random selection)

The webservice then responds by outputting an XML file containing these elements (stored in a MySQL database), sorted with the nearest element first. Each element contains its geographical location, rotation, icon texture location, a value indicating whether its a bar, café or a restaurant, and content as HTML (description text, images, and rating). The application running on the phone will request this information whenever the "Places" lens is activated and the user moves a certain distance or changes zoom level. It works roughly the same way for the "Public transportation" lens, except for some minor differences. The data about the public transportation elements is provided by NTlive.dk, which is a website featureing live data about all bus stops in northern Jutland.

For the "People" lens its a little different. Requesting the XML file is done based on time (every 5 seconds in our implementation), so that it can be seen on the screen if people are moving around. A value in seconds defining a time window is also send to the webservice, to define how long ago a given person must have been active to be displayed in the application. The application running on the phone is also submitting its current possition every 5 seconds regardless of which lens is selected, so that it can be broadcast to other users of the system when they use the People lens.

Administrative tools

To add and edit content to the system/webservice, we created a series of administrative web-based tools. To handle content shown in the "Places" lens, we made a tool to add and edit places as can be seen on Figure A.3 on the following page. On the left is a complete list of Places within the system represented by their icons, and on the right is an editor with Google maps web API implemented to display the location and easily support changeing the location by clicking on the map.

Figure A.3: The Places administration tool

A similar tool to administrate Public transportation was also made. To administrate users there is just a list with phone ID's (IMEI numbers) known to the system, which can then be assigned a display name.

Logging

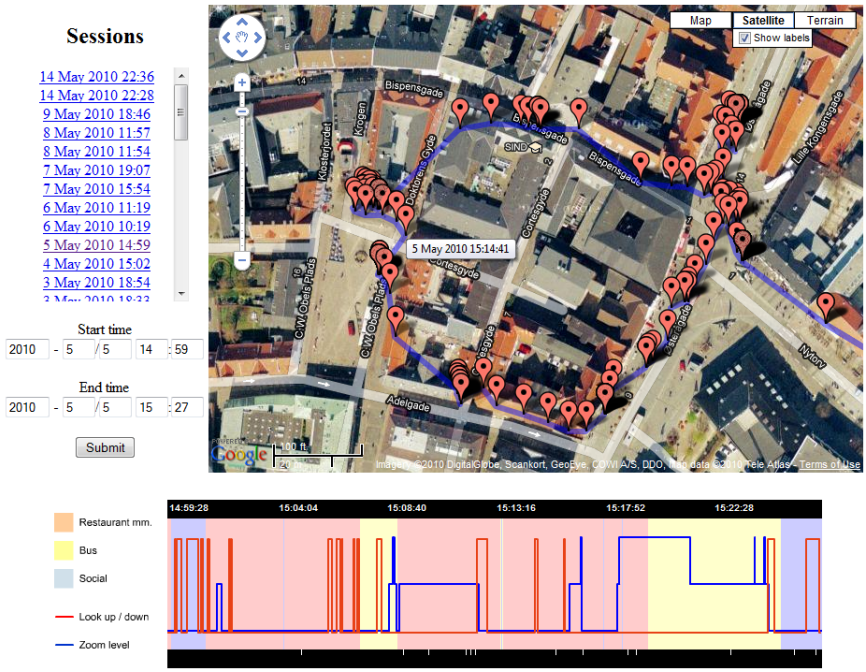

Figure A.4: The log tool showing a test session conducted at the center of Aalborg

To facilitate our evaluation, we needed some raw data on how the application is used when we were not there to monitor the use, and for post analysis. To do this, we saved the location information that the application broadcasts every 5 seconds, to see

where and when the users used the application. Further more it send back data about which lens was selected, the zoomlevel, if the users has used the ArchZoom, and if the user has tapped on an icon. The log tool, which can be seen on Figure A.4 on the preceding page, uses Google maps web API and shows red balloons where the log data was send from at a given time, and the blue line shows the aproximate path the user has traveled. The graph at the bottom shows which lens, zoom level, etc, that the user used at a given time.

A.4 Interview Guide

An interview guide was made for conducting semi-structured interviews during the Field Evaluation. The interview guide can be seen on the following page.

Interviewguide

Restaurant, Café og Bar - visning
Hvad synes du om måden at restauranter, caféer og barer blev vist på?

Gav denne visning dig mulighed for at overskue hvilke restauranter, caféer og barer der ligger i Aalborg?

Synes du at "slideren" gav dig bedre overblik over de omkringliggende restauranter, caféer og barer?

Foretrak du ét zoom niveau frem for et andet for at se restauranter, caféer eller barer?

Hvad syntes du om 3D visningen til at se restauranter med?

Var der noget i forbindelse med visningen af restauranter, caféer og barer som undrede dig?

Bus
Hvad synes du om måden at information omkring busser blev vist på?

Gav denne visning dig bedre overblik over hvilke busser der afgår i nærheden af dig?

Foretrak du ét zoom niveau frem for et andet for at se busstoppesteder i nærheden af dig?

Hvad syntes du om 3D visningen til at se busskilte med?

Var der noget i forbindelse med visning af bustoppesteder som undrede dig?

Socialt
Hvad synes du om måden at information omkring systemets øvrige brugere blev vist på?

Gav denne visning dig bedre overblik over hvor brugerne befandt sig?

Foretrak du ét zoom niveau frem for et andet for at se brugere i nærheden af dig?

Var der noget i forbindelse med visning af brugere som undrede dig?

Samlet
Samlet set, synes du at indholdet i applikationen var {brugbart, spændende}?

Hvordan synes du om måden man interagere med applikationen?

Hvad synes du er godt/dårligt ved applikationen?

Havde applikationen efter din mening nogle mangler?

Kunne du godt forestille dig at bruge denne applikation eller én tilsvarende på daglig basis? Hvorfor

Mønstre
Er der mønstre i den måde de brugte systemet på, så spørg ind til det.

A.5 Evaluation data

In this section, the properties from our Open Coding is presented. The properties were found while examining approximately 4.5 hours of recorded interviews with all of the participants, and approximately 5 hours of video material from the one-hour study. The letters in the paranthesis indicates the following:

- L : Interview from one-month study
- W : Interview from one-week study
- U : Interview from one-hour study
- V : Video from one-hour study

The number after the letter refferes to the number of the user or interview session in our recordings.

A.5.1 Properties from Open Coding

Kunne godt forestille sig at bruge app'en i sin dagligdag
(L3)Kunne godt forestille sig at bruge en lignende app i sin daglig dag. (L3)Hvis han havde net ville han helt sikkert have brugt det mere (L1)Mener app'en kan bruges til at gå på jagt efter nye spisesteder. (spontant) (L1)Selv brugt den for at finde steder, når der generelt var optaget (L1)Ville fremover primært bruge den til bus og indimellem til restauranter, for at prøve noget nyt. (W1)Vil gerne beholde telefonen. Kunne sagtens bruge app'en på daglig basis. (W3)Ville gerne bruge det dagligt hvis han havde det. Kan bruge applicationen til mange forskellige ting. (W5)Kunne måske godt finde på at finde den frem, hvis hun selv havde telefonen, for at se på en restaurant inden hun gik inden eller hun ikke kendte den (W4)Kunne sagtens forestille sig at bruge den hvis man skal med bussen, eller vil prøve at spise et nyt sted (W6)Kunne godt forestille sig at han kunne finde på at bruge den i sin hverdag, for at prøve nogle andre restauranter end han plejer at bruge

Applikationen hjalp med at give et godt overblik over restauranter
(U1)Applikationen gav et indblik i den umiddelbare omkreds (restauranter, osv.) (U3)Applikationen gav overblik, men svært at se præcis lokation pga. de er klumpet sammen (U3)Det kan give et overblik over i hvilke områder der er restauranter (W5)Synes man fik et godt overblik over restauranter (W4)Det gav et godt overblik over restauranter (W3)Synes at restaurant visningen gav et godt overblik. (W6)Synes Places gav et okay overblik (U5)Synes restaurant visningen fungerede meget godt. (V10)Vil se om en restaurant der ligger længere oppe ad vejen også er plcaeret på vores kort. Finder en restaurant som han ikke vidste lå der. (V10)Finder La Strada på kortet, men den ligger ikke det rigtige sted. Bemærker at restauranten han finder som den næste, ligger rigtigt. (V10)Der ligger to oven i hindanden. Forsøger at skjule pool house vha. slideren (V10)Prøver at zoome ud, siger at det giver bedre overblik men der er problemer med at de klumper sammen. (V8)Synes det er smart at man kan se restauranter på kortet, og trykke på dem for at læse mere om dem

Applikationen hjalp med at give et godt overblik over busser
(U3)Applikationen gav overblik, men svært at se præcis lokation pga. de er klumpet sammen (U3)Busserne gav et godt overblik over hvor den nærmeste bus afgår fra (U4)Busser var rigtig godt, gav et godt overblik (U4)Synes applikationen virkede mere overskuelig end traditionelle busplaner (W5)Busser var smart, gav et godt overblik over nærliggende busstoppesteder (W4)Giver et godt overblik over hvor nærmeste busstoppested er, han anede f.eks. ikke hvor de var (W4)Specielt det med busserne er meget brugbart (V1)Skifter til buskategorien, og finder hurtigt ud af hvornår busserne kører. (V1)Bliver bedt om at finde flere informationer om busserne, og klikker derefter på dem. (V8)Prøver at tappe på dem, for at finde ud af hvornår den næste bus går. Læser op hvornår den næste bus går. (V7)Lokaliserer hurtigt busserne og går hen til dem. (V6)Finder hurtigt ud af at danne sig et overblik over hvor busserne går fra. Bruger kortet til at finde det nærmeste busstoppested

Savner at kunne panorere rundt på kortet
(L1)Vil gerne kunne panorere rundt på kortet (L3)Kunne godt tænke sig at han kunne flytte centeret af kortet rundt, uden selv at skulle gå rundt (L4)Man kunne godt være interesseret i at se ting der er længere væk, savner mulighed for at panorere rundt (W1)Ville gerne panorere. Synes at det var en rimelig stor ulempe at man ikke kunne det. (U3)Ville gerne kunne flytte rundt på kortet (panorere) (U4)Savner muligheden for at kunne panorere rundt - surfe rundt og se hvad der er i området (W5)Savner at kunne panorere rundt på kortet (W4)Kunne godt tænke sig at man kunne flyve rundt og ikke altid var låst fast (W6)Savnede lidt at man kunne panorere rundt

Synes godt om busvisningen
(U5)Bus, fungerede fint. (U5)Der var godt med korte præcise informationer (var godt hvis man var kendt) (V10)Tapper selv på busserne for at læse hvad der kommer. Finder ud af hvilken retning bussen går i fordi han kender byerne omkring Aalborg. (V8)"Busserne ser nice ud" (W6)Har haft trykket på et busstoppested og set at man kunne se tider (W6)Mener helt sikkert det er brugbart for folk der tager bussen mere, eller nye i byen. Kunne forestille sig at han kunne bruge det, hvis han f.eks. skulle tage en bus, da han ikke kender busserne i byen.Man kan sidde hjemme og få overblikket på rejseplanen eller sådan noget, men ville være rart nok at få den med ud

Har primært brugt / vil bruge den til bustider
(L1)Primært brugt til bustider, bedre end NT live. Også brugt til restauranter. (L1)Ville fremover primært bruge den til bus og indimellem til restauranter, for at prøve noget nyt. (L2)Begrænset anvendelse - er godt kendt i Aalborg i forvejen. Primært busser. Har brugt app'en hjemmefra (L2)Busserne virkede fint, hvis det var noget man skulle bruge. Har ikke haft brug for at finde busser, kender selv bustiderne på dem han skal med (L3)Primært brugt til busser (Har ikke flatrate, bruger den derfor kun de steder hvor der er wireless, eksempelvis i xbussen) (L4)Synes bus delen er rigtig smart, god mapping med kort og markering af hvor busstoppestedet er på kortet (W1)Brugt det til at finde busser (W1)Det bedste ved applikationen var mulighed for at se busser. "It was great for finding the right bus stop" (W1)Man kunne klikke på de forskellige bus stoppe steder for at se hvilke busser der gik fra disse. (W2)Brugte primært app'en til busser. "Used it a lot for that". Brugte det hver dag for at finde ud af hvornår hans bus kommer. (L1.2)Brugt den primært til bus (U3)Busserne virkede rigtig godt - til lokale primært (U3)Bus og restaurant delen er det mest brugbare (W4)Har prøvet at tjekke en bus han skulle med (U5)Kunne godt bruge bus delen.

Bus visning var smart, men tager ikke selv busser
(W3)Bus visning var smart, men det vil være rart hvis man kunne se bussens rute samt næste stop. (W3)Har ikke selv kørt med bus, fordi han cykler. (W3)Det var rigtigt godt til busser. (U4)Busser var rigtig godt, gav et godt overblik. Synes applikationen virkede mere overskuelig end traditionelle busplaner. - Tager næsten aldrig busser i Aalborg (W5)Busser var smart, gav et godt overblik over nærliggende busstoppesteder (W4)Synes busserne var smart - tager dog ikke så meget bybusserne

Tager ikke selv busserne
(U3)Tager sjældent selv busserne (W6)Har ikke kigget meget på busvisningen, har selv bil

Savner at kunne se mere information om busruten/planen
(W3)Bus visning var smart, men det vil være rart hvis man kunne se bussens rute samt næste stop. (U1)Savner at man kunne se en regulær busplan, som der normalt er ved busstoppestederne (U2)Busskilte skulle være på begge sider af vejen for at give mening. Troede at det busstoppested ved Nytorv kun viste busserne der kørte den ene vej. (U2)For at kunne bruge busvisningen i 3D, skal man vide hvor bussen kører hen. Ved ikke hvor 1C kørte hen. Synes det var åndsvagt. (U3)Busserne ville være svære at bruge for udefra kommende, da man skal vide, ud fra busnummeret, hvor den kører hen (U5)Hvis man skulle benytte sig af 3D funktionen skulle den være mere præcis, den kunne være smart til at adskille de forskellige stoppesteder fra hinanden. (V4)Finder ud af at visningen af busser viser busser der kører i begge retninger. Mener at der skulle have været en på hver side af gaden. (V4)Synes ikke busskiltet siger så meget, fordi hun ikke ved udfra nummerene hvor de kører hen.

NTs bus oversigt er uforståelig
(V1)Forstår ikke bus oversigten. Vil gerne kunne sige hvor man skal hen

3D busvisningen var ikke nødvendig, når man alligevel stod tæt på en digital tavle
(U2)Unødvendigt med busskilte når der er en tavle.

Hvis man alligevel skulle gå hen til stederne kan man lige så godt læse/få information derfra
(U5) Hvis man alligevel går rundt, kan man lige så godt kigge på menuskiltene ved restauranterne.

Vil / har indimellem brugt den til restauranter
(L1)Ville fremover primært bruge den til bus og indimellem til restauranter, for at prøve noget nyt. (L1)Primært brugt til bustider, bedre end NT live. Også brugt til restauranter (L1)Mener app'en kan bruges til at gå på jagt efter nye spisesteder. (spontant) (L1)Selv brugt den for at finde steder, når der generelt var optaget (W2)Brugte app'en mens han kørte bus. Synes det var sjovt hvordan restauranter poppede frem, mens han kørte forbi dem. (U3)Bus og restaurant delen er det mest brugbare (W4)Det med restauranterne er meget spændende (W6)Har haft trykket på en restaurant for at se en bekrivelse af den.

Brugte kun app'en i korte sessioner
(L1)Brugte app'en i korte sessioner, fordi: -Den bruger meget strøm -Ville gerne have at den kunne køre i baggrunden, for hurtigt at starte op -Man bare lige skal tjekke noget -App'en er til lige at lave et hurtigt tjek på hvad jeg ska lave lige her -Bruger

generelt apps til korte tjeks; "ind og gik og så ud igen på hovedskærmen." (L1)Ser på app'en, som en "jeg er i tvivl om hvad jeg skal gøre her, nå man så går jeg lige ind og kigger." (L1)Ved ikke helt med venner, forestiller sig at det eksempelvis er hvis man sidder på en bar, kan man tjekke om der er nogle venner i nærheden. (L2)Ville mest bruge app'en i korte sessioner, grundet at han vil bruge den for lige at finde det nærmeste busstoppested eller spisested (L3)Vurdere at det nok kun vil være i korte sessioner han vil bruge app'en

Brugt app'en i længere sessioner
(W1)Har haft den tændt i et længere stykke tid (20 minutter). Har været i lommen, eller på bordet.

Prøvet den sociale del, men kunne ikke se nogen i nærheden
(L1)Prøvet social delen 2 gange (Mangler folk der bruger det) Har ikke set at der har været nogen i nærheden. Har været begrænset fordi han ikke har haft nogle venner der har brugt det. (L4)Har ikke brugt den sociale del - Mangler at han havde nogle venner som også brugte det (L1.2)Prøvet People, men kunne ikke finde nogen, så gik væk fra det igen.

Har ikke brugt den sociale del ret meget, da man ikke har nogle venner der bruger systemet
(L1)Prøvet social delen 2 gange (Mangler folk der bruger det) Har ikke set at der har været nogen i nærheden. Har været begrænset fordi han ikke har haft nogle venner der har brugt det. (L2)Har kun brugt den sociale del lidt, men kunne se folk, dog ikke trykke på dem. Ville gerne kunne se hvor vennerne var og trykke på dem. (L3)Har ikke brugt socialt - har en forståelse for at det skal bruges til at se hvor venner i nærheden er (L4)Har ikke brugt den sociale del - Mangler at han havde nogle venner som også brugte det (L4)Det sociale er smart nok hvis man skal finde hinanden, det kan man dog også i google maps (W1)Prøvede social, men så kun en grå person, som han ikke kunne klikke på. (W1)Kunne ikke se venner. (W2)Brugte ikke People ret meget. Kunne ikke se nogle venner. Synes det var trist at der ikke var nogen. (U3)Kræver mange der bruger det, for at det bliver interessant (U3)Kunne være smart hvis man kunne linke det sammen med facebook venner, evt. gøre opmærksom på hvis der er en ven i nærheden (U4)Det ville være smart hvis den sociale del var linket til facebook, med venner osv. (W6)Har ikke rigtig fået brugt den sociale del

Kunne se grå personer, men undrede sig over at man ikke kunne gøre noget med dem
(W2)Så en grå person og ville gerne tilføje ham som ven, men det kunne ikke lade sig gøre. Blev ked af at man ikke kunne. Ville gerne kunnne skrive/ringe til ham ved at tappe på ham. Lave konference kald ved at klikke på flere. (U1)Ikke intuitivt med forskellige farver på grå/blå smurfs (U2)Forstod ikke hvorfor nogle var grå. (U5)Forstod ikke det med de grå personer. (V1)Forstår ikke de grå mennesker. (V10)Ser en grå mand. Bemærker at den grå mand går hen i mod ham. Vil gerne tappe på den grå mand, men kan ikke. Tror at det er en der er offline. (V4)"Hov, der er en mere. Og der er mange. Hvorfor er de grå?". Sprøger om man kan komme i kontakt med dem der er grå og om man kan ringe til dem.

Kunne se grå mænd og forstod det
(V8)Siger med det samme at den grå mand er ukendt

Har fundet blå personer

(W3)Så Markus, Ali og en anden person via person visning. (U2)Det var lidt sjovt at man kunne se hvor hinanden var, men vil kun bruge det hvis der var mulighed for at gå offline. (U3)Social del var meget sjov at kunne se at der var andre der brugte det (V1)Men finder hurtigt de blå personer. (V3)Havde lidt sjov med at kunne se veninden (V3)Leder efter Niels i 3Dviewet og finder ham (V10)Lokalisere Niels i en gade. Skifter til restaurant visning, for at konstatere at han står lige uden for Polly's. (V7)Finder Niels uden problemer. (V6)Social kategorien vækker interesse og hun finder hurtigt sine to kammerater (V4)Finder kammerat på kortet. Udbryder: "Hey. Det er Henriette."

Har lidt svært ved at se hvad man skulle bruge People delen til
(W3)Synes ikke at man kunne bruge det til noget. (U3)I tvivl om hvad man egentlig ville bruge det til (U5)Ved ikke helt hvad man skal bruge det til.

People delen kan bruges til at finde hinanden
(W3)Person visning kan bruges hvis nogen ikke kan finde vej. (W3)Man skal kunne filtrere visningen, hvis der er mange mennesker. Fx hvis man gerne vil finde sin ven. (U2)Det var smart hvis man skulle mødes. (U3)Det er måske nemmere at ringe til hinanden, hvis man lige vil finde hinanden, fremfor at starte applikationen op for at finde hinanden (W4)Gav et godt overblik over hvor ens venner befandt sig (U5)Kan hjælpe andre med at finde vej. (V1)Skal finde kammerat, siger: "Så må vi håbe at han står stille, så han ikke går den anden vej rundt om blokken for at finde mig." (V1)Bruger app'en til at se hvad retning han står i, og finder ham ved at kigge i den retning. (V7)Vil finde Thomas: Håber ikke at han er på vej væk. Udbryder: Fundet! Når hun kommer hen til thomas. (V4)Møder kammerat, og skifter selv over på People for at se om hun nu virkelig også er der hvor hun er. Det er hun, konstatere hun.

People delen er mest for sjov
(W4)Det sociale er mest en lidt sjov ekstra ting (W4)Det sociale er mest en tillægs ting som er mest for sjov

Udtrykker bekymring i forhold til privatlivet og people delen
(U2)Det var lidt sjovt at man kunne se hvor hinanden var, men vil kun bruge det hvis der var mulighed for at gå offline. (U2)Bekymret over at folk ville kunne vide hvor man er. Hvis man melder afbud til noget, og så folk kan se at man går rundt nede i byen. (U2)Man skulle også kunne vælge om alle venner skal kunne se én eller det kun er nogle. (U2)Er temmelige bekymret for privat livets fred. Samme princip som Facebook, med flere indstillinger for privacy. (U3)Bekymrede omkring hvordan man håndtere privatlivet, i forhold til at vise hvor man er (U4)Kommer kort ind på problemet omkring privatlivet, i forhold til at alle kan se hvor man er (W4)Synes man skulle kunne slå den social del fra og til, i forhold til privatlivet (U5)Meget BigBrother-agtigt. Det er fint nok så længe man kan slå det fra. (V8)Kommer kort ind forbi problematikken med privatlivet og at man kan se hvor folk er

Savner at kunne se hvad klokken er
(L1)Savner at kunne se hvad klokken er i toppen, som man plejer at kunne på telefonen. Bruger telefonen som et ur, har ikke armbåndsur. (U3)Kunne være rart at man kunne se et ur

Det er frustrerende at skulle vente på GPS signal
(L1)Bliver forvirret når man tænder og slukker, bruger for lang tid på at find GPS. (L1)GPS langsom - er ikke velegnet til at man går rundt i byen og slukker og tænder

app'en. (Skal finde nyt GPS hele tiden) (L4)En barrierer at man skal vente på det starter op hver gang og finder lokationen (V10)Finder først ud af at den gule mand er ham senere fordi at gps'en hænger.

Har ikke lagt mærke til slideren
(L2)Han havde ikke lagt mærke til / brugt slideren. (U1)Ikke opdaget slider

Har ikke forstået ideen med slideren
(W3)Forstod ikke hvad slideren gjorde. Troede bare at den gjorde skiltene større og mindre. (U5)Mente at man ikke ville vælge mellem mad og drikke. (Muligvis misforståelse) (V4)Skal zoome, sprøger om man både kan zoome på hjulet og på slideren. Men konstatere derefter at de fremhæver istedet for at zoome. Med lidt hjælp finder hun ud af at det fremhæve henholdsvis caféer og restauaranter.

Slideren var kilde til forvirring
(U1)Slideren var kilde til forviring (U1)Hjul interaktionen var god, slideren var svær at gennemskue (U2)Synes det var mere logisk, hvis steder der både er restauranter og barer var store, hvorend slider-arrowen var placeret. (U2)Slider effekt var ikke tydelig nok. Foreskellen på størrelsen var ikke tydeligt nok. (V1)Klikker i hver sin ende af slideren. Ved tilsyneladende ikke at man kan flytte med "pilen" (V3)Tager lidt tid at finde ud af at det er slideren man skal flytte på, for at ændre på om man finder restauranter eller barer. Ser i første omgang ikke et billboards ændrer størrelse

Har brugt slideren
(L1)Slider: brugt den lidt. Gjorde nogle ting større og andre mindre. (W1)Brugte slider. Den var god til at sortere mellem restaurenter og barer. (W4)Har leget lidt med slideren

Har forstået ideen med slideren
(L1)Slider: brugt den lidt. Gjorde nogle ting større og andre mindre. (L2)Har gennemskuet at man kan slide under informationen for restauranter. (L4)Har ikke brugt slideren ret meget, kunne ikke lige gennemskue hvad den gik ud på. Har heller ikke været i et område hvor der er meget indhold. Forventer umiddelbart at den sortere i hvilke type spisestedet man vil se (W1)Brugte slider. Den var god til at sortere mellem restaurenter og barer. (W2)Forstod sliderens formål, men synes ikke at den gav den store effekt. Mente at det var fordi han ikke brugte den hvor der var mange forskellige typer steder. Forstod dog ikke at slideren kunne stå på fx 3/4. Dvs. mellem café og bar. (U1)Gav lidt bedre overblik (U3)Slideren virkede meget godt (W4)Slideren gav en lille smule ekstra overblik over hvor der f.eks. var drikke steder, men ikke nemt at vide at det var cafeer i midten (U5)Slider lidt gimmick, men det virkede meget godt at de ikonerne skiftede størrelse.)V10)Da han får at vide at han skal finde en bar, kører han slideren over mod drink glasset. Går ud fra at hvis man køre slideren helt over, så forsvinder alt der ikke er en bar. (V7)Finder ud af at slideren fremhæver henholdsvis barer eller restauranter. (V6)Tror først at man kan sorterer bar/cafe/restaurant på hjulet, men finder hurtigt ud af at det er vha. slideren i bunden (V4)Spørger om slideren fremhæver steder. (V4)Testleder siger, "Når du nu skal finde en restaurant?" Og så finder hun selv ud af at flytte slideren over til venstre. (W6)Slideren fungerede meget godt - han har forstået ideen med den

Har prøvet 3Dview for busser og synes det var smart
(L1.2)Har prøvet 3d en del - Synes det var meget cool, men skiltet var meget stort når man stod henne ved busstoppestedet. (L1.2)Synes det gav god mening den måde

at busskiltet var udformet på. (L1.2)Ville gerne have at man kan se busskilte i zoom 2x og 4x (U1)Kristina oplevede ikke samme problemer - det fungerede rigtig godt (U4)3D var rigtig smart til busser (V8)Det ser nice ud med 3Dview af bustiderne (V7)Holder telefonen op mod busserne og konstatere: "Det er smart."

Har prøvet 3Dview og synes det var smart/cool
(U3)3D-visning var cool - blev dog lidt småt indimellem (V8)Går lidt rundt med telefonen i 3Dview. Forsøger at finde flere logoer/billboards i 3Dview. Står nærmest og spejder efter steder i 3Dview. Synes det ser fedt ud med "de ikoner der". Stiller sig igen helt op foran stedet for at se det svævende logo (V9)Syntes 3D visningen er sjov.

Har prøvet 3Dview og synes mest det var for sjovt
(U2)3D view var meget smart, men nok ikke særlig brugbart. Forstod ikke hvorfor man skulle "kigge igennem" telefonen. (U3)3D var mest "for sjov" (U4)3D restauranter delen var knap så nyttig eller smart (W5)Synes at 3D-visning var sjov at bruge - brugte den med sin kæreste rundt om i byen en dag (W4)Har brugt 3D-visning - synes det er meget sjovt når man går rundt ved stederne (W4)Tror det sjove ved det er at det er anden måde at vise det på og det er meget sjovt at lege med (W4)Kunne også være sjovt i områder hvor der er meget, så man kan se mange svæve rundt (U5)3D er måske mest en gimmick. (W6)Har prøvet 3D / AR delen, tror mest det er noget man kan bruge for sjov

Har prøvet 3Dview for restauranter, havde lidt problemer
(L1)3Dview virkede næsten - kun se ting der var meget tæt på (L1)Prøvede 3D i restauranter nede i byen. Det virkede næsten, var lidt problematisk hvis man stod og kigge på dem fra siden af. (L4)Har leget lidt med 3D delen, men der er ikke noget indhold omkring ham (W3)Prøvede 3D, men kunne ikke se noget. Prøvede den ikke siden. (V10)Finder et skilt i 3D. Det hænger skævt, så han kan ikke se det ordentligt. Går over på den anden side af gaden for at se det ordentligt.

Har prøvet 3Dview for busser, havde lidt problemer
(L1)3Dview virkede næsten - kun se ting der var meget tæt på (L1)prøvede bus 3D ved AAU busterminal, kunne ikke se den ordentlig (L3)Har prøvet 3D delen - men ikke set et busstoppested (W3)Prøvede 3D, men kunne ikke se noget. Prøvede den ikke siden. (U1)Jakob havde problemer med et meget stort busskilt i 3D viewet (V10)Kan ikke se busskiltet i 3D. Prøver at gå skygge, men så står han bag en bygning og går ud derfra igen. Tænker ikke over at han godt ville kunne se busskiltet "igennem" bygningen. (V8)Spørger lidt indtil hvordan man ser busserne i 3D (V7)Vil gå helt hen til busstoppestedet for at bruge 3D view.

Forventede at logo/billede af facade ændrede sig når han gik i 3D view
(W2)Forventede at logo/billeder af restauranter ville ændre sig når man kiggede op via 3d view. Da de stadig så ens ud, troede han at det ikke virkede.

Har ikke prøvet 3D visning
(L2)Havde ikke brugt 3D visningen. (W1)Brugte ikke 3D. Prøvede det på kontoret, og så intet, vidste ikke det kunne bruges i byen. (W2)Vidste ikke at man kunne se busser i 3D mode.

Svært at se / finde ud af hvad der foregår når billboards drejer i 3Dview
(U1)Svært ved at se billboards i 3D når det står på skrå (At man se det fra siden) (V1)Kan ikke se Natalies i 3D, fordi den pejer den anden retning.

Svært at se hvad billboards forestiller, de er små
(U2)Billederne var også for små til at man kunne se hvad de forestillede. Vil være bedre med ikoner. (U2)Billeder (planes) var meget, meget små. Når man havde zoomet ud kunne man ikke se hvad det forestillede. (U4)Det kunne være svært at adskille dem, når ikoner var små og ikke så nemt at se hvad de forestiller (U3)Det var smart når billboardet var et logo, var nemmere at se (U3)Billboards logoer var små, nogle gange svære at se hvad de forestiller (U4)Det kunne være svært at adskille dem, når ikoner var små og ikke så nemt at se hvad de forestiller (V2)Nogle af billboardsene er noget små og det er lidt svært at se hvad der står der

Brugte mest kortet til at finde rundt
(W3)Brugte kun 2D. Brugte det for at finde steder. (U1)Kortet er nemmere at bruge end 3D view (U1)Man sidder lidt fast i enten at bruge 3D eller bruge kort (U3)Man ville nok ende med at bruge kortet mere, fremfor 3D-visningen (U5)3D er måske mest en gimmick. (V8)Går rundt med telefonen i holdt nede, sådan at man kan se kortet

Brugte mest zoom niveau 2x(Zoomet helt ud)
(L1)Var altid zoomed helt ud i busview (L3)Mest zoomet helt ud - gav bedst overblik. Har dog skiftet lidt mellem zoom niveauerne. (W1)Foretrækker 2x til at finde restauranter mm. Dog too crowded i dette zoom level. (W1)Foretrækker 2x til at finde busser. (W2)Brugte primært 2x til busser, men brugte også 4x hvis de lå lidt for tætte. Så var det nemmere at ramme. (W3)Brugte 4x og 2x til at overskue restauranter. (W3)Brugte 2x til at overskue busserne. (W4)Har mest brugt det yderste zoom niveau i bus filteret, da han skulle kunne se den ved kennedy arkaden (W4)Foretrak det største zoom niveau for at få et overblik (W6)Fortrak det zoom niveau helt ude, for at kunne se det hele og så blev det klumpet sammen og ville gerne kunne flytte centrum

Brugte mest zoom niveau 4x(mellem niveauet)
(L2)Zoom helt ind viste ikke nok. Brugte istedet mellem zoom niveauet. Da det zoom helt ud var for uoverskueligt. (W3)Brugte 4x og 2x til at overskue restauranter. (W3)Når han kom tættere på selve busstoppestedet brugte han 4x. (U4)Foretrak zoom niveau mellem (W5)Zoom niveau mellem var nok det mest brugte

Brugte 8x eller 4x til at udvælge ting. Brugte 2x til at denne sig et overblik
(W1)Foretrækker 2x til at finde restauranter mm. Dog too crowded i dette zoom level. (W2)Brugte 8x zoom for restauranter, brugte 2x for at få et overblik. (W4)Har mest brugt zoom niveau x8, nok fordi han bor helt inde i midtbyen, hvor der er massere af indhold(restauranter). Ville nok være et zoom niveau med mere overblik hvis man boede længere ude (V10)Kan ikke se nogle busser umiddelbart, zoomer derfor ud for at få overblik. (V4)Testleder spørger hvad hun kan gøre for at se nogle der måske er længere væk. Hun zoomer derefter ud.

Har ikke noget favorit zoom niveau
(L4)Har ikke noget favorit zoom niveau - synes det er godt man kan vælge forskellige zoom niveauer (U1)De var lidt ueninge om hvilket zoom niveau var bedst (U1)Favorit buszoom niveau er afhængigt af hvor langt der er til det nærmeste bussted og hvor man er - Når man står så tæt på er det alligevel nemmere at gå hen til stoppestedet (U2)Bruger zoom afhængig af hvad man skal med det. Skal man have overblik bruges 2x. (U2)Hvis man skal finde vej var det nemmere i 4x eller 8x så man kunne se vejene og deres navne ordentligt. (U2)Det var nemt at finde busserne i forhold til kortet

ved zoom 2x. (U2)Zoomede ind når man nærmede sig bussen. (U3)Krævede man skulle zoome ind for at se helt præcis placering, men så mistede man overblikket. (U3)Zoom niveauet var generelt kontekst afhængig. Var der meget indhold i området blev tingene klumpet sammen, var der lidt kunne man ikke se noget når man var zoomet helt ind (U4)Zoom ville være smartere, hvis det var ligesom man kender det fra iPhone

Zoom interaktionsmedtoden er svær
(V1)Har virkeligt svært ved at zoome. (V7)Zoomer lidt længere ind, men kan så ikke se restauranten længere. (V7)Spørger hvilken vej der zoomer ud. (V6)Har lidt problemer med at skifte til zoom niveau 8x, da der kommer et lille hak/lag når man gør det (V4)Kommer meget af tiden til at dreje hjulet forbi 8x, fordi systemet venter på cam bliver tændt.

Indholdet under restauranterne er varierende
(L1)Meget varieret hvor meget tekst der var under restauranterne (L1)Ville gerne kunne se menukortet / en liste over hvad man kan få / Mere kategorisering (L4)Indholdet til restauranterne virker lidt kort og kedelig - Har ikke set at man kan slide til siden. (U3)Content var af forskellige kvalitet, vil gerne have bedre og mere information (V10)Inkonsistens hvor rate modulet er henne i indholdet. (V4)Klikker på SushiSushi. Er overrasket over den korte beskrivelse.

Indholdet er brugtbart
(L2)Mener indholdet er brugbart, dog mere for folk der ikke er så kendt i området. Kan sagtens se hvad man kan bruge app'en til. (L3)Busview virkede overskueligt - gav godt overblik. Smart at man kan se busstoppestederne på kortet. (L3)Har brugt systemet til at checke en bus han skulle med (L3)Mener app'en er brugbar og indeholder brugbar information (L4)Mener generelt at indholdet er brugbart (W2)Synes der var en god forklaring ved stederne. Især John Bull hvor der stod hvad der var af highlights på stedet. Eks. hvornår er der tilbud og fodbold på projektorer. (W2)Fandt ud af at der var mange spændende steder (restauranter mm), som han ikke kendte til. (W3)Det var godt med en forklaring på hvad der var i restauranten mm. Beskrivelserne af restauranter var gode. (U2)Men det var også godt med en generel beskrivelse af stedet. (U2)Billeder i indhold var godt, så man kunne fornemme hvilken stemning der var inde på stedet. (U5)Det var godt med en kort beskrivelse der klassificerer restaranten. (V10)Går hen til Big Mamma, vil se om der er nogle der har ratede den. Siger, at det er nok det der er mest interessant. (V6)Synes det er smart man kan trykke på dem og så få ekstra information om dem

Har fundet ud af at man kunne scrolle i content viewet
(W2)Har scrollet i indholdet, og så flere billeder af stedet. (V3)Forsøger at slide op og ned et par gange, inden hun opdager at man skal slide sidelæns under contentview, for at kunne rate (V4)Hun får at vide at hun kan læse mere om det, og finder derefter selv ud af at hun kan scrolle i indholdet.

Svært at finde ud af at man kan scrolle på contentview
(L1)Tog lidt tid at finde ud af at man kunne slide til siden på informationssiderne for restauranterne (L2)Han havde ikke lagt mærke til / brugt slideren. (L4)Indholdet til restauranterne virker lidt kort og kedelig - Har ikke set at man kan slide til siden. (U1)Contentviewet er ikke intuitivt at man skal slide til siden og ikke ned, som man er bekendt med (U1)At man kunne se billedet gav en ide om at man kunne slide i

contentview (U2)Opdagede kun ved et tilfælde at man kunne "bladre" i indholdet. (V10)Skal have hjælp til at scrolle med indholdet. (V8)Scroller i starten den forkerte vej i webviewet

Savner mulighed for at få en listevisning over steder i nærheden
(U3)Efterlyser mulighed for at kunne browse steder på en liste, vælge en og derefter få vist dem på en liste (U3)En i nærheden-af funktion, man kan indstille til at finde steder indenfor en bestemt afstand (U4)Måske man skulle have mulighed for at få vist restauranter på en liste (V8)Leder først efter en søgefunktion, for at finde en restaurant, bar eller café (V8)Savner at man kan søge på et sted og blive guidet derhen (V6)Efterspørger at kunne søge efter et bestemt sted, men synes så at den bliver mere GPS agtig

Synes at det var smart at ikonerne var på kortet, og ikke en liste
(U5)Smart at man kan tilgå NTLive's stoppesteder på et kort frem for en liste.

Ønsker mere indhold / flere kategorier
(L4)Kunne godt tænke sig noget mere indhold, der er ikke så meget i hans område + at det kunne være interessant med andre ting, som f.eks. forlystelser (L4)Kunne godt tænke sig mere brugergenereret indhold, f.eks. kommentarer, anmeldelser (L4)Savner lidt uddybende information om hvor busserne kører hen (W1)Ville gerne have kategorier der viste zoo, politistation, benzinstation, hoteller, attraktioner osv. (W1)Mangler flere kategorier. (W2)Synes der var mest indhold i byen. (W2)Vil gerne have at der også blev vist en menu, når man tappe på en restaurant mm. (W2)App'en var rigtig god, men manglede flere kategorier. (W3)App'en manglede caféer og restauranter (W3)Systemet ville være godt hvis mange ratede restauranter mm. (W4)Man kunne læse noget om restauranter, ville være godt hvis der stod nogle bruger meninger, nemmere og hurtigere at danne sig et indtryk af restauranten (W4)Ville gerne have haft noget mere indhold (W4)Synes der skulle være turistattraktioner med (W6)Ville gerne have haft et menukort under stederne (U1)Meget centreret. Kun restauranter i centrum så det ud til. (U1)Ville være godt med menukort, priser og mad type under content view (U1)Menuer, priser og kategori inddeling kunne gøre det mere interessant for folk der er kendte i området (U1)Kunne være rart hvis man kunne se hjemmesiden for stederne (U1)Applikationen kan udbygges i det uendelige, med f.eks. taxaer, bowlingbaner, forlystelser, skaderstuer osv. (U2)Der måtte også gerne være menukort, priser og åbningstider. Skulle representeres som punkter man kunne vælge. Ensrettet for alle steder. (U3)Alternativt til slideren kunne man også lave en kategori til hver type, i stedet for at have alt samlet i en (U3)Ville gerne have haft informationen ensrettet, sådan at det var ens alle steder. (U3)Man kunne lave prisniveau (U3)Applikationen kan udvides med mange ting (U4)Ville være smart hvis der var mange der brugte den og der var meget indhold (U4)Savner mere inddeling og kategorisering. Prisklasse, type, osv. (U4)Vil gerne have flere ting, som eksempelvis butikker (U5)Indholdet var ok, var måske rart med en smiley rapport. (U5)Ville være smart at udvide ratingen til hele brugeranmeldelser. (En trustpilot med mad) (V1)Vil gerne kunne se mere information fx. ved et link til hjemmeside.

Ville gerne kunne sortere yderligere i hvilke places der bliver vist
(U2)Vil gerne kunne filtere efter flere kriterier. Fx. mad type og pris, ko, fisk. (U5)Vil gerne kunne sortere efter pris, eksempelvis via farver på ikoner. (U5)Hvis man skulle bruge restauranter, skulle man kunne filtrere bedre. Indtaste oplysninger for at få

bestemte restauranter vist. (V3)Ville vælge en restaurant ved at læse om de forskellige enkeltvis, kan ikke finde nogen søgefunktion

Ville gerne have mulighed for at få en anbefaling fra systemet, baseret på andre brugeres rating
(U1)Kunne være smart at få anbefalet et sted ud fra andres rating (U4)Kunne være godt med flere parametre, sortering efter hvad andre brugere har rated osv.

Har ikke set at man kan rate / ikke prøvet at rate
(L1)Fandt først sent ud af at man kunne rate (V6)Ved ikke hvor man skal rate stederne, men finder det med lidt hjælp

Har besøgt et sted, pga. af app'en
(L1)Selv brugt den for at finde steder, når der generelt var optaget

Har ikke besøgt et sted, pga. af app'en
(L2)Har ikke besøgt nogle steder på baggrund af app'en (W1)Spiste ikke på nogle restauranter på vegne af app'en. (W2)Besøgte ikke nogen restauranter på baggrund af beskrivelserne i app'en. (W3)Har ikke besøgt nogle restauranter. (W5)Har ikke besøgt en restaurant pga. app'en (W4)Har ikke besøgt en restaurant pga. app'en

Har set at man kan rate, evt. ratet steder
(L2)Synes godt om at man kan trykke på dem, se en beskrivelse af cafe/barer og rate dem. Virker som det skal. (W1)Ratede kun en restaurent. (W2)Har ratede nogle af restauranter mm. (W3)Rated pizza ved Klingenbjerg og 5 restauranter mere. (V10)Har været mange gange på Las Vegas. Siger at det er et godt sted. Rater det derfor højt. (V7)Klikker på en RiceIn, og rater den uden problemer.

Finder hurtigt stedet hvor man rater
(V1)Finder hurtigt ud af hvor man skal rate (V10)Ratede automatisk et sted uden at han er blevet bedt om det.

Problemer med at interagere med rating
(V1)Prøver at rate ved at "slide" hen over sjernerne (V4)Ser ratingen og udbryder: "2 en halv. Den er jeg ikke enig i."Får at vide at hun kan ændre det. Klikker men rammer forkert og giver den 3. Klikker igen og giver den 2, siger: "De har nemlig engang glemt at putte oliven på min mad." (V4)vil gerne rate den 4. Forstår ikke hvorfor den så kun viser 3 stjerner.

Har (stortset) kun brugt app'en hjemmefra
(L2)Begrænset anvendelse - er godt kendt i Aalborg i forvejen. Primært busser. Har brugt app'en hjemmefra (L4)Stortset kun brugt app'en hjemmefra og en enkelt gang et andet sted (W6)Har primært leget lidt med den hjemmefra

Har brugt app'en i bussen
(W2)Brugte app'en mens han kørte bus. Synes det var sjovt hvordan restauranter poppede frem, mens han kørte forbi dem.

Applikationen er velegnet til folk som ikke er kendt i området
(L2)I det hele taget var app'en nok mere velegnet til folk der ikke er så kendt i området. (U1)Når man er kendt i området er applikationen ikke så brugbar (U1)Ville ikke bruge den ret meget i Aalborg - Måske menukort/restaurant del, de tager ikke selv bussen normalt (U1)God hvis man er ude at rejse / nye steder (U2)Restaurant funktion var spændende når det var steder man ikke kendte. (U2)Vil ikke bruge

app'en til at finde restauranter i hjemby. (U3)Mener den er mest velegnet til turister, men kan også bruges af lokale (W5)Det er nok mere hvis man er turist/ny i byen man bruger appen til det (U5)Restauranter passer måske bedre til turister, eller hvis man kom til en ny by. (V7)Siger at man skulle prøve den et sted man ikke kender byen, men den kunne da også være smart nok til at finde inspiration til hvor man skulle spise. (W6)Hvis man er fastboende i byen er den nok ikke så brugbar, som hvis man er ny i byen

Interaktionen var nem
(L2)Interaktionen var nem og forståelig (L4)Interaktionen er meget cool - man skal dog lige vænne sig til det, da der ikke er nogen guide til det i starten (W1)Simpelt og intuitivt at bruge. (W2)Den var nem at bruge. Det var første gang han havde brugt touch screen over længere tid. (Se too crowded) (W3)Interaktionen var okay. Havde ikke problemer. (W4)Synes inteaktionen er meget lige til, det med hjulene er nemt at forstå (U1)Hjul interaktionen var god, slideren var svær at gennemskue (U3)Man fangede hurtigt interaktionen, det kunne være lidt svært at få den til at blive på 8x zoom (V1)Finder hurtigt ud af at hjulet er en form for menu. (V1)Finder selv ud af at man kan scrolle i indholdet. (V1)Har ikke problemer med at zoome.

Interaktionen med hjulet gav problemer
(U2)Telefonen var nogle gange for langsomt til at registre input fra brugeren. Hjulene reagerede langsomt. (U2)Mærkeligt med et hjul når der kun er tre muligheder. Bruger forventede at der var flere kategorier "på den anden side" af hjulet. Testperson "ledte" efter flere kategorier. (U4)Hjulet var smart, men der var ting i det der ikke var så logisk bygget op (V7)Spørger om det også er på hjulet man skal dreje på for at se personer. (V6)Tror i første omgang at man også skal trykke på hjulet efter at have drejet det

Too crowded/svært at se billboards. For mange barer og caféer
(W1)For mange barer og caféer. Too crowded. (W1)Det var svært at tappe på dem, når der er for mange. (W2)Problemer med at tappe på skærmen når der var for mange restauranter mm eller busser. "Man rammer forkert når man har travlt" (W5)Nogle gange klumpede de lidt sammen, men så kunne man zoom ud/ind (W6)Hvis man zoomer meget ud bliver det meget klumpet sammen (U2)Der var mange restauranter. Så mange at det var svært at skelne dem fra hinanden. (U2)Det var svært at tappe på den enkelte restaurant, når der var så mange omkring dem. (U3)Billboards kunne være klumpet sammen (U3)Applikationen gav overblik, men svært at se præcis lokation pga. de er klumpet sammen (U4)Billboards virkede meget godt, men manglede overblik når de klumpede sammen oven på hinanden (U5)Problemer når der var for mange restauranter på skærmen. Bøvlet når to låg oven i hinanden. (U5)Besværlig hvis man leder efter en speciel, men måske ikke noget problem hvis man blot udforsker. (V4)Lukker indholdet og vil gerne åbne det igen, men kan ikke ramme restauranten pga. salt lageret ligger lige oven i.

Svært at ramme logoerne/busserne etc.
(W2)Problemer med at tappe på skærmen når der var for mange restauranter mm eller busser. "Man rammer forkert når man har travlt" (W2)Problemer med at tappe på noget når der er for mange. Restauranter lå meget tæt, var svært at ramme det man søgte. (W4)Synes det kunne være rart hvis man kunne undgå de var så flyvsk i 3D visning. Det bevæger sig meget rundt og er svært at ramme dem (U1)Logoer/billboards

hopper rundt i 3D - tilbagevendende problem (U2)Det var svært at tappe på den enkelte restaurant, når der var så mange omkring dem. (U2)Skilte "fløj" rundt. Så det var lidt bøvlet at læse. Fløj sidelæns. (Pga. kompas) (U5)Ikonerne hopper for meget rundt. (U5)Svært at ramme ikonerne. (V1)Problemer med at klikke på skærmen. (V1)Har svært ved at klikke på logoer i 3D, da de flyver rundt på skærmen. (V2)Har lidt svært ved at trykke på smurfs i 3Dview, da de hopper lidt når man trykker på skærmen (V6)Har svært ved at trykke på / ramme de små billboards på kortet

Ønsker satellit view til kortet
(W1)Ville gerne kunne se kortet i satelit view ligesom Google Maps, så man bedre kunne kender forskellige steder på eksempelvis bygninger.

Har ikke haft tid / brug for at bruge app'en ret meget
(L2.2)Har ikke rigtigt brugt den siden sidst (L2.2)Har ikke haft tid, pga opgave (L2.2)Vil nok kun bruge den hvis han havde fri (L4.2)Har ikke brugt den siden sidst (L4.2)Har ikke haft behov for det

Hardware / app problemer
(L4)Kompasset driller indimellem lidt (L3)Oplevede et bug, der var pludselig ingen busser på kortet (L4)En barrierer at man skal vente på det starter op hver gang og finder lokationen (L1.2)Dårligt gps signal gjorde at han ikke kunne kigge direkte mod busstoppestedet. (W1)Nogle gange dukkede buser ikke op. (W1)GPS var ikke god når han var indendørs. Han bor ved havnen, og når han tænder den, står han i følge gps'en ude i vandet. (W1)Synes det bruger for meget strøm. (W3)App'en bruger meget strøm. (U3)GPS problemer gav indimellem en lidt blandet oplevelse (V9)Store problemer med GPS'en til at starte med. Kan overhovedet ikke få pejling (V9)GPS'en driller dog lidt og han kommer til at stå bag ved burger king skiltet selvom at han står lige uden for. Kigger nogle gange helt op i luften. (V1)Bemærker at gps'en er bagefter. Hendes position på kortet er ikke opdateret. (V2)Det tager lidt tid at hente kortet (V3)Forsøger at finde en restaurant, som er på kortet, men pludselig hopper gps'en til en anden position og den er væk. Kan skyldes at der er mere end 20 i området eller at gps'en var meget uprækis.Efter lidt tid bliver gps'en præcis igen (V3)3Dviewet er ikke helt præcis og det gør at hun ikke kan se en restaurant hun står foran (Måske GPS) (V7)Konstatere at kortet viser at han står på samme side af vejen som hende, men reelt set står han på modsatte side. (V7)Konstatere at den er ved at loade. Afventer. (V6)Prøver 3Dview ved at finde en bar på kortet og gå helt hen foran den, der kommer dog ingenting i 3Dviewet, da gps'en mener hun står på den forkerte side af baren. Hun går herefter længere tilbage og finder den så i 3Dview (V6)GPS'en er upræcis inde mellem de store bygninger

begrænset kendskab til smartphone
(V7)Sprøger hvordan man bruger telefonen. Får derefter en kort introduktion til hvordan hun kan tappe på skræmen osv.

Oplevede problemer med at adskille billboards fra logoer på kortet
(U1)Lidt forvirrende at der er markeringer på kortet man ikke kan trykke på, lidt svært at adskille fra billboards (V9)Troede han kunne trykke på tegningerne på selve kortet (ikke billboards) (V1)Problemer med at der er faste ikoner på skærmen.

Ville helst have alt indholdet på dansk
(U2)Ville helst have beskrivelser på dansk.

Vil gerne kunne finde ud af hvor man skal hen, inden man begiver sig afsted
(U2)Vil ikke tage ud og spise uden at have planlagt hvor man skulle hen. (U2)Har brugt gps på ferie, til at finde hoteller. Hver gang de kørte hen til hotel, var der optaget. Tilsidst brugte de bare gpsen til at finde telefonnummer på hotellet. Og ringede i stedet for at køre rundt. (U5)Hvis man skulle længere væk, vil man nok bruge rejseplanen hjemmefra. (i stedet for bus visning red.)

At kortet drejede alt efter hvilken retning man kiggede mod, hjalp på at finde rundt
(U2)Det var godt at kortet drejede rundt, så der ikke var en fast nord. (V6)Mener det er smart at kortet selv drejer rundt, sådan at det pejer i samme retning som man kigger (V4)Siger at hun er dårlig til at finde vej via kort. Siger at det er rart at kortet vender og drejer efter hvilken retning hun går. Det er svært hvis kortet altid blot havde nord opad, siger hun. (V4)Skal finde Henriette: Konstatere at hun er lige omkring. Drejer rundt indtil hun kan se ikonet umiddelbart foran den gule mand.

Vil gerne kunne se bustiderne, når man er zoomet længere ud
(U3)Vil gerne kunne se bus nr. i zoom helt ud og kunne se hvilken bus man skal med for at komme et bestemt sted hen

Brugsmønster afhængig af hvordan man er turist eller lokal
(U3)Brugen er afhængig af hvordan man er, både som turist og lokale. Nogle ved hvilken restaurant de skal på inden de tager i byen, andre mødes bare og finder en (U5)Man er mere målrettet når man bor i samme by.

Savner det der får applikationen til at skille sig ud fra det han ellers har set
(U4)Synes der mangler det element, hvor man bare tænker det er bare endnu smartere, men det har elementer som er smart

Vil gerne at applikationen kan guide
(U4)Vil gerne at man kunne vælge et sted og så derefter blive guidet derhen

Har ikke brugt app'en så meget, da det ikke er på min egen telefon den har kørt
(W5)Havde ikke tid til at bruge app'en så meget, når det er ikke er ens egen telefon skal man tage den med som en ekstra telefon (W4)Svært altid at have den med og få den brugt, når det ikke er sin egen dagligdags telefon

Savner at man kan spole længere frem i klokkeslæt
(W4)Savner at man kan spole længere frem i klokkeslæt

Sollyset driller
(V9)Kæmper lidt med lyset fra solen. (V1)Problemer med solskin.

Ved ikke at 3D-visning kun virker i zoom 8x
(U5)Undrede sig over man ikke kunne bruge 3D ved andet end 8x zoom. (V9)Kan ikke se at han skal være i zoom 8X for at bruge 3D visning (V1)Tror at man kan få adgang til 3D i andre zoom niveauer. (V3)Har lidt problemer med at finde ud af at skifte til 3Dview zoom niveauet (V10)Undrer sig over at man ikke kan gå i 3D mens man er i 4x og 2x (V8)Stiller sig lige foran Rice-In og forventer at kunne se logoet svæve i luften. Får forklaret at han skal zoom ind for at kunne gøre det (V8)Forsøger sig med 3Dview og zoomer lidt frem og tilbage (V7)Tror at man kan bruge 3D view når den er zoomet ud. (V6)Er ikke klar over at zoom niveauet skal være 8x for at kunne se ting i 3Dview

Ville gerne kunne pinge en position på kortet
(U5)Kunne være smart hvis man kunne "pinge" venner på kortet.

Naturligt at orientere sig vha 3d view
(U5)Den ene synes at det var en mere naturlig måde at orientere sig, i stedet for at kigge ned, så kan man kigge rundt. (V2)Kan lokaliserer et sted helt præcist ved brug af skiltet og placeringen i 3Dviewet

Kan lokaliserer et sted helt præcist vha app'en
(V3)Hun finder et sted og kan lokalisere stedet ud fra logo og placering på kortet (V8)Leder lidt på kortet efter en restaurant han gerne vil hen til og går afsted efter at have besluttet sig

Øvrige kommentarer/shoutouts om systemet
(V9)Meget fancy system. (V2)Det er i sidste del af testen ved at være koldt for hænder og fingre

Finder sted ved at: Kigger på restauranter og læser om dem
(V1)Kigger efter forskellige restauranter, og læser om de forskellige. Finder til sidst Kong Richard

Situationer hvor kortet er unødvendigt, pga. man allerede kender byen
(V1)Skal finde Niels, og siger, "Han står i Maren ... gade". Bruger ikke app'en til at gå derop, da hun godt ved hvor gaden er.

Opdager selv funktionalitet / begynder selv at bruge funktioner uden nogen instruktioner
(V2)Finder hurtigt ud af at man kan trykke på de forskellige steder (V2)Er hurtig til at finde ud af at bruge 3D viewet for restauranter (V3)Starter med at undersøge de forskellige kategorier og zoom niveauer (V10)Ratede automatisk et sted uden at han er blevet bedt om det. (V4)Drejer hjulet og finder ud af at den også viser busser.

Får god forståelse af interaktionen med app'en og brugen af hjul og slider bliver naturligt for testpersonen
(V2)Testpersonen har godt styr på både zoom, busserne og 3Dview (V3)Finder hurtigt ud af at skifte zoom niveau - trykker og drejer på hjulet, hvor det kun er nødvendigt at dreje (V3)Vil gerne finde et sted hvor man kan få en burger og leder lidt efter en måde at gøre det på. Zoomer ud, bruger slideren

Problemer med at se roterede planes
(V2)Har lidt svært ved at se billboards i 3Dviewet som står med siden / skrå til (V2)Oplever igen problemer med at se hvad der står på et billboard, da det står skråt på skærmen

Tror i første omgang hjulet skal bruges til at adskille barer og restauranter
(V2)Leder først med hjulet for at finde ud af at vælge barer fremfor cafeer, finder derefter slideren. Finder hurtigt slideren under restaurant viewet (V6)Tror først at man kan sorterer bar/cafe/restaurant på hjulet, men finder hurtigt ud af at det er vha. slideren i bunden

Står oven i et ikon, så det bliver for stort til at se i 3D visning
(V2)Testpersonen står lige oveni et busskilt og det bliver så stort i 3Dviewet at han ikke kan se det hele. Han forsøger at gå tilbage, men det hjælper ikke umiddelbart.

Bruger mest 3D view

(V2)Bruger meget af tiden i 3Dview til at finde ting (V3)Går hele tiden med telefonen fremme foran sig

Står stille når 3D delen bruges
(V3)Står stille eller stopper op når hun bruger 3Dview delen (V7)Bruger kun 3Dview når hun stille, eller stopper op for at bruge det

Ved ikke at man kan klikke på ting
(V3)Er i tvivl om hvordan man finder mere information om et sted. Forsøger efter lidt tid at trykke på et billboard og informationen kommer frem (V4)Spørger om man kan trykke på logoerne.

Ikon misforståelse
(V4)Spørger om "Manden" symboliserer toiletter.

Fejl i indhold / kan ikke finde indhold
(V10)Finder La Strada på kortet, men den ligger ikke det rigtige sted. (V7)Kan ikke finde restauranten. Den ligger ikke i gaden. Muligvis fordi den er placeret forkert. (V4)Hun siger at hun gerne vil finde Klostertorvet, men kan ikke finde den på skærmen. (V4)Kan ikke finde cafe vi2. Spørger om det er fordi hun har hentet den frem og læst om den. Står for tæt på caféen til at hun kan se den i 3D.