Wrist-Trading

The Nordnet Smartwatch App: An Interaction Design Thesis

Rebecka Alves-Martins & Frida Bredberg

2015

Master's Thesis

Department of Design Sciences
Lund University

Abstract

Wearable electronics is the technology on everybody's lips as of 2015. Different companies release smartwatches almost once a month. One of Jayway Syd AB's clients is the trading bank Nordnet and together they saw an opportunity with trading in combination with smartwatches. This master's thesis describes the process in which the possibilities around smartwatches and trading were explored with the goal being to create an MVP (Minimal Viable Product) as a concept of a Nordnet smartwatch app. Another goal, apart from creating the concept, was to make the app as usable and as user friendly so that Nordnet customers actually would be inspired to purchase a smartwatch. To achieve this highly set goal the guidelines provided by the UX specialists were followed and this thesis describes the different stages the development went through to finally land on an MVP.

This thesis commenced with an investigation phase in which both the public's perception of wearables — and smartwatches in particular — and trading were investigated. When a clear view of the two aspects was formed the design work was initiated, starting with exploring the opportunities around navigation. The question this phase centered on was "how much information is possible to squeeze in without making the app too overwhelming?".

Once the hierarchy was decided, it was time to determine exactly which information was to be included in the limited space. To untangle this, Lund University's Finance Society (LINC) was consulted in a focus group.

When both hierarchy and information were decided upon, the graphical and detailed design phase commenced. The Lo-Fi design was created and evaluated, whereupon improvements were made and applied on the Hi-Fi prototype. This prototype was reviewed by the stakeholders and further alterations were made prior to the development phase. The final product is an MVP, which was evaluated in a usability study with both interaction designers, experienced Android Wear users and LINC.

The result was highly appreciated among experienced stock traders, as well as interaction designers, confirming that the goal of this thesis was reached!

Keywords: wearables, smartwatch, trading, user-centered design, Android Wear, stocks.

Acknowledgments

First of all we would like to express the deepest appreciation to the staff at Jayway for making us feel welcome and included from day one. They have also always provided the help and assistance we needed.

We would like to thank Jonas Flodqvist, our supervisor at Jayway, for always being there for us as both support and sounding board. We also want to express our gratitude towards Conny Wadbro, who has shown a tremendous engagement and enthusiasm, bringing us energy and inspiration. We also want to give thanks to Pär Sikö, who has acted as our technologically aware guide through the forest that is Android Wear. We want to say a special thanks Stefan Persson, who has shown a great interest in this master's thesis, and helped us achieve our goals.

We also wish to express gratitude to our supervisor at The Faculty of Engineering at Lund University, Dr. Joakim Eriksson, for mentoring us throughout the course of this thesis, as well as providing us with required interest and knowledge during our master program.

Last, but not least, we owe our deepest gratitude to Lund University's Finance Society, who have been a well of knowledge and have stood by our side from the beginning. We also want to thank everyone who has participated in our user studies.

Malmö, May 2015
Rebecka Alves-Martins & Frida Bredberg

Table of Contents

Abbreviation list

OS	-	Operating System
UI	-	User Interface
UX	-	User Experience
MVP	-	Minimal Viable Product
Lo-Fi	-	Low-Fidelity
Hi-Fi	-	High-Fidelity
SDK	-	Software Development Kit

1 Introduction

1.1 Background

Jayway Syd AB, later referred to as Jayway, is an engineering consultant innovation and software development firm headquartered in Malmö, Sweden, with offices around Sweden and abroad. Their clients include IKEA, Elib, DSB and Nordnet. The company offers IT solutions with great focus on design.

Jayway was in the final stage of developing the second rendition of a phone application on behalf of the trading bank Nordnet when the writers of this thesis first contacted them. The app features include stock overview, finance news, stock price and associated features such as selling and buying stocks. As a supplement to the phone app, Nordnet requested an extension in the form of a smartwatch app. Smartwatches is a rather new form factor and the area is quite unexplored. When commencing this thesis work just a few smartwatch apps were available to the public, and the Apple Watch was not yet released, automatically driving this master thesis towards Android Wear.

This master's thesis describes the exploration of the possibility to improve and extend the trading services, with focus mainly being on usability and design, by developing an MVP (Minimal Viable Product) of a smartwatch app.

The design and user evaluations were done collaboratively. Due to the short period of time this thesis ran over, the workload of the last iteration was however allocated between the two writers according to their previous knowledge and experience, resulting in Rebecka taking main responsibility of the programming and Frida of the documentation

1.2 Goal

The goal behind this thesis was to investigate the possibilities of smartwatches and based on the finds create a product so easily operated and valuable that it might inspire people to acquire a smartwatch. The result was aimed to be a functional app as far as interaction goes. A future goal is to connect the smartwatch app with the already existing phone app. To achieve set goal, a quotation stated by Google was kept in mind during the entire process. The citation reads "What couldn't we do on the phone, that we can now do on the wrist?" (Jordan, 2014). Jayway's interest lies in finding out whether the technology is worth looking into and explore further.

2 Technical Background

2.1 Smartwatches

Smartwatches have been around since the 1980s, the definition simply being a watch capable of doing more than timekeeping (Martin, 2014). However, imagining what else wristwatches could do has been featured in media since the 1940s — in the comic strip Dick Tracy (1945) for instance (Figure 2.1), then in Star Trek (1979) (Figure 2.2), and in the 1980s TV series Knight Rider, we see David Hasselhoff talking to his artificially intelligent car KITT on his wristwatch (Figure 2.3).

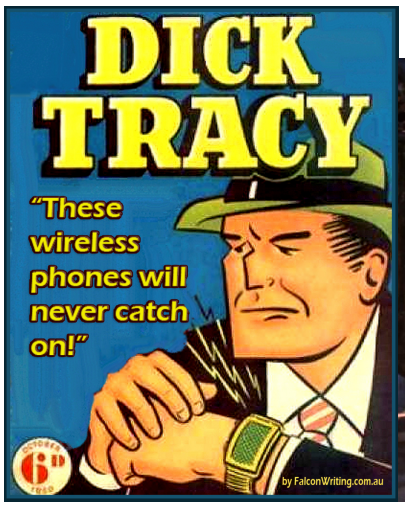

Figure 2.1: Dick Tracy

Figure 2.2: Star Trek

Figure 2.3: Knight Rider

The first embodied smartwatch to be released was Pulsar, manufactured by Seiko, and was able to store 24 digits of information (Marshall, 2015). During the 80s, a string of smartwatches (Smartwatch Group, 2013) with LCD displays was released, containing databases, dictionaries and blood pressure sensors.

With the arrival of smartphones, speculations of new form factors began, and in 1993 the American telecommunication company AT&T patented a wrist phone. A bundle of companies started R&D activities during the 90s, and Samsung released their first product in 1999. IBM, for instance, launched a watch housing an OS and a fingerprint reader, among other functions. However, the introductory ecstasy died out after this phase, due to the realization that the hardware of the era forced the devices to be bulky and clumsy, and therefore would fail as consumer products. A few models were launched in the following years (such as Microsoft's SPOT smartwatch in 2004 (Lamkin, 2015) and Sony Ericsson's MBW series in 2008), but none of them was successful (Smartwatch Group, 2013).

In 2012, Pebble launched a Kickstarter campaign (Burns, 2013), which resulted in selling 70,000 smartwatch units within a month (Vatanilajal, 2013). This turned out to be the starting shot of the renascent smartwatch race between today's electronics companies.

Apple's much vaunted Apple Watch was released in May 2015. The company created a hype around the product more than half a year before its initial launch date, causing tremendous expectations. They were however outrunned by a number of companies, such as Samsung and Motorola, who both released their first watches during the previous year. However, the created hype seems to have paid off given the number of pre-orders placed only the first day, which was as high as 1 million units (Keizer, 2015). In comparison with the 700,000 Android Wear watches that were sold during the entire year of 2014 (Canalys, 2015) it is quite astounding.

The first smartwatch running Android was manufactured by the Italian company Blue Sky and goes by the name I'm Watch (Ramachandran, 2011). Since then a number of smartwatches have been released; Samsung Gear S, Motorola Moto 360, Sony SmartWatch, Pebble Steel and LG G Watch, to name a few. Samsung Gear Live and Moto 360 have been evaluated and discussed in conjunction with this master's thesis. They both run the OS called Android Wear.

2.2 Android Wear

Android Wear is the name of the new OS that extends the Android platform to wearables. Android Wear is designed specifically for smartwatches and has a brand new interface, which gives a whole new user experience.

The idea behind Android Wear is to show information when the user most likely needs it. A smartwatch app should therefore, as far as possible, launch automatically and not by the user clicking on the app icon. An example of when a fitness app should be automatically launched is when the wearer starts running.

Android Wear is controlled by gestures and voice recognition, and allows showing notifications, which are synced with the connected smartphone. The OS consists of cards (Figure 2.4), comparable to pages, and gestures take the user between these cards. The voice recognition makes it possible for the user to execute a Google search using voice control.

Lastly, Android Wear allows apps that are specially designed for smartwatches, which can access all the sensors directly on the smartwatch. The apps are located in the UI, as opposed to the notifications which are extensions of the smartwatch apps, and can be opened on demand. The apps can consist of either cards or full screen activities, or both.

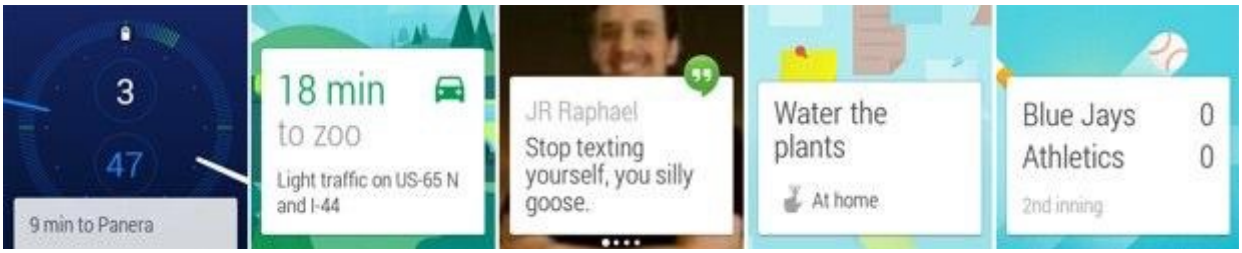

Figure 2.4: Example of cards

An OS for a new form factor needs a new UI. The Android Wear UI entails two core functions named Suggest and Demand.

The home screen in the Android Wear UI is the customizable watchface. Apart from the watchface, the home screen also shows the most recently created card at the bottom of the screen, as shown in Figure 2.5, and is also illustrated in the leftmost image in Figure 2.4. All features are accessed from the home screen.

Figure 2.5: The home screen

2.2.1 Suggest: the context stream

Whereas the home screen is the personally selected watchface (easily selected by long-pressing the home screen and then picking your favorite one in a horizontal row of different designs), contextual cards are accessed vertically. The cards view a relevant or timely piece of information (see Figure 2.6). Google Now is a virtual assistent and is implemented as a part of the OS, which creates cards when the user supposedly needs a piece of information, such as weather report. Apps can also create cards when assumed necessary or convenient, disclosing information presumably useful to the user. The cards are added in the context stream, as a stack, with a background picture serving as additional visual information. The point of the context stream is to eliminate the action where the user actively has to locate the app in the UI to launch it. As the reader might understand, these cards are not enough on their own. Thus, by swiping horizontally when having reached an interesting context card, additional information is accessible. Swiping further may lead to action options, such as Open on phone. By swiping the card from right to left, it is dismissed from the context stream until a new card is created.

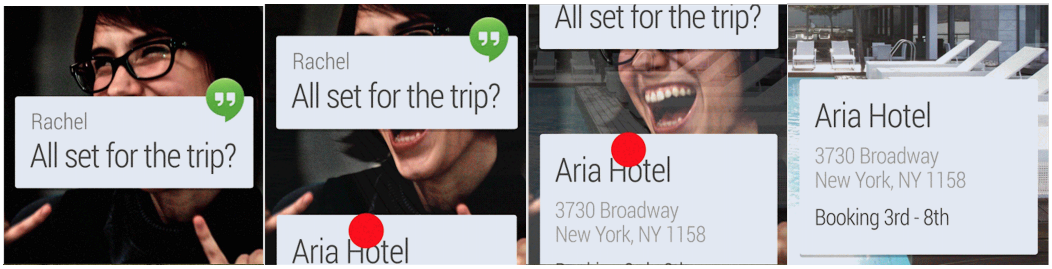

Figure 2.6: Suggest: the context stream

2.2.2 Demand: the cue card

When a user wants to perform an action on demand, they can open the cue card by either tapping the home screen, or just by saying "OK Google" (in the 2nd step in Figure 2.7 is the voice recognition active and the watch is listening to speech). The cue card contains a list of suggested voice commands (as seen in step 3 and 4 in Figure 2.7) and a start option, where the user actively can browse through the smartwatch apps until they find one they wish to launch.

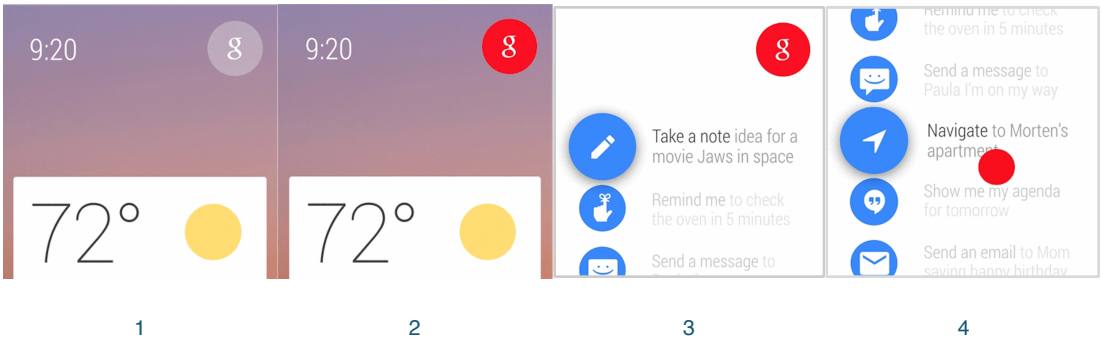

Figure 2.7: Demand: the cue card

2.2.3 Guidelines

All information that is shown on the watch should be glanceable. The user should easily and quickly get an overview of the information without losing too much focus on the outside world. An app should be designed so a typical use case only takes five seconds. Android Wear focuses on easy and quick interactions and is therefore gesture based and allows only simple swipes, taps or voice commands.

2.2.4 Standards in Android Wear

Navigation

The cards in Android Wear are placed after one another, horizontally. Navigation between the cards is done by sideway swipes. Cards can also be placed vertically, called a 2D picker (Figure 2.11). As seen in section User Flow Patterns, a deliberate choice may be done, by swiping vertically.

The default way to navigate back to the home screen (ergo the watchface) in Android Wear is to go back the same way you came from. The home screen is always placed to the left of the notification flow or the app flow, thus making the default way to return to the home screen from a notification or an app to swipe from left to right as shown in Figure 2.8. However, if the app consists of full screen activities and the swipe-to-dismiss-feature interferes with the app structure, Google recommends implementing a long-press to exit the app.

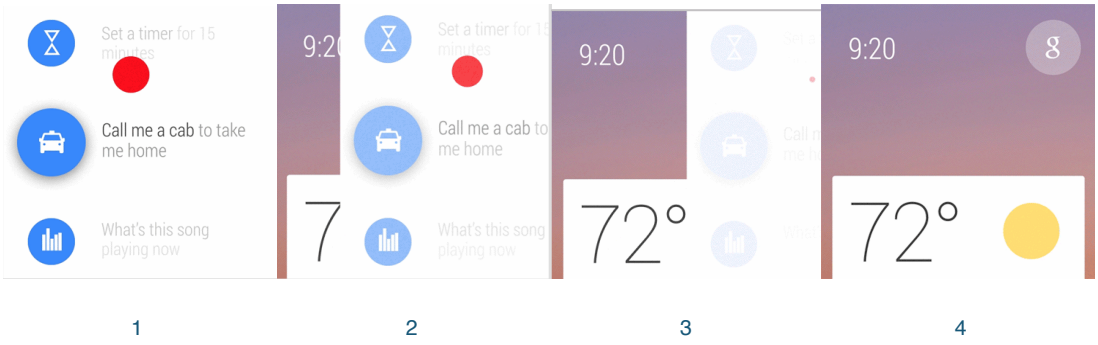

Figure 2.8: Navigation example

Another common way to return to the home screen is using action buttons. An action button performs an action, such as open the app on the phone, when you press it and then returns directly and automatically to the home screen.

Additionally, by placing a palm on the screen, covering the light sensor, the display is put to sleep.

Action buttons

There are a number of standard action buttons in Android Wear, which are automatically placed in the user flow for a notification. Two of these are the action buttons 'Block app' and 'Open on phone' which are illustrated in figure 2.9 and 2.10 below. These buttons make it possible for the user either to block the notifications from this app or to act upon a notification quickly by open it on the phone. When pressing an action button a confirmation animation is shown on the screen. In addition to the standard action buttons Android Wear allows the developer to add personalized action buttons.

Figure 2.9: Action button 'Block app'

Figure 2.10: Action Button 'Open on phone'

User flow patterns

Google has released a number of guidelines for the user flow patterns where they show how to make a chain of different components into a collective flow pattern. Figure 2.11 shows the meaning of the different colors and icons that are used in the selected user flow patterns below.

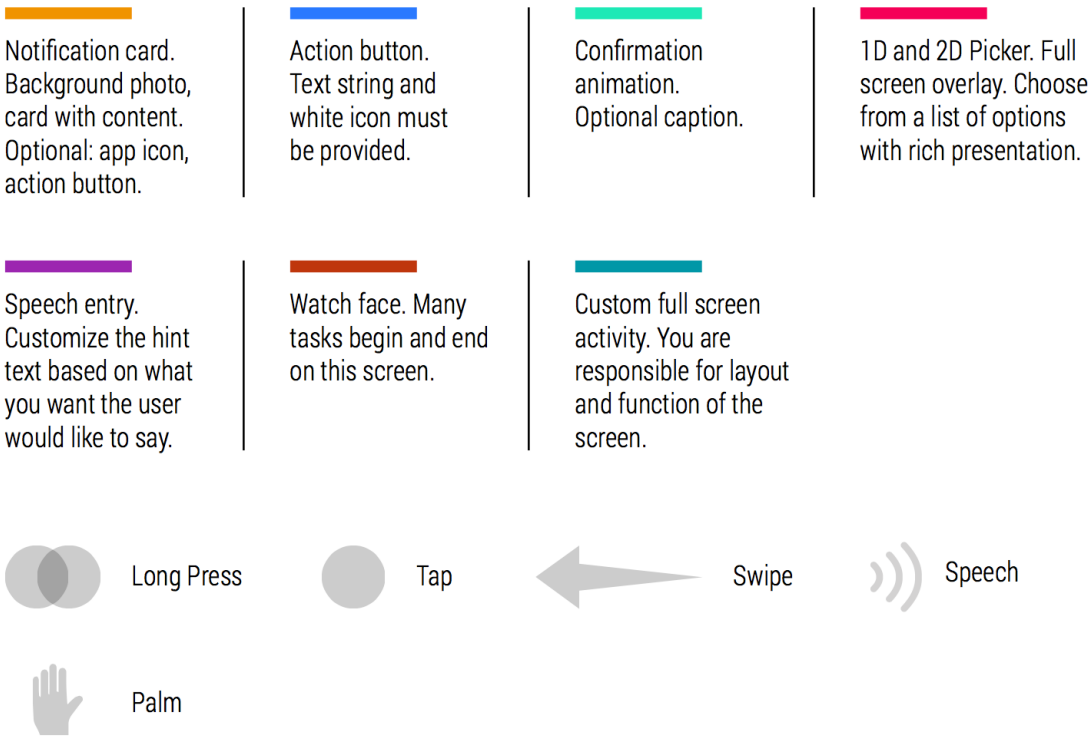

Figure 2.11: Instructions

Figure 2.12 shows a simple flow pattern for a notification with an action button to check in. When a wearer walks by a bar, the smartwatch receives a notification telling the wearer that one of their friends likes the drinks there. The user can then swipe to the left to reach the action button 'Check in here'. A click on the action button completes the action and informs the user that they have checked in, and then returns to the home screen.

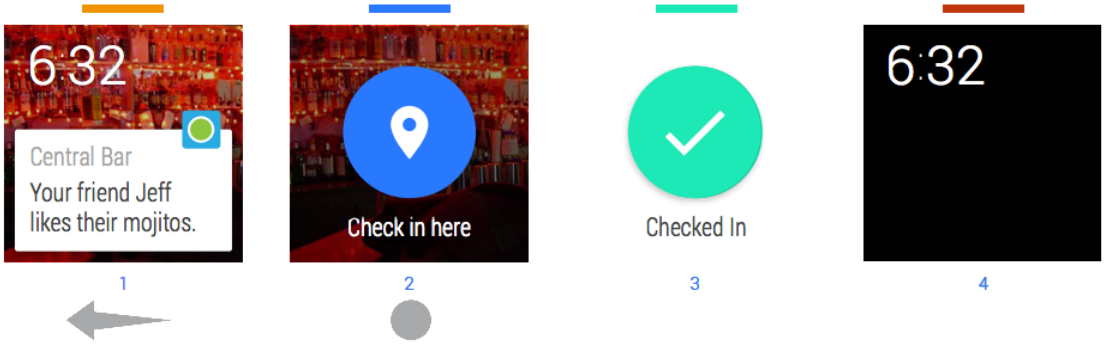

Figure 2.12: Action button: Check in here

In Figure 2.13 the action button is placed directly on the notification card instead (marked as number 1 in the illustration). Pressing the action button (marked with 1 in the illustration) allows the user to check in immediately without any further steps in the flow, but also choose to change the location by swiping to the left and then click on the action button 'Change location' (marked as number 2) and swipe upwards until the right location is found.

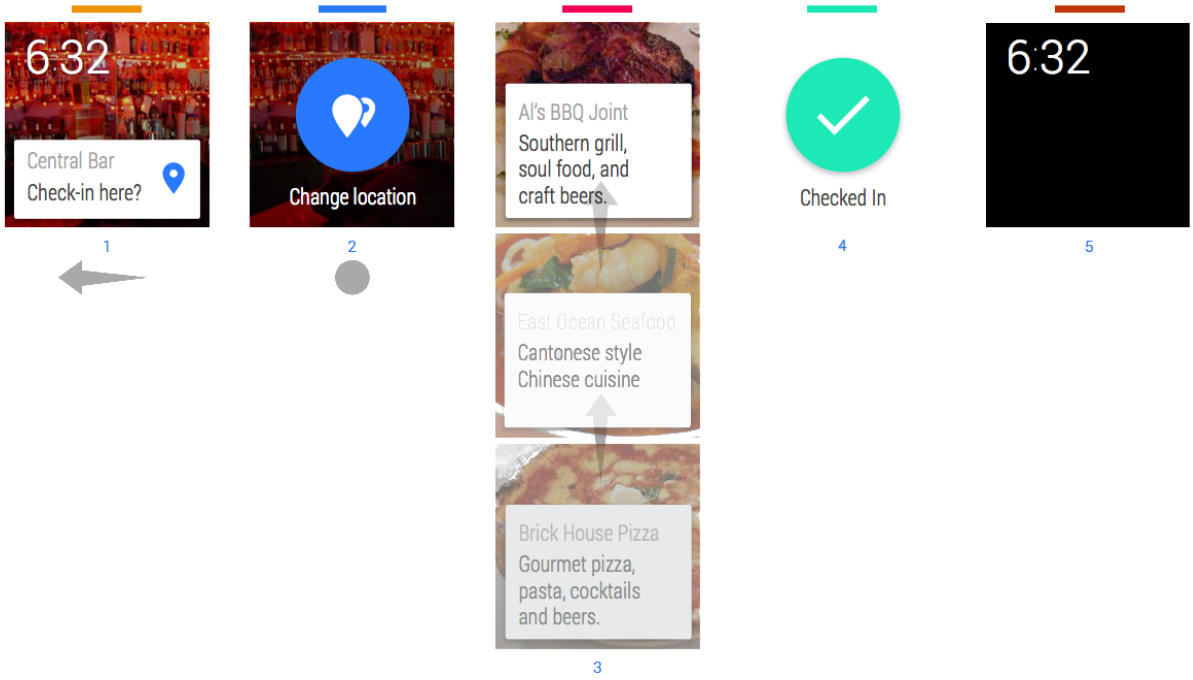

Figure 2.13: Shortcut to check in: an action button on the notification card

A more advanced user flow pattern is shown in Figure 2.14. In this flow, the action button 'Change music' hides multiple choices transforming the flow into a matrix. The user can select an album by swiping up or down in the flow (step 3) and then swipe left or right to select a song in that album (step 4). A press on a song takes the user back to the homescreen and the chosen song starts playing. On the home screen there is an action button as well, placed in the notification card, allowing the user to either pause or play the song directly from the home screen.

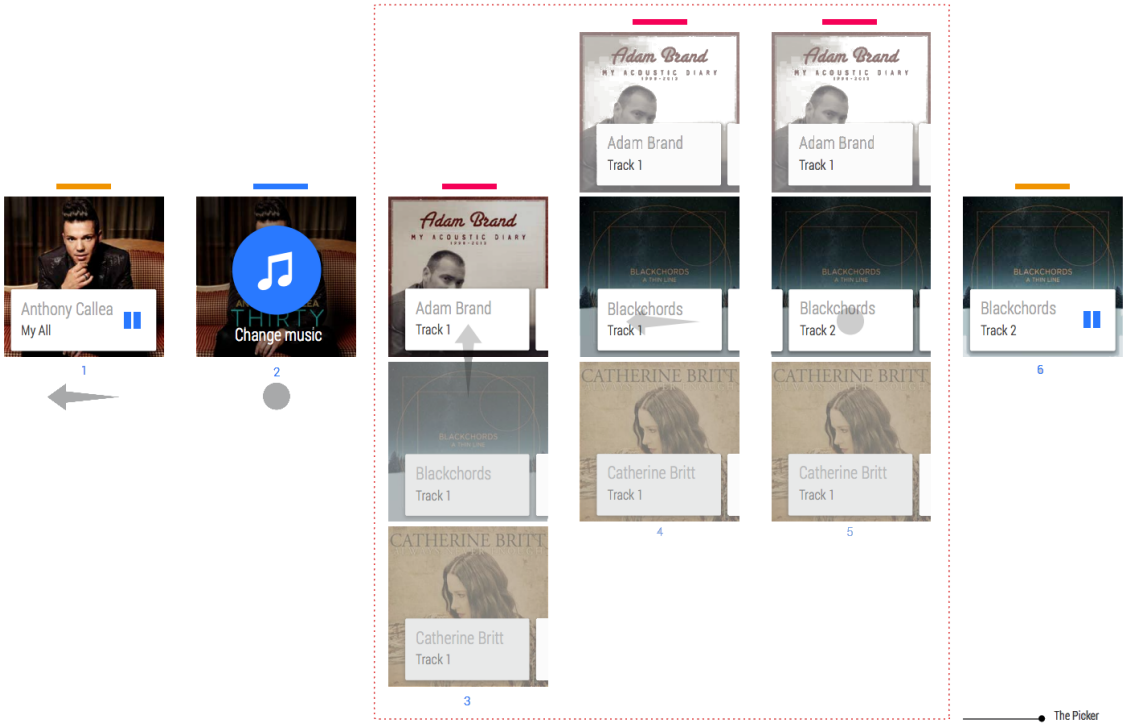

Figure 2.14: Change music

2.2.5 Summary

Android Wear basically consists of, in addition to the deeper hierarchy of more capable apps which are reached and launched on demand, context cards. The context cards are either generated from the smartwatch apps installed on the unit when the user supposedly needs a certain piece of information, or pushed out as live updated notifications from Google Now and appear in a vertical context stream accessed directly from the watchface. Ergo, text messages, emails and weather updates are represented on separate cards, appearing vertically after one another. A context card is designed according to its purpose, making them all look a bit different. The context cards can contain action buttons, allowing the user to act upon a card, like open a certain app on the phone, for instance.

Another major feature is push notifications. A buzz on the wrist lets you know something relevant and hopefully interesting has happened. These notifications are pushed out from the phone application, and the design is pretty much default.

Google has published quite strict guidelines regarding both design and interaction, which developers are recommended to follow.

3 Theoretical Background

3.1 User-Centered Design

The core definition of user-centered design (UCD) is to be influenced by the end user throughout the entire design process. There are various methods on how to achieve a user-centered design, where the grade of involvement of the end users varies.

The term user-centered design was first printed in the book User-Centered System Design: New Perspectives on Human-Computer Interaction, co-authored by Donald Norman and Stephen Draper in 1986. The concept of UCD is to make a design so easily manageable, the heavy user manuals could be exchanged with pamphlets. Striving for this, multiple design gurus and user experience experts have collected a number of points to follow.

Gould and Lewis have formulated three key principles regarding UCD: Early focus on users and tasks, empirical measurement and iterative design (Gould & Lewis, 1985).

Donald Norman composed his own set of design principles, describing what makes a UI — or any design as a matter of fact — easy to use (Norman, 2013). By following his rules, the design ends up user-friendly. The principles are:

- Visibility — Can I see it?
- Feedback — What is it doing now?
- Affordance — How do I use it?
- Mapping — Where am I and where can I go?
- Constraint — Why can I not do that?
- Consistency — I think I have seen this before?

Shneiderman's eight golden rules provide great guidance when designing a UI (Shneiderman et al., 2009). And even though the guidelines were stated long before the appearance of smartwatches, the rules still apply in some content. The rules especially considered are the following.

- Strive for consistency
- Enable frequent users to use shortcuts
- Offer informative feedback
- Reduce short-term memory load

3.2 Usability Testing

Usability has been given many definitions. The ISO 9241-11 definition reads “The effectiveness, efficiency and satisfaction with which specified users achieve specified goals in particular environments. Effectiveness: the accuracy and completeness with which specified users can achieve specified goals in particular environments. Efficiency: the resources expended in relation to the accuracy and completeness of goals achieved. Satisfaction: the comfort and acceptability of the work system to its users and other people affected by its use.”

Usability testing is done for different purposes. There are four types of usability tests: exploratory, assessment, validation and comparison testing (Rubin, 2008). Exploratory testing is also called formative testing and is usually done in the beginning of the design phase when nothing is set in stone. The purpose of assessment, or summative, testing is to localize design flaws and is usually done in the end of the design phase or during the implementation phase. Validation testing is done to verify the product’s usability and function towards release. The last one is comparison testing which as the name hints to is done when the design team wishes to compare two or more versions of the design or the project manager wants to compare own product with opposing companies’ products for instance.

When conducting the test plan, it is of great importance to make clear which purpose the test has. Based on this, the research questions are formed, the participants are chosen and the test method is established. The goal is to be able to answer the research questions when the test session is completed.

3.3 Focus Group

A focus group is a qualitative research method that consists of a group of people whom answering and discussing their opinions towards a product or concept. Focus groups are practical when trying to figure out a certain unclarity, and is supposed to take place in a situation where the participants are familiar with the subject, and of a strong opinion. There are quite strict guidelines for the structure and approach, in order to make the result as giving as possible (Edmunds, 1999).

Mini Focus Group

In a mini focus group, only five to six participants take part, giving the moderators more space to focus on the topic as opposed to polling the participants. Additionally, mini focus groups allow greater opportunity to observe and follow the discussion.

3.4 Interviews

Interviews are a good way to gather a lot of data about the target group’s needs and attitude, but it takes a lot of time to keep interviews (Preece et al, 2002). There are three different kinds of interviews; open, semi-structured and structured.

In an open interview the questions asked are open in order to explore a topic. The questions in a structured interview on the other hand are closed which limit the extent of the participants' responses. A semi-structured interview consists of a mix of open and closed questions.

When creating interview questions one should have in mind to avoid technical terms and leading questions and to keep the questions neutral.

3.5 Scrum

Scrum is an agile software development method, with the definition "a flexible, holistic product development strategy where a development team works as a unit to reach a common goal" (Schwaber, 2004). There are three core roles in this approach, namely product owner, development team and scrum master. The product owner makes sure to meet the stakeholders' needs. The development team is responsible for delivering value to the stakeholders. The team itself is interdisciplinary and performs the actual work, from designing, developing and testing. The scrum master's role entails synchronizing between actors and removing obstacles for the development team.

In scrum, the workload is divided into different sprints, where each sprint is started off by a sprint planning event, where the team determines what is to be done during the sprint and how to distribute the time dedicated to that sprint. Subsequent to each sprint all involved parties engage in a scrum retrospective, where the past sprint is evaluated and reflected on. Each sprint consists of work elements, which are categorized and prioritized, and presented accordingly, usually on a whiteboard or in a digital form.

Daily scrum meetings are usually held every day of each sprint, where all parts are included. The following questions are asked during the meeting. What did we do yesterday? What will we do today? What holds us back? Weekly meetings are usually held in company with supervisors and other interested parties.

3.6 Related Work

The area is new and little research has been done on the subject. The main discussion has been the future of wearables and smartwatches. They are still trying to figure out the best way to exploit the new technology and to pin down the main advantage with the wearable electronics.

No app similar to the one this thesis describes had been released as of spring 2015. The writers were thus forced to create a completely new concept with the target group in mind without being able to rely on similar applications, but consider comparable research.

As discussed in an article in Communications of the ACM (Petre et al, 2015), there is still a balance between size and capacity. The main advantage, however, they claim is the constant contact to the

wearer's skin, accessing physical data. They also point out the fact that the small screen forces new interaction techniques to arise, such as haptic and voice.

A paper written at University of California analyzes the Nike+ FuelBand in terms of design and usability (McDowd, 2012). The writer evaluates the product according to a number of heuristics. McDowd especially emphasizes the importance of displaying relevant information and not to make the screen too obtrusive. The display should be exploited but not cluttered. It should also be easy to find further information.

A bachelor thesis (Sörling and Botani, 2014) about achieving usability on smartwatch applications was written at Södertörns Högskola, where the concept of auction apps was focal point. The writers have done research on what makes an interface on a small screen easily manageable and effective.

4 Working Method

4.1 Structure

In this master's thesis, scrum was combined with user-centered design resulting in an iterative working process divided into five different phases, as seen in Figure 4.1.

A free web-based project management application called Trello was used to plan the different tasks. There was a board in Trello dedicated to each sprint, divided into four columns: *ToDo, In progress, Waiting* and *Done*. An additional column called Backlog stored various ideas and potential development steps. In addition to the Trello boards, all project bricks — such as user studies and design phases — were represented by color coded post-its and placed on a whiteboard, arranged in chronological order. The board was dynamic and a way to get a grip of what has been done and what is yet to come, and what the time frame is.

The master's thesis workers held daily scrum meetings each morning, in which the supervisor participated in once a week. Daily scrum meetings offers a good overview of the project and brings clarity to possible obstacles and how to get around them.

Each sprint was completed with a sprint review, which the product owner, the supervisor from Jayway, other interested parties and the other master's thesis students were invited to. At the sprint reviews the finished tasks were presented and demonstrated. A sprint retrospective meeting was held thereafter, where the team members reflected on the past sprint with the purpose of pointing out improvable elements and highlight what was appreciated, with the upcoming sprint kept in mind.

4.2 The Iterations

The first sprint is divided into two iterations in this thesis: Investigation Phase and Prototyping Phase 1. In the Investigation Phase, knowledge about smartwatches was gathered and two different interviews were held in order to get an idea of people's opinion about smartwatches and trading. The collected information from this phase provided a solid basis to start creating the first user flow patterns in the next phase; Prototyping Phase 1. Six different user flow patterns were created and evaluated in this phase resulting in two final pattern and three features to be further developed in the next phase.

In the third iteration, Prototyping Phase 2: Lo-Fi, the features and produced flow patterns in the previous phase were developed into a Lo-Fi prototype, which was evaluated and refined. In the following phase, a Hi-Fi prototype was created, based on the results in the previous iteration.

The first four iterations led up to the last iteration — Prototyping Phase 4, which ended in a final MVP with clear objectives established on beforehand.

Figure 4.1: The phases in this thesis

Each prototyping phase has been influenced by the traditional concept of user-centered design (section 3.1), leading the development and design teams through three iterative stages; design, prototype and evaluate, as illustrated in Figure 4.2.

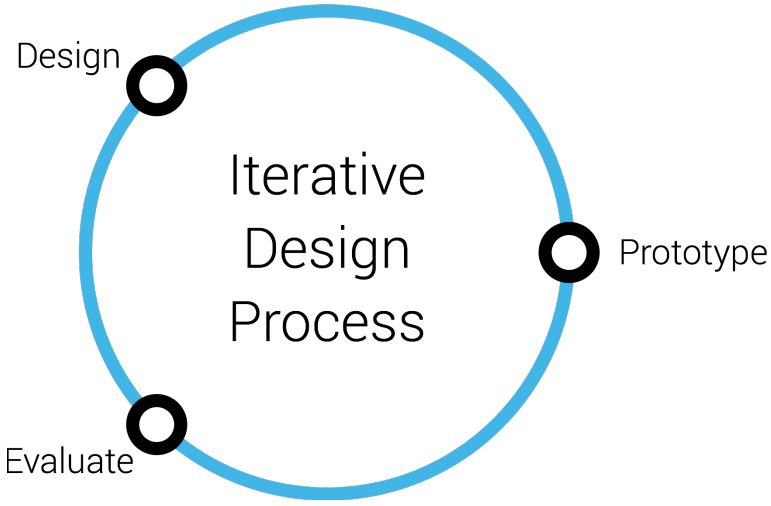

Figure 4.2: The design process

5 Investigation Phase

5.1 The Nordnet Application

In order to be able to develop a smartwatch app on Nordnet's behalf, the phone app was put under the microscope. The Nordnet app Jayway has developed allows the user to invest in stocks, view current prices, read up-to-date news that affects the stock market, but also keep an eye on their portfolio. There are five different menus in the app; home, accounts, markets, transactions and news.

5.1.1 The Menus

Home

Figure 5.1 shows the page called home, which is the page first shown when the app is opened. This page is customizable, which means that the user can decide which stock or index shall be shown on the top of the page and also decide which stocks that should be placed in the list 'Instruments' below. The 'Instruments' list works as a favorite list of instruments, where the user can change the order in which the stocks should be presented in. In addition to instruments, both currencies and commodities may be displayed in the same way.

When pressing on a stock in the 'Instruments' list you get more information about the stock, as shown in Figure 5.2.

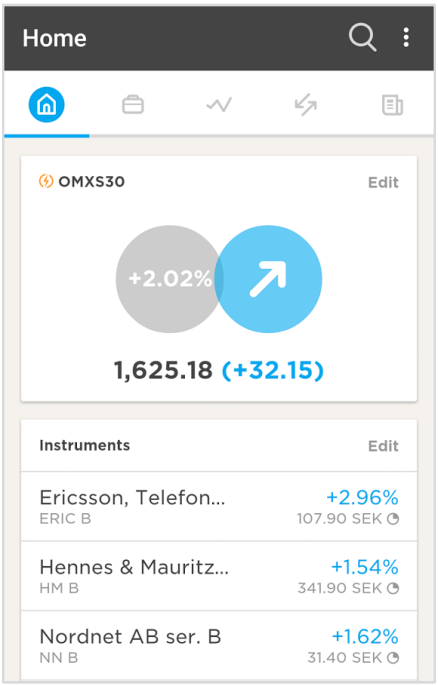

Figure 5.1: Home

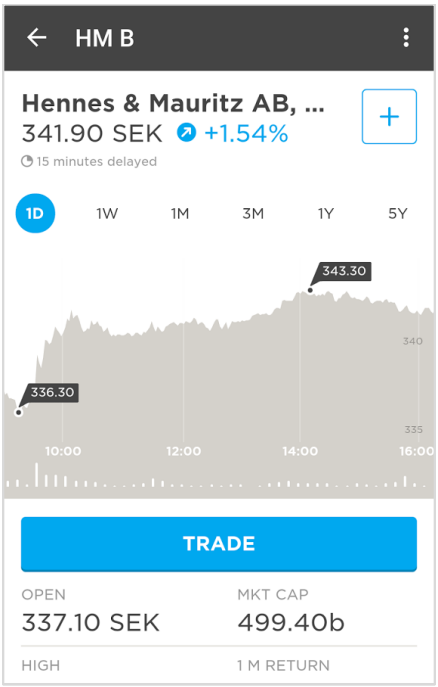

Figure 5.2: Stock information

Accounts

A user can login to its account with mobile BankID. On this page a user can buy and sell stocks/funds and keep an eye on its investments.

Markets

This page is only accessed in a logged in state. This is where the user may see current exchange rates.

Transactions

This page is only accessed in a logged in state. This is where the user can check its current transactions and orders.

News

The last page in the navigation bar is News. On this page one can get the latest financial news from different news agencies and choose what news one may want to subscribe to.

5.1.2 Esthetics

The design of the app is simple and flat. The app essentially consists of five colors; white, blue, grey, black and red. Its shell is white and the currently active tab is blue, making it clear to the users where they are located in the interface. The same color is used in various symbols, and numbers to indicate that a certain stock has gone up, as shown in Figure 5.3. In the same way is a nuance of red used to quickly and effectively show that a stock has fallen (Figure 5.4) and the color grey indicates that a stock is unchanged (Figure 5.5).

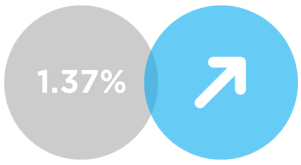

Figure 5.3: Success arrow

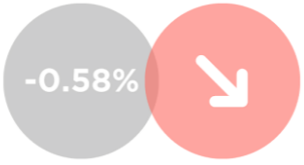

Figure 5.4: Danger arrow

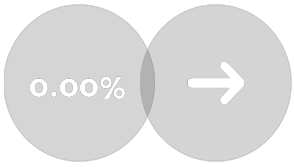

Figure 5.5: Neutral arrow

5.2 Interaction With Smartwatches

To get a deeper insight in the technology and interaction behind smartwatches, one was worn every day for a one week's time. The smartwatches used were Moto 360 by Motorola and Samsung Gear Live. Said smartwatches are powered by the same OS, namely Android Wear. The big difference is that Moto 360 has a circular (hence its name) screen while Samsung Gear Live's screen is squared.

The goal with this interaction exercise was to get a better knowledge of smartwatches and to better understand the smartwatch users by becoming one of them.

5.2.1 Observations

Android Wear

The first impression of Android Wear was that it is difficult to understand for a first time user. Due to the gesture-based interface, navigation and orientation is troublesome. It is easy to get lost in the hierarchy. Finding the apps in the interface was also tricky, even for an experienced user. The apps are hidden far into the interface which makes them hard to access.

Another problem with Android Wear that was encountered during the usage was that presently there is no way to uninstall apps from exclusively the smartwatch. If you wish to uninstall a smartwatch app you must uninstall it from your smartphone as well, or reset the device.

Apart from mentioned problems, the interface design is very simple and clean. Despite the small screen size it is very easy to view the information and interact with the interface.

Moto 360

What catches one's eye when first handed the Moto 360 is its attractive design, especially for being an electronic device, mainly due to its round screen (see Figure 5.6). Despite its elegant design, though, it feels clumsy and cumbersome on the wrist. An upside with the watch's size, however, is that the screen does not feel too small to interact with. As for the technical aspect, the battery life is questionable. It needs charging every night to survive a whole day of average use. Additionally, it is supposed to wake up when tilted, provided that that certain option has been chosen in the settings, but it does not always. Not only is the activation of the screen inconsistent, but the notification function is arbitrary too. Almost as if it has a filtering feature.

Figure 5.6: Moto 360

Samsung Gear Live

This was one of the first smartwatches released to the public alongside Moto 360 and LG G Watch.

Design-wise, it is clearly meant for a man's wrist rather on a woman's, as it on a slimmer arm sticks out, making it cumbersome to wear. In addition to its thickness, it has a masculine look (see Figure 5.7). As for the display, the squared screen makes more sense than a circular one, due to the fact that it is the shape we are used to. Moreover, most smartwatch applications available today are suited for the squared design, eliminating unexpected interaction hassles.

Apart from above, this device, too, suffers from teething problems — presumably because of its young age. The battery life is problematic, and the software (Android Wear OS) appears unfinished.

Figure 5.7: Samsung Gear Live

5.2.2 Conclusion

An overall perception about the technology after interacting with actual smartwatches was that it suffers from a lot of teething problems, such as interaction unclarities and shortage of useful hardware entities. There are still glitches in the OS, and some features, like being able to delete an app from the watch, are conspicuous by their absence.

5.3 Evaluation of Existing Smartwatch Apps

To spark the imagination and hopefully get ideas for the design of the Nordnet app, existing smartwatch applications were evaluated. This analysis showed which gestures and which interaction methods are applicable. Three smartwatch apps were evaluated; Google Fitness, ViewRanger and Moto Body Heart Rate. A number of push notifications sent from smartphone apps were evaluated as well, including Hangouts, Messenger, Snapchat, Gmail and Phone.

5.3.1 Conclusion

In summary the smartwatch apps on the market today are very inconsistent when it comes to the design of the interaction. The push notifications however are more consistent and follow a similar flow pattern, regardless which app the notification come from the user feels familiar with the interaction.

One flow pattern that stood out is Google Fitness', which is described and pictured in section 6.2.1 (Figure 6.6).

5.4 Perception of Smartwatches

The first step towards forming a clear vision of what wearable electronics are and how the technology is perceived by the public, an investigation of the area was initiated, with smartwatches being the focal point. The smartwatch is a relatively new gadget, and therefore little information is accessible. When first released, smartwatches were directed against technically interested people and companies. It was not until recently that the device reached the public.

The initial investigation took place on forums, technology blogs and online magazines. Once enough information was assembled, four interview questions were compiled, as shown in section 5.5.1.

5.5 Interviews at Wearables Pop-up Lab by Ideon and Øredev

5.5.1 Execution

An interview investigation took place at a wearables fair at *Ideon* in Lund, resulting in a target group consisting of technology interested people with some — to great — knowledge on wearables. The goal with this investigation was to collect broad information on the subject rather than deep. The interviews were semi-structured and consisted of both open and closed questions. Three questions were designed to get the participants' opinions on smartwatches, and a fourth, more targeted, question about trading in combination with smartwatches.

The questions were:
1. What possibilities do you see with smartwatches?
2. What constraints do you see with smartwatches?
3. What do you think about the future of smartwatches?
(4.) Do you trade? If so, which exploitation possibilities do you see in combination with smartwatches?

Fifteen people participated in the study.

5.5.2 Results

The results from the interviews confirmed the results from the initial investigation. About half of the participants were very interested in smartwatches and believed it to be the future of technology, while the other participants did not see the point with having a smartwatch and believed that it is simply a passing trend.

Question 1: What possibilities do you see with smartwatches?
As mentioned above, about half of the participants had a very positive view of smartwatches and believed that the possibilities with the technology are endless. They believed that a smartwatch could be an asset in various areas such as healthcare and sports, due to immediate objective data as an instant feedback.

Question 2: What constraints do you see with smartwatches?
The majority of the respondents pointed out technical limitations like the short battery life, design flaws and lack of functionality.

Question 3: How do you perceive the future of smartwatches?
There were divergent views of the future. One forecast was that smartwatches will develop a lot but not replace the analogue wristwatch, whereas others believed the technology will be dead in a few years.

Question 4: Do you trade? If so, which exploitation possibilities do you see in combination with smartwatches?

Six of the participants were involved in trading, and they all thought that a smartwatch is unsuitable for buying and selling stocks because of the small display. Instead they believed that a smartwatch app only should contain notifications and an overview of the share price. More advanced features should be done on the smartphone app instead. The overall opinion was that a smartwatch app only should serve as an extension of the smartphone app.

5.6 Interview at LINC — Lund University's Finance Society

Considering a starting point with zero knowledge on stock trading, an initial move was inevitable: learn stock trading. Subsequent to reading up on the subject, an interview was conducted, where the ambition was to receive an experienced stock traders' take on trading. Specifically what material they considered useful and which information channel they used to access said material.

5.6.1 Execution

In order to get a deeper insight of the behavior in a regular trader, a member of the Executive Committee of the business club LINC (Lund University's Finance Society) was interviewed. The interview was kept open, but was based on the following questions.

1. Do you trade stocks?
2. In what capacity?
3. How do you trade? Computer/mobile phone? Which website do you use?
4. What information do you find important? How many joint stock companies do you follow?
5. Do you see a possible usage of smartwatches when trading?

The interview session took place at the School of Economics and Management in Lund, where the interview object was the Head of Education, as well as the Executive Committee. The interview resulted in an overview of the most common tools in terms of trading and an opinion of what features should be included in Nordnet's smartwatch app.

5.6.2 Results

The interviewed board member of LINC claimed to rely on CNBC's phone app, which gives him relevant news on an instant. He asserted that because he is not a day trader, the information given to him through mentioned app was enough to keep him updated. The news notifications were something he was very interested in getting in a smartwatch. Detailed stock information, however, was considered unfitting to such a small screen. As he did not see the smartwatch's purpose for day traders to begin with, due to the limited screen (and apparently they need more than one large screen), impulsive decisions are rarely made and a buy/sell feature would therefore be excessive.

5.6.3 Conclusion

Having reached two different target groups simplified the process of realizing what was desirable regarding both the physical technology and the software. Based on the conducted interviews, a limited number of software features were selected and some features were dismissed.

Selected features

- News (push notifications)
  News notifications immediately in the watch
  — If interesting, open app in phone
- Alarm (push notifications)
  Notification once a stock has reached a certain pre-determined value
  — If urgent to act upon, open app in phone
- Quick overview
  A flow of selected stocks — click on one to view more detailed information

Dismissed features

- Buy/sell stocks
- Voice control
- Extensive information

6 Prototyping Phase 1: Flow Patterns

The first prototypes of the flow pattern were sketched on a whiteboard as a part of a brainstorming session, and was followed by an individual design exercise. Combining the ideas resulted in six different prototypes, with interaction and flow as focal point. Because of the technology's youth and its gesture based concept it felt necessary to refine the interaction. An ordinary user is not used to this new way of interacting with an electronic device — or any device for that matter. To reduce unnecessary confusion and hesitation an easily understandable and effortlessly navigated interface is the key to a successful smartwatch application.

Three different arrows are used in the user flow pattern prototypes in section 6.1 and 6.2. These arrows are described and illustrated in Figure 6.1 through 6.3 below.

Figure 6.1: One-way swipe

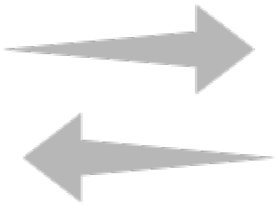

Figure 6.2: Two-way swipe

Figure 6.3: Direction arrow

The arrow in Figure 6.1 illustrates a swipe to the right. To make the flowcharts easily understandable the arrow points in the direction of the next page in the flow. Thus will a swipe from left to right take the user to the page to the left. A single arrow in the flow patterns illustrates a one-way navigation. The two arrows in Figure 6.2, however, shows a two-way navigation, meaning that users can return to a page by going back the same way they came from.

The last arrow in Figure 6.3 differs from the other arrows. This arrow is just a direction arrow and does not illustrate a swipe. The arrow points to the location a swipe will take us.

It should also be mentioned that all images show sample information, and is not definite in any way.

6.1 Push Notifications

When designing the notifications, the standard notification flow pattern developed by Google was kept in mind. It felt unnecessary to cause confusion by changing the concept too considerably. Two versions of the flow patterns were created, where the difference is slight.

6.1.1 Notification Flow 1

The flow shown in Figure 6.4 is very simple and clean and is inspired by several existing app notifications. When the wearer receives a notification, it pops up on the homescreen on top of the watchface, showing a small piece of information, as shown in the leftmost clock face in the figure. The user can then choose to swipe upwards to view further, although still limited, information, as shown in the second clock face. A swipe to the left takes the user to the action button 'Open in phone' and another swipe to the left takes the user to the action button 'Block app'.

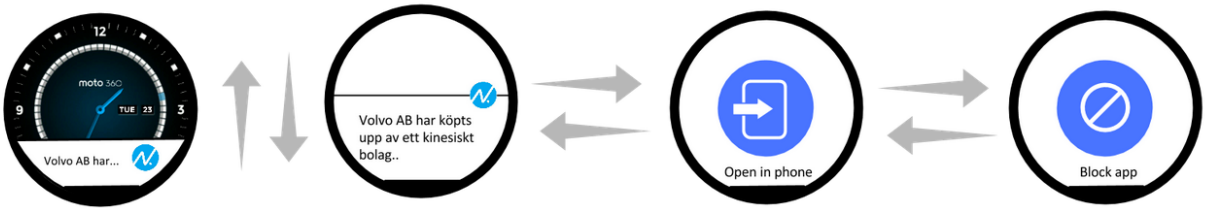

Figure 6.4: Notification flow 1

6.1.2 Notification Flow 2

In the second rendition, Figure 6.5, a further step is added to the flow, where additional information is viewed by swiping upwards. The user can choose to read the entire article directly on the watch by swiping upwards, or simply open it on the phone, by an additional right-to-left swipe.

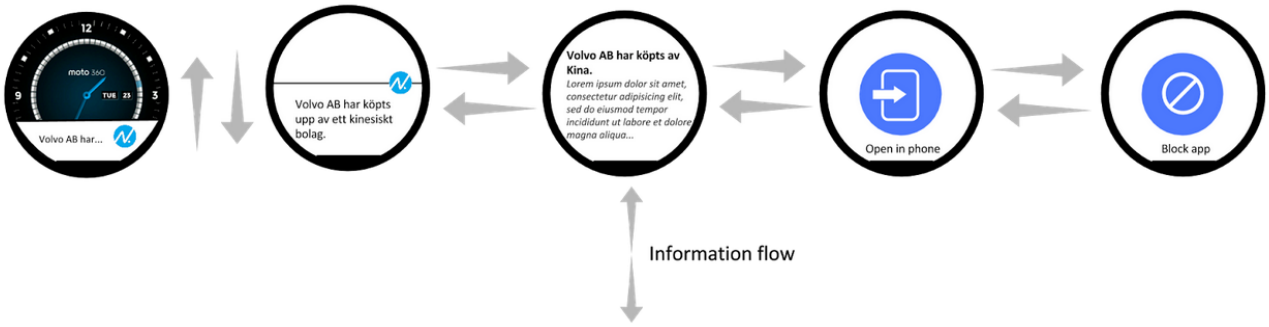

Figure 6.5: Notification flow 2

6.2 Application

When designing the prototypes of the flow pattern for the app, the standard navigation in Android Wear was kept in mind. The user should easily know how to navigate through the interface. After evaluating existing apps some flaws were discovered, which were aimed to be improved.

The smartwatch apps on the market today are few and do not follow a standard flow pattern in the same way push notifications do. An initial flow from an existing Android Wear app was therefore used as a source of inspiration when designing the different versions.

6.2.1 Initial Flow

Figure 6.6 below shows the flow pattern of the Google Fitness smartwatch app, as mentioned in section 5.2.1. The flow pattern creates a matrix with two different levels; a parent view (the first level in the matrix) and the child view (the second level in the matrix). The flow pattern allows two-way navigation except from the navigation between the first and the second level at the two leftmost pages which is one-way, causing the user to having to go through the entire interface in order to find their way back to the home screen.

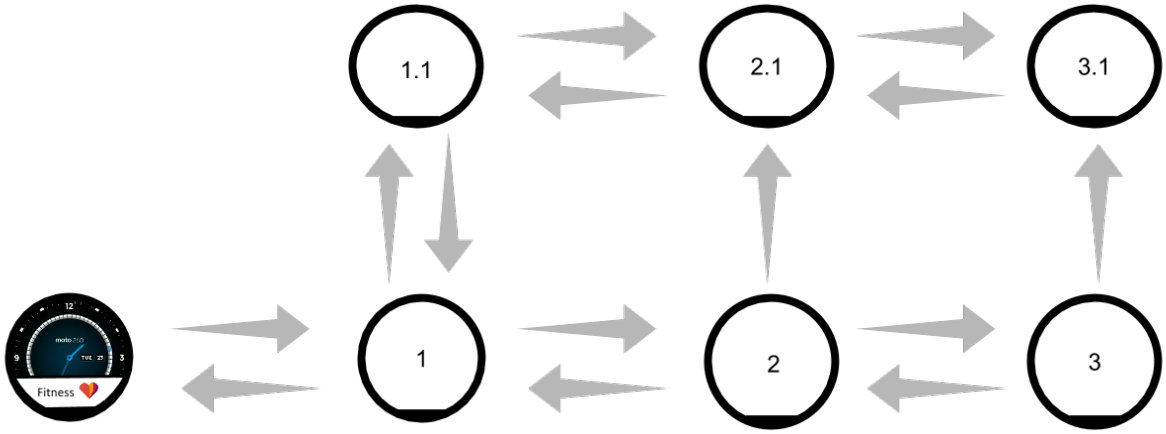

Figure 6.6: Initial app flow

This flow pattern was a starting point for the following four flows described below.

6.2.2 Flow 1

With words like *simple*, *quick* and *smooth* in mind, the first flow (Figure 6.7) surfaced. The interface is manageable through solely lateral swipes, which is a great advantage. However, it limits the amount of viewable information, imposing high demands of precisely which information should be included.

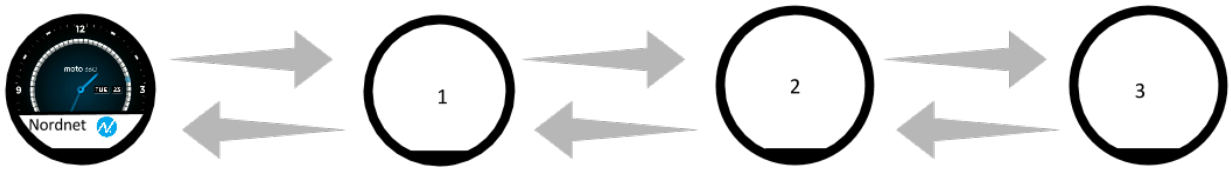

Figure 6.7: App flow 1

6.2.3 Flow 2

This second flow (Figure 6.8) emerged from the thought that a trader might be interested in viewing deeper information of one certain stock. After a quick browse through the stock names, it is easy to navigate to sought after information. However going from H&M's current price change (shown in percentage) to Volvo's is a hassle, as is the home navigation.

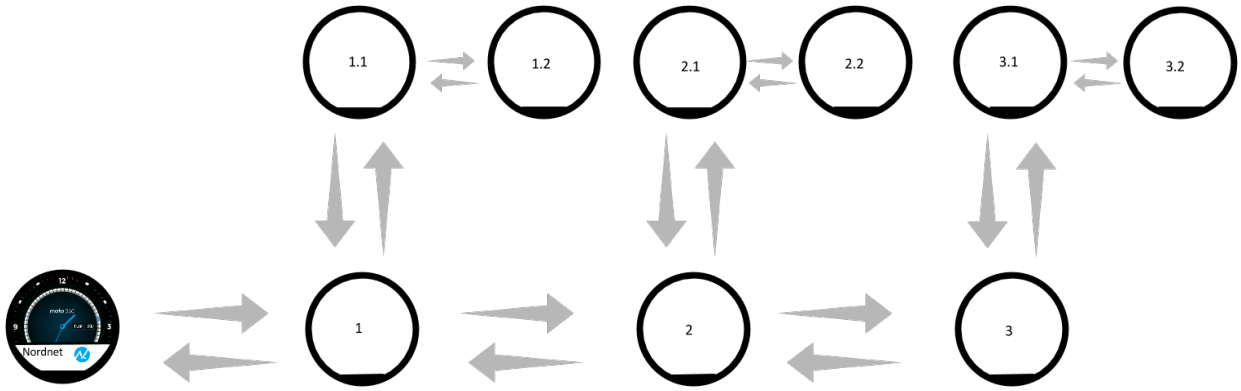

Figure 6.8: App flow 2

6.2.4 Flow 3

One issue that arose when discussing flow patterns was the home navigation. Because of the hierarchy, going back all the way back to the home screen felt cumbersome. Flow number 3 (Figure 6.9) shows a solution to that. Starting from any position in the interface, one, two or three swipes, respectively, from left to right ends up on the home screen. Although this solution offers a quick way home, it may also lead to users closing the app by accident. To smoothly interact with this matrix, it helps to know which stock to inspect on beforehand, as it is tricky to navigate from H&M's underlying level to Ericsson's.

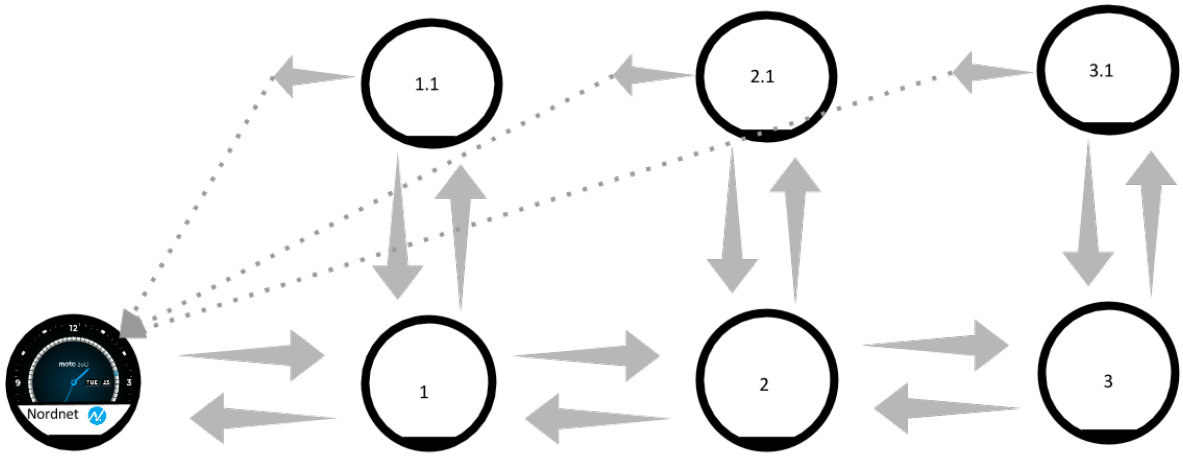

Figure 6.9: App flow 3

6.2.5 Flow 4

This last flow pattern (Figure 6.10) shows a possible design for an app filled with extended information. The goal was to find a solution which compromises between agility and data. By swiping from left to right one, two or three times, respectively, takes the user to the watchface.

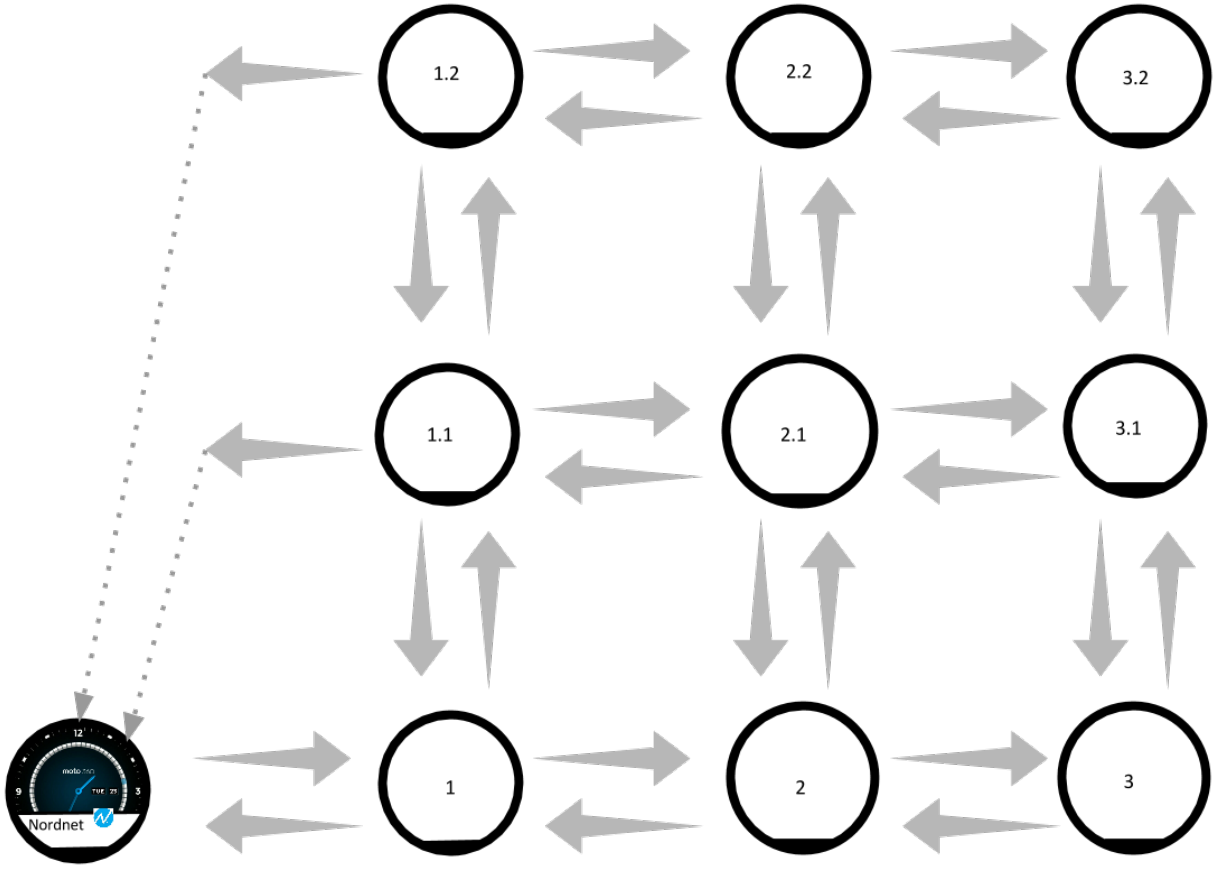

Figure 6.10: App flow 4

6.3 Evaluation

During the first presentation of the project, the six different flow patterns above were shown. Having the different solutions discussed in a group of employees at Jayway — including the supervisor and the product owner of this master's thesis — resulted in a brand new flow pattern. The chosen features were also discussed with the product owner and at a focus group with members of LINC. The product owner's opinion along with the input from the participants in the focus group resulted in more specific features, displayed in section 6.4.

6.3.1 Customer Input

The consensual opinion in the conference room during and subsequent to the demonstration was that the interaction was the utmost important component of the development of the Nordnet app. Because of the gadget's youth, the public is still unused to this new way of interacting with an electronic device. Thus must the interaction flow feel natural to the point where it is almost obvious. Out of all the flowchart propositions, the fourth one, Figure 6.10, was best received, although with one fewer level (see Figure 6.11). This conclusion followed the realization that the information in the smartwatch app should rather be limited and to the point than too ambitious. In the context of the Google quotation, as stated in section 1.2, which this thesis revolves around, the answer should be *Overview*. Quick access to necessary information.

6.3.2 Mini Focus Group

After recognizing that the information in the smartwatch app should be restricted, it was crucial to unravel exactly which information is vital to stock traders. To sort that out, a focus group with a five members of LINC was organized, and held in the organization's facilities.

Method

The participants were recruited through the Head of Education at LINC. He was given instructions for the number of participants needed along with knowledge requirements, and gathered a group consisting of five students, all members of LINC and therefore well acquainted with stock trading. Moreover, two participants were Nordnet customers and users of the previous Nordnet phone app.

The common denominator of the participants was the fact that they were all men and active in the same stock trading network. A moderator led the exercise while a hostess took notes of what was said during the hour. Considering the goal of the act being to untangle a specific uncertainty, it was relatively simple to compile a document containing the key opinions. Thanks to the relaxed circumstances and the open form of questioning, all participants felt comfortable sharing their views. The five persons engaged in the focus group complemented each other's answers to the questions and started an open discussion without being told to do so, generating a lot of quantitative information.

The focus group started off by the moderator introducing herself and the hostess, explaining the purpose of the gathering and asking for a short introduction of the group. Short thereafter, the interviewing began, commencing with the Nordnet phone application being the point of attention; which features are most indispensable, which parts are less relevant?

In the next phase of the group exercise, there was a weight shift. With a smartwatch in mind, what information is desirable? Imagine a very limited space; what would you want to fill it with?

And lastly, what functions would bring you to purchase a smartwatch?

Results

Question 1: Which information in the Nordnet app is indispensable?

Key points (alphabetical order)

- Financial news
- Graphic displays
- Key indicators
- Overview of the past year's result

Summary

When focusing on the Nordnet phone app, the group mentioned the key indicators and the graphic displays with the arrows of the stocks as necessary and important pieces of information. It is mainly a trader's own personal portfolio that is interesting. The participants seem to be interested in having access to quick information of their own stocks, both present and from the past year.

Selected responses

- "The overview graph is great. I especially like that the time horizon is adjustable."
- "I mainly use the app to check my portfolio."

Question 2: What information would be desirable on the wrist?

Key points (alphabetical order)

- Arrows along with the rate
- Browsing through own portfolio
- Press releases
- Shortcut to open app in phone

Summary

The main thing being emphasized during the hour with LINC was that the application should be personifiable to the utmost, making the information restricted and relevant to each user. The smartwatch being attached on the body allows quickly accessed information relevant to each user and could serve as a shortcut to the phone app. The participants also all agreed that having an alarm for stop-loss (Aktieskolan, 2009) is a highly desirable feature. Stop-loss is described in section 6.4.2. It would keep the users even more up-to-date regarding their own investments and open up the possibility to act even quicker on the stock market.

Selected responses

- "I would really appreciate up-to-date news, especially those relevant to me and my portfolio. I would also like to get a heads up when a press release is about to come!"

- "Super interesting to be able to browse through my portfolio and maybe use the smartwatch to open the app on the phone. I've got so many apps on my phone that it would save me time."

Question 3: Which functions would bring you to purchase a smartwatch?

Key points (alphabetical order)

- Constant access to the world
- Easy and smooth accessibility
- Timesaver

Summary

In the beginning of the session with the LINC members, they were all hesitant and skeptical towards this new technology, but after discussing smartwatches in combination with stock trading there was a change of attitude. One of them even did a full turn and ended up very intrigued and would definitely consider purchasing a smartwatch. As a group they could see the benefits of using a smartwatch, especially because of its discreteness and efficiency. They also pointed out the importance of being connected to the stock market on a regular basis, which a smartwatch facilitates.

Selected responses

- "I'm addicted to the internet and feel the need to be constantly connected. That's what I want from the smartwatch."
- "A wristwatch is the only accessory for us men, which makes me wonder whether the smartwatch ever will outcompete the classic Rolex."

Conclusion

The input from both the customers and the stock traders led to a brand new flow pattern, and the three previously chosen features were confirmed to be valuable, but primarily they developed into more specific ideas. All involved parties were eager to make sure that the interaction is quick, which led to the simplest flow for the notifications, Figure 6.4, being chosen. For the app was the fourth flow, Figure 6.10, chosen, although with one fewer level (see Figure 6.11). The features are described in details in the next section.

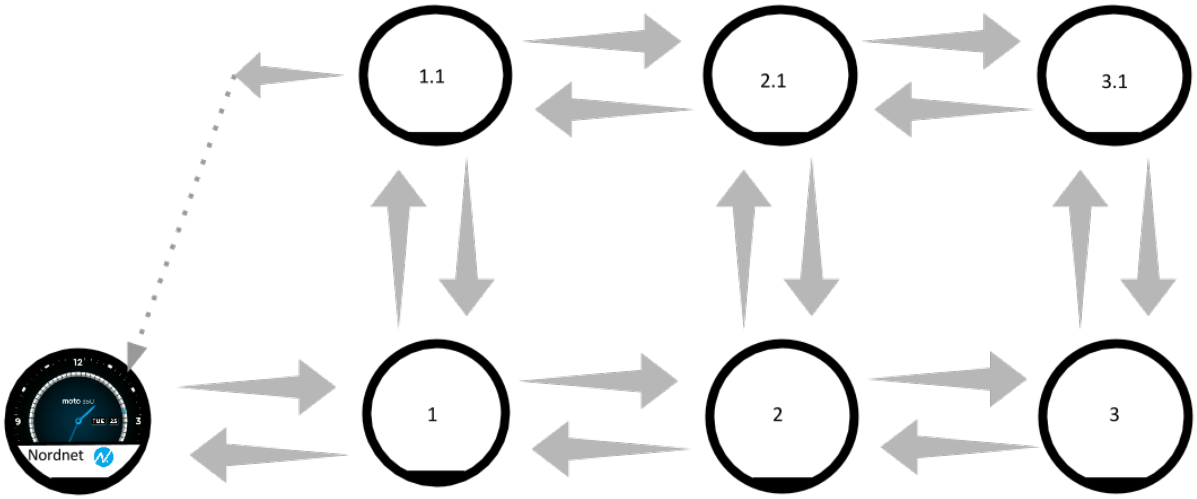

Figure 6.11: The final flow

6.4 Features

As mentioned in section 5.5.3, three different features were selected; two push notifications and an additional feature for the smartwatch application. The app and notifications were supposed to revolve around what in the phone app is called instruments. It is the list of stocks, or instruments, the user follows.

6.4.1 News

A person who trades regularly is interested in getting news updates affecting their stocks. The smartwatch receives notifications as soon as the news arrives to the smartphone app. The user can then easily glance on the news headline and quickly decide whether the news will affect their stocks. If the news is of interest will the user be able to get extended information by either open the phone app from the clock or by swiping to the left and read the news directly on the wrist.

Since a smartwatch is fixed on the wearer's wrist it is of great importance that the news being pushed out to the smartwatch is relevant to the wearer, or they will not take notice. Due to this, the user should be able to personalize the news feed to be shown on the smartwatch. The customization is done on the smartphone app, where the news is retrieved.

6.4.2 Stop-Loss

When trading it is common to use a stock trading technique called stop-loss, meaning that a trigger condition is set, which helps the trader to automatically sell or buy a certain stock. When a stock hits that pre-determined value, the smartwatch will receive a notification and trigger an alarm on the wrist, instantly letting the wearer know a stop-loss order has been activated. The user will be able to personalize which alarms that should be triggered on the smartwatch from the phone app.

6.4.3 Overview

In addition to receiving notifications, a smartwatch also holds their own apps. A smartwatch app is more advanced than a notification and has a deeper hierarchy tree which makes it possible to present more data. A person who trades may like to get a quick overview of their favorite stocks and a smartwatch app makes this possible. The user decides, by changing the instruments list in the phone app, which stocks will be shown in the smartwatch app.

Each stock is represented on a separate page containing the stock's name and a percentage in combination with an arrow indicating that the stock has either gone up or down. Each page has an underlying page showing three key indicators; price-to-sales (P/S), price-to-earnings (P/E) and price-to-book (P/B).

6.5 Conceptual model

6.5.1 Conceptual Design

This application consists of pages called full screen activities containing stock, and key indicators. The stock pages are imagined to be written down on pieces of papers and placed in a row. The key indicators, each belonging to a certain stock, are also visualized pieces of papers placed in another row, directly above each stock. All navigation is swipe based, and to get to another page, one should imagine to push away the piece of paper, to make room for a new piece of paper.

6.5.2 Grouping of Services

The app is composed of two dimensions of information placed on two levels; the first one consisting of a chain of selected stocks — i.e. the parents, and a second level viewing another dimension of each stock — the children. They are linked together in a matrix, where a swipe downwards from a parent leads to further information belonging to that parent. Sideswipes take the user to another page on the same level.

6.5.3 Terminology

This smartwatch application is based on a phone application, but a very slim part of the app is indeed adapted, in fact only the list of instruments. When isolated from its context, it was decided "Instruments" felt unclear and was thus renamed to 'Watchlist', as it in the smartwatch app is a list of stocks the user is interested in following.

7 Prototyping Phase 2: Lo-Fi

Subsequent to selecting features, the design process was initiated, which commenced with a brainstorming session. The Lo-Fi prototype was designed on paper, in order to open up to possible changes or improvements during the succeeding user study.

7.1 Interaction

The way to interact with a smartwatch is mainly through swipes. Taps are used to open an app or to act upon action buttons. It appeared, while getting familiar with Android Wear and existing apps, to be easy to get lost in the UI, and one of the large hurdles was to figure out a way to effortlessly return to the home screen. The solution was a double-tap that leads to the start page independently of which page is the starting point.

7.2 Design

7.2.1 Notifications

As for the notifications, they are designed according to Android's standard, with the Nordnet logotype placed on the edge between the notification area and the watchface.

7.2.2 Current Price Change

The first level (consisting of the circles entitled 1, 2 and 3 in Figure 6.11) was decided to contain each stock in the watchlist's current price change (Figure 7.1). The ratio provides a quick overview, and by swiping sideways, the user can easily view and compare the different values.

The stock name is stated in the lower part of the screen, in order not to steal too much visual attention but still offer the user awareness of which stock each page belongs to.

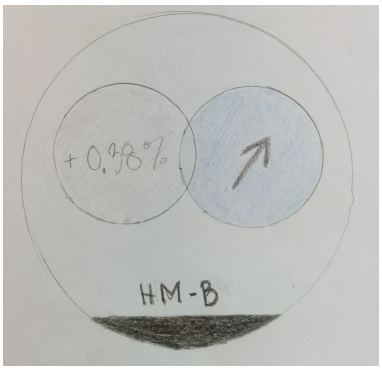

Figure 7.1: Current price change

7.2.3 Key Indicators

The second level (entitled 1.1, 2.1 and 3.1 respectively in Figure 6.11) was decided to show each stock's key indicators (P/E, P/S, P/B). The circles were adopted from the original design, to make the entire UI uniformly (Figure 7.2) and to achieve the feeling of consistency. Due to the constraining screen, only a limited number of circles would make sense. Three seemed like a good number and makes an attractive shape, as opposed to four circles.

According to Google, a smartwatch app is well designed if it only takes five seconds to use. Based on this criteria, colors (which people have a tendency to, regardless of the level of consciousness, mentally

associate to an object or other information source) were decided to play a big part of the design. One color for each value makes it easier for the user to quickly find the information they are looking for, without having to read the labels, once they have made the connection between value and color. The colors chosen at this stage are temporary.

By limiting the information viewed on each page, the eyes go straight to the essential information making the visibility clear.

Figure 7.2: Key indicators

7.3 User Study

In the final stage of the Lo-Fi process user studies were held, in order to confirm the design and interaction decisions and discover potential problems. The goal with this user study was to sort out whether the interaction flow was understandable and the navigation was clear, making it an exploratory test. Locating crucial flaws in an early stage provides a great opportunity to avoid major design mistakes, subsequently leading to less time wasted on failed prototypes.

7.3.1 Test Subjects

Seven test subjects participated in the user study, five of whom were women and two were men. Five of the subjects were students at the Faculty of Engineering where three of them studied Biomedical engineering and the other two studied Information and communication engineering and computer science engineering. All of the students were technically minded and were at different stages in their education. The other two subjects worked on the campus of the Faculty of Engineering. They were from the United States and had no technical background.

None of the test subjects had any experience in stock trading, nor smartwatches.

7.3.2 Task Scenarios

The user study consisted of nine different task scenarios that covered both the navigation through the interface and the app features.

Notification

Task 1: You receive a news notification from Nordnet on your smartwatch. You want to get some more information before you decide whether the news will affect your stocks. Navigate to the page where you can view further information about the news.

Task 2: The news was of interest and you want to read even more about it in your phone. Open the news on your phone.

Task 3: You receive another notification on your smartwatch from Nordnet, which you want to read later. Make it temporarily invisible.

Now, you have got the time to read the notification you hid. Make it reappear.

Task 4: You receive another notification on your smartwatch from Nordnet, but it is not of interest. Make it disappear.

Task 5: You are no longer interested in getting any further notifications from Nordnet. Block the app.

Application

You are interested in getting a quick update of the stocks in your portfolio, so you launch the Nordnet app on your smartwatch.

Task 6: Has ABB gone up or down? How much? Return to the home screen when you are done.

Task 7: Find PE ratio of Eric-B. Return to the home screen when you are done.

Task 8: Compare PB between Eric-B and ABB. Return to the home screen when you are done.

Task 9: Which stock has the highest PS ratio? Return to the home screen when you are done.

7.3.3 Test Environment and Equipment

The user study was decided to be held in an environment where the subjects feel comfortable and relaxed, to subtract possible disruptions or external distress. Since most of the test subjects were students at The Faculty of Engineering, it was natural to hold the study sessions on their premises.

The equipment at hand was an iPhone with the application POP installed, where the paper prototypes were linked together in the exact same way as the smartwatch app was intended, and with the correct gestures. The prototypes in POP are the exact the same size as the screen of Moto 360.

The choice to use paper prototypes together with POP was made after a brainstorming session together with the supervisor. The first proposal was to make the Lo-Fi prototypes in the correct size from the beginning and place them on the user's arm during the test. However, this solution was difficult to accomplish, because of the small screen. The best way to do this was decided to be to use another product with a touch screen. Unfortunately there were no applications similar to POP customized for a smartwatch at the time, which led to the idea to use a smartphone as a smartwatch instead.

The user study was recorded with a video camera and a voice recorder in order to more easily evaluate the results later.

7.3.4 Execution

In order to minimize the number of beginner mistakes the test subjects were given a few minutes to familiarize themselves with Moto 360 and Android Wear before the actual test session commenced.

In the beginning of the test session, the subjects took a background questionnaire, regarding demographics. The test subjects were then asked to perform the tasks while speaking their thoughts out loud. The test leader introduced the test person to the tasks and clocked key elements while the assistant

observed and documented the test. During the test, the test persons were only allowed to use one hand to interact with the prototype, in order to make the interaction as realistic as possible. Subsequent to the test, the subjects answered a couple of post-test questions as a debriefing session. Figure 7.3 shows the test environment.

Figure 7.3: The test environment

7.3.5 Results

Table 1 presents each subjects' expenditure of time per task and the average time spent on completing each task. The slots written in bold indicate which task each person spent most time on completing. The numbers written in red show which tasks the test subjects needed assistance with.

Table 1 shows that four persons experienced most difficulty with task number 5; two persons with task number 6 and one person with task number 1. Hence, the most problems generally arose while testing the notifications.

Worth noting was that the time per task varied greatly from one person to another. One example of this is task number 5, which the test subjects generally experienced most problems with, as seen in Figure 7.4. The average time spent on it was 100 seconds, as seen in graph 1, but only three persons exceeded this time. In fact, three other of the test subjects needed very little time to complete this particular task, the shortest time being 7 seconds. This major time difference is caused by the said test subjects founding the page by mistake in a previous task. They remembered the navigation to the page and then solved the 5th task quickly and easily.

Table 1: Time per task

		Subject 1	Subject 2	Subject 3	Subject 4	Subject 5	Subject 6	Subject 7
Notifications	Task 1	60 sec	47 sec	50 sec	56 sec	39 sec	**74 sec**	78 sec
	Task 2	80 sec	4 sec	15 sec	36 sec	20 sec	28 sec	24 sec
	Task 3	6 sec	2 sec	54 sec	39 sec	9 sec	29 sec	13 sec
	Task 4	2 sec	4 sec	10 sec	5 sec	17 sec	10 sec	28 sec
	Task 5	7 sec	**93 sec**	15 sec	**205 sec**	**227 sec**	11 sec	**143 sec**
Application	Task 6	**122 sec**	60 sec	**109 sec**	45 sec	44 sec	42 sec	89 sec
	Task 7	9 sec	25 sec	21 sec	11 sec	34 sec	16 sec	15 sec
	Task 8	11 sec	21 sec	22 sec	20 sec	23 sec	56 sec	50 sec
	Task 9	12 sec	21 sec	26 sec	17 sec	7 sec	15 sec	15 sec

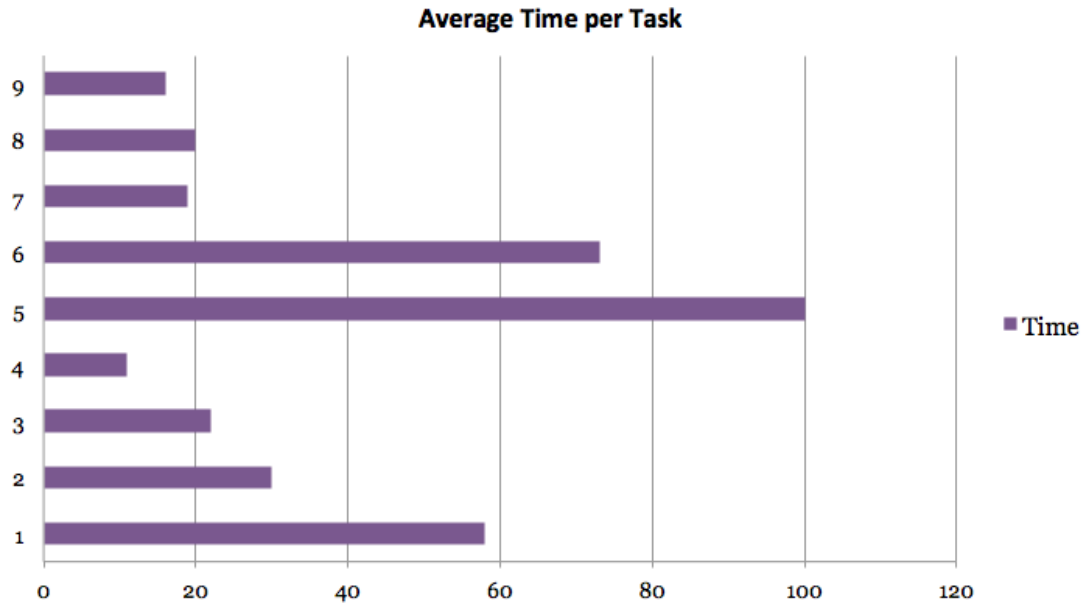

Figure 7.4: Average time spent per task

When looking at the measured time for task 6 and task 1, which were the tasks with the second and third longest average time, it appears the times per task for each subject did not vary as much as in the previous example. In these tasks, the test subjects had trouble understanding how to open the notification/the app to view further information. They wanted to click on the first page rather than swiping it to the left or upwards, which caused confusion. An inconsistency that caused confusion was the fact that there were two possible ways to open the notifications (task 1); either by swiping upwards or to the left, but only one way to open the app (task 6); by swiping to the left. The test subjects had learned from the previous tasks that a swipe upwards worked and tried this in task 6 as well, which did not work. This inconsistency explains why the average time spent on completing task 6 was 15 seconds longer than the average time for task number 1.

The measured times for the other tasks were much shorter and did not vary between the subjects in the same extent. The measured times displayed in table 1 shows that the tasks were solved faster after the subjects had been acquainted with the interface.

During the test session, several test subjects expressed the wish to have the ability to read the entire news directly on the watch. It also became clear that the shortcut to navigate home faster was a requested feature. Even though only one of the test subjects found the implemented shortcut in the app by themselves, the other test subjects agreed that a double tap was a good and quick way to navigate home after having demonstrated it to them.

In the debriefing session, the test subjects were asked to answer which task they felt was the trickiest, and which one was the easiest. All test subjects were unanimous and considered task 5 the most challenging and task 9 the most apparent. The trouble with task 5 appeared to be finding the Block app card, and understanding where in the UI they were. It surfaced that the test subjects were uncomfortable with the gesture-based interface, which was unfamiliar to them. By the time they were about to take on task 9, the test subjects had come to a point where they were more confident interacting with the gesture-based UI and had understood the hierarchy. The presentation of data in the different pages was quickly interpreted and the location of the different pages had become clear. It was therefore named the easiest task.

When rating the app on a scale from 1 to 5, with 5 being the best, 4 was average. The test subjects included the notifications in the rating, which they expressed lowered the score.

A citation from the debriefing session with one of the test subjects was ”It frees up your hands!”, which captures the essence of the concept of a successful smartwatch app.

7.3.6 Confounding Factors

There were several factors that may have affected the outcome of the user study, and one of them was the app POP. The application is not very reliable. Sometimes when the test subjects performed the right

gesture, it was not registered by the app. POP also provided hints to the user when a wrong gesture was made. The test subjects got confused when they did the right gesture but the app responded as if it were wrong, whereupon they did not dare repeating the same gesture, which led to longer execution times and created insecurity. The hints provided by POP both confused and helped the test subjects, even though they were told to ignore them. Worth mentioning is that POP is designed for testing prototypes that are meant for the device used. Since an iPhone 5c was used to illustrate the screen of a much smaller size it was easy to accidentally tap or swipe outside the prototype which meant that the app could not register the gesture, which also affected the outcome.

The test subjects also had difficulty seeing the depth in the UI illustrated on paper prototypes. They found it difficult to distinguish buttons from cards and they also had difficulty seeing that the black line in the bottom bar was a light sensor and not a part of the UI.

Since Android Wear is a gesture based OS, and lacking any interaction clues in the UI, it is quite difficult to understand for a first-time user. The time the test subjects got to familiarize themselves with the OS was not long enough to make them feel completely confident with Android Wear. This uncertainty may also have affected the outcome of the study.

7.3.7 Conclusion

Even though the test subjects were given a few minutes to familiarize with Android Wear, there was a learning curve before they were completely comfortable with the interaction and navigation. Apparently it requires a developed habit of using wearables in order to fully understand the OS. This became clear when overviewing the results from the task scenarios. A part of the learning curve was apparently to make mistakes and find pages that were supposed to be found later on. The latter tasks were completed with confidence and much quicker than the previous ones. The main troubles were obtained while testing the notifications and the test subjects found the interaction with the app easier.

Taking account of the outcome of the study it was decided to keep the user flow pattern and the shortcut for the app, and even though the test subjects did not understand Android Wear's standard flow for the notifications it was decided not to change this since it would cause confusion for the users having an app that does not follow the standards. But it was decided to make the standards in Android Wear more user-friendly by helping the user to easier understand how to navigate in the UI by adding navigation dots (as commonly used in smartphones as well) and a mid-swipe view which shows both the starting page and the destination page in a swipe.

8 Prototyping Phase 3: Hi-Fi

In the beginning of this phase, the development team had a discussion with the product owner, resulting in a change of key indicators. P/B and P/S were exchanged to Volume and Price.

When certain of which parts of the design were easily understood and which parts accounted for hurdles, the high-fidelity design phase was initiated. The design was made in Sketch.

8.1 Interaction

Some changes were made — or added in fact — to the interaction flow during this phase.

8.1.1 Stop-Loss

Due to the realization that the Block app card in the notification flow was infuriatingly difficult to find, navigation dots viewing the current position in the UI and the number of cards included in the flow were added. Two new action button cards were added to the stop-loss flow patterns; Add to watchlist and Remove from watchlist, respectively. Also, a step where more detailed information about the stop-loss action was added. Figure 8.1 and 8.2 shows the new design for the stop-loss notifications.

Figure 8.1: Stop-loss: add

In the second variant of the stop-loss flow pattern, Add to watchlist is simply exchanged with Remove from watchlist (see Figure 8.2).

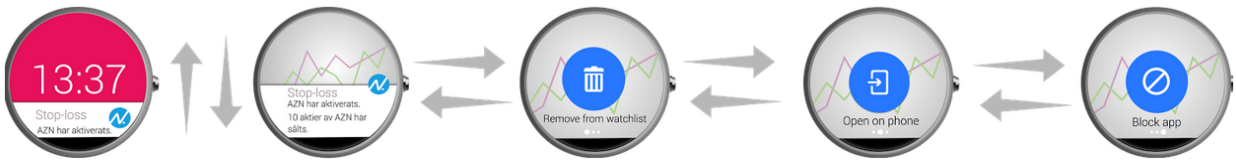

Figure 8.2: Stop-loss: remove

8.1.2 News

As for the news notification an additional step was added, where the user is given the opportunity to view the entire news article immediately on the watch, as wished by the test subjects. Figure 8.3 shows the new design for a news notification.

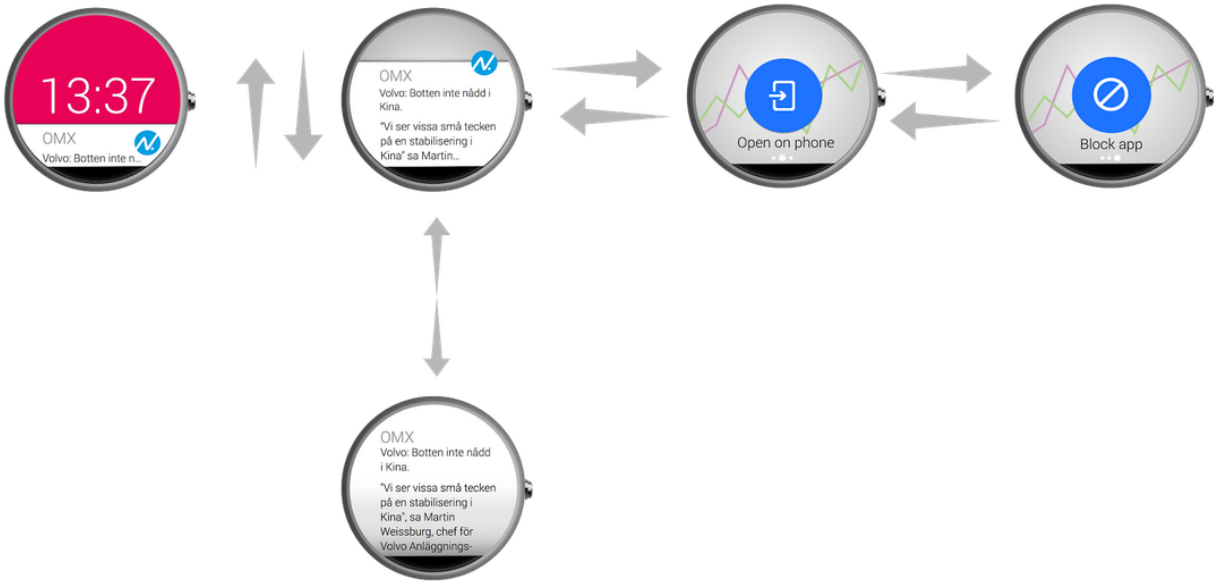

Figure 8.3: News

8.1.3 App

The evaluated app flow pattern was received very well by the test subjects why it was decided to be kept the same. The first level shows the stock current stock change and the second level shows the key indicators for each stock. The flow pattern is shown in Figure 8.4 below.

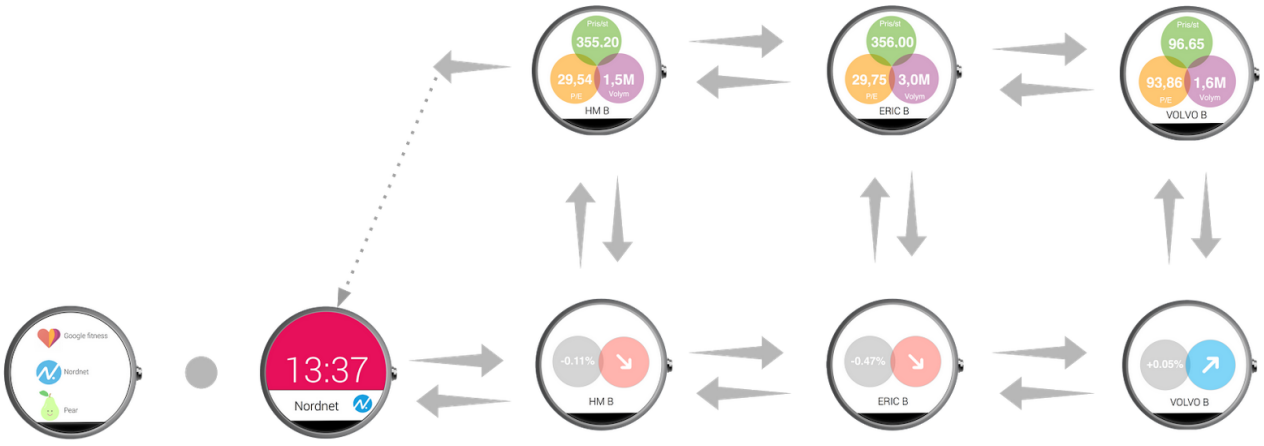

Figure 8.4: App

8.2 Graphic Design

An early goal was to make the smartwatch app feel consistent with the phone app. To achieve said goal, colors, shapes, dispositions, icons and terminology were carefully chosen.

8.2.1 Iconography

In order to achieve the on beforehand set aim, all icons are either Android Wear standard or inspired by the phone app.

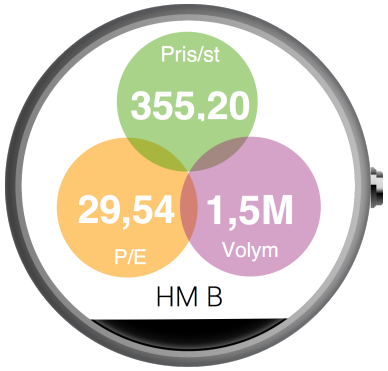

Figure 8.5: Information

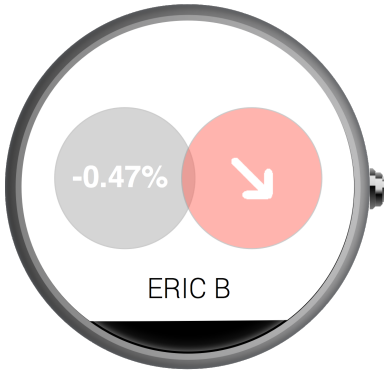

Figure 8.6: Danger

Figure 8.7: Success

The double circles (Figure 8.6 and 8.7) are adapted from the phone app, whereas the triple circles (Figure 8.5) are inspired by the design and create a feeling of recognition.

Figure 8.8: Background

Figure 8.9: Remove from watchlist

Figure 8.10: Add to watchlist

The background (Figure 8.8) is used in the notification flow, as a quick reminder of which app the user is currently interacting with. The graph used for the background was inspired by Nordnet's webpage.

8.2.2 Colors

The colors throughout the UI are adapted from either the Nordnet phone app or the bank's web page http://www.nordnet.se. The circles displaying the current price change (Figure 8.6 and 8.7) are copied from the phone app. However the triple circles displaying the key indicators for each stock, are colored with colors adapted from the web page, where they represent different parts of the menu system. The green and purple colors in the background picture (Figure 8.8) are the same as those in Figure 8.5.. Both the Remove (Figure 8.9) and Add buttons (Figure 8.10) are created to fit in with the other cards in the flow, with a blue background and a white colored icon.

8.2.3 Typography and Terminology

The font throughout the UI is Roboto Light, which is the Android Wear standard font.

As for the language choice, all standard cards are written in English, whereas the Nordnet specific pages are written in Swedish, due to the bank's origin. Due to the limited screen size the shown stock name is the stock market acronym instead of the full name.

8.3 Error Management

The notifications are standard, but with added navigation dots to eliminate confusion over location in the UI, which turned out to be the main error users do. Another standard in Android Wear's notifications, is confirmation buttons, offering the choice to undo the tap on an action button.

To facilitate the interaction and navigation through the app, both the starting page and the destination page will be shown mid-swipe (Figure 8.11), offering natural mapping.

When closing the app through long-press, a confirmation button pops up, where the user either confirms the action, leading to the app being closed, or regrets its choice and returns safely to the underlying page.

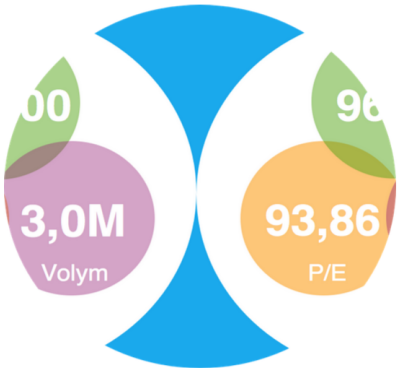

Figure 8.11: Mid-swipe

9 Prototyping Phase 4: MVP

9.1 Implementation

9.1.1 Environment

The MVP was developed using the development environment Android Studio synced with the distributed revision control system GitHub. Two Android smartphones and the two smartwatches Moto 360 and Samsung Gear Live were used for debugging, where the smartphones were connected to the computers over USB and communicated over Bluetooth with the smartwatches.

9.1.2 Development

Two different apps were developed; one smartwatch app and one smartphone app. The latter app was only used as a remote to send push-notifications to the smartwatch by simply pressing a button.

To design and develop a customized notification for a smartwatch app there is a class available where the wearable specific design and functions are declared. Apart from this class the notification for a wearable is implemented in the same way as an ordinary phone notification.

To implement the flow pattern for the app a view of the standard class GridViewPager was used. New instances of two different fragments containing the layout views are created in a matrix which later is handled by a FragmentGridPagerAdapter making the flow pattern reality.

The class DismissOverlayView is used when a long-press is captured. This class adds an action button above the current view when a long press has been detected, as shown in Figure 9.1. By pressing the button the app closes while pressing outside the button takes the user back to the current view.

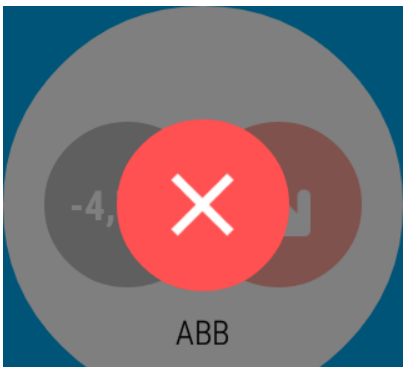

Figure 9.1: DismissOverlayView

A UML (Unified Modeling Language) diagram representing the smartwatch app can be found in Figure A-1 in Appendix A.

9.1.3 Layout

In order to get the layout to work on both circular and square Android Wear devices it is possible to only implement one XML file for a square screen and place this box-layout inside of the round screen. A disadvantage with this method is that it does not utilize the circular watch's screen size. The solution to this was to implement separate XML files for circular and square screens, and one XML file containing a layout called 'WatchViewStub', which creates a link between the layouts and determines the shape of the screen at runtime and inflates the correct layout for the running device.

9.2 Design

In this master's thesis, the goal was to implement an MVP which shows if the design concept works, leading the main focus being on the design and not on the code behind it. The implemented push notifications are therefore forced and the action buttons 'Add to watchlist' and 'Remove from watchlist' do not have any functionality and are left to be implemented in the future. The smartwatch app, too, only contains dummy data. The stock indicators are faked with a mathematical function in order to illustrate a live update of the stocks by ticking.

9.2.1 Alterations

During this phase, small changes and additions were made. The Android SDK was changed over the months the project ran, leading to a forced change in the flow pattern for the app. Instead of placing the underlying level containing the three key indicators above the list of stocks it was moved to being below it, which is shown in Figure 9.2 below.

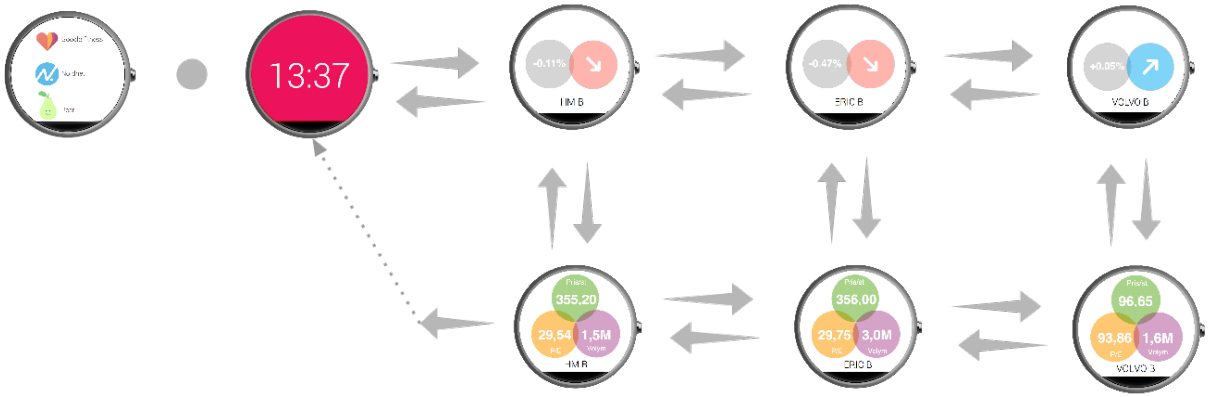

Figure 9.2: Flow pattern of the MVP

In the previous design, there was a small card, acting as a home screen, indicating the app was running. It was removed once the implementation commenced, due to the feel of excessiveness.

An additional push notification was added, upon request from the supervisors at Jayway. A user can set a threshold value on a stock in the phone, and when that limit is reached, an alarm is triggered and the phone app pushes out a notification to the smartwatch. This notification follows the same flow pattern as the two other implemented types of notifications.

Lastly, the term Watchlist was changed back to Instruments, as it is called in the Nordnet phone app.

9.2.2 Interaction

The way to interact with the implemented MVP is mainly through swipes. Taps are used to open the app or to act upon the action buttons. The previously determined double-tap gesture to be used as a shortcut to return back to the home screen was changed due to hardware limitations to a long press-tap instead. It is also recommended by Google to use long press to navigate home and close the app.

Vibration

Vibration is a commonly used interaction when notifications are being pushed out to the smartwatch, and was implemented in this MVP. It offers a dimension of feedback, in case the user actually relies on the notifications being consistent.

Navigation dots

Push notifications and some smartwatch apps are equipped with navigation dots, as a guide for the user to know where in the interface they are located, and so does the push notifications in the Nordnet app. However for the smartwatch app, this option was discussed, and finally discarded due to the dynamic construction. If the watchlist consists of, say, 10 stocks, the dots would only make the interface messy. Moreover, since the app is two-dimensional, the dots would take up too much space, and therefore be distracting.

9.2.3 Graphic Design

The previous iterations concluded with a final design, down to every detail, based on the designers' choices combined with the evaluation results and the standards coming with Android Wear. No further design changes were made during this phase. Figure 9.3 through 9.5 shows some screenshots from various parts of the app interface.

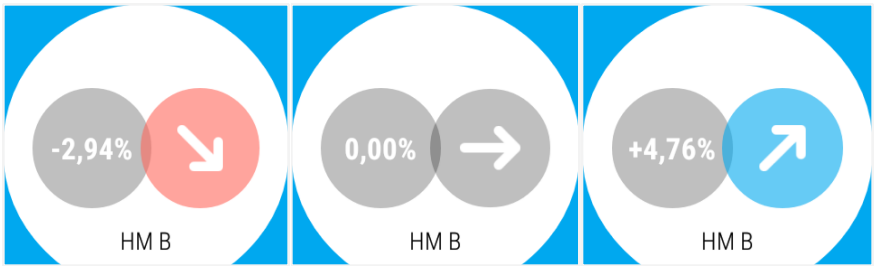

Figure 9.3: Current price change

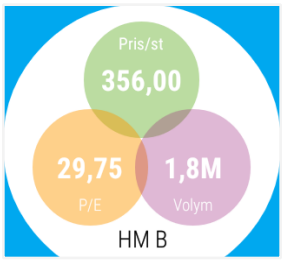

Figure 9.4: Info layout

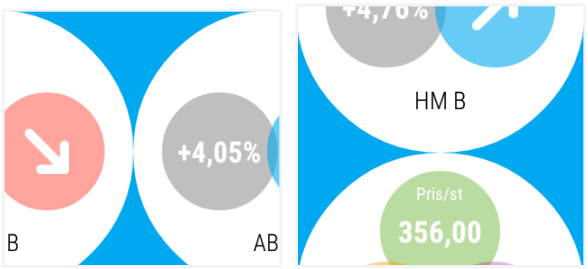

Figure 9.5: Mid-swipes

Figure 9.6 shows screenshots from one of the news notifications.

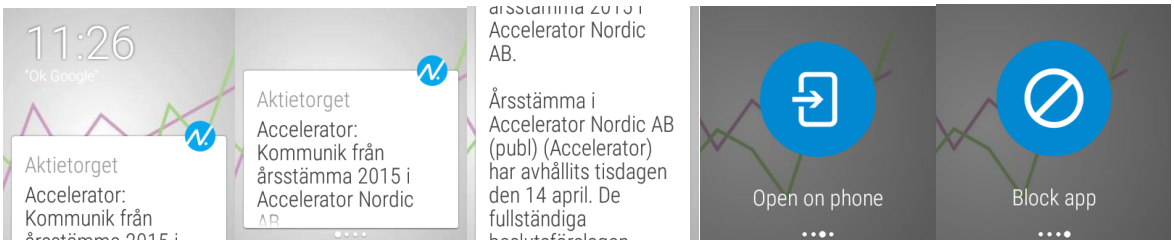

Figure 9.6: Push notification: news

9.3 Usability Testing

In order for the designers to be able to confirm the design choices, as well as information selection, that were made during the different prototyping phases, a final validation usability test was conducted, where the definite MVP was evaluated. For a more representative result, the test was based on the previously conducted test in phase 2. However the steps where the default Android Wear navigations were evaluated, were excluded in this phase, since the outcome, regardless result, would not affect this app.

9.3.1 Test Subjects

The test subjects were selected based on two different aspects which the MVP was evaluated according to, the first being whether the Nordnet smartwatch app meets the requirements and expectations of the end user. In order to unravel that, the app was tested on Nordnet customers. The other aspect was the degree

of usability, why it was interesting to evaluate the app by dint of experienced Android Wear users. Three UX students with experience of Android Wear and six members of LINC participated in the user study.

9.3.2 Task Scenarios

The user study consisted of eight different task scenarios that covered both the navigation through the interface and the features of the app. The task scenarios are described below.

Notification

1. You receive a news notification from Nordnet on your smartwatch. The news was of interest and you want to read even more about it directly on the watch.
2. You receive a stop-loss notification from Nordnet. Add the mentioned stock to the list of instruments.
3. You receive an alarm notification. Open it on the phone.

Application

You are interested in getting a quick update of the stocks in your portfolio, so you launch the Nordnet app on your smartwatch.

1. Has ABB gone up or down? How much?
2. Find PE ratio of AAPL.
3. Compare Volume between VOLV B and AZN.
4. Which stock has the highest price/share ratio?
5. There is a shortcut to navigate home. Can you find it?

9.3.3 Test Environment and Equipment

As the final MVP was developed on the two smartwatches and they were the goal equipments, all tests were done on one of those, with the help of a handheld to push out the notifications from.

All user studies were recorded with a video camera in order to more easily evaluate the results afterwards. Figure 9.7 shows the test environment and equipment.

9.3.4 Execution

In order to minimize the number of beginner mistakes, the test subjects without any experience of Android Wear were given a few minutes to familiarize themselves with the smartwatches and Android Wear before the actual test session commenced, just like in the Lo-Fi evaluation session.

The test subjects were then asked to perform the tasks while speaking their thoughts out loud. The test leader introduced the test person to the tasks and clocked key elements while the assistant observed and documented the test. Subsequent to the test, the subjects answered a couple of post-test questions as a debriefing session. The two groups were engaged in the tests because of their different areas of expertise, why the debriefing questions also differ.

Figure 9.7: test session with LINC

Debriefing questions: Experienced Android Wear users

1. How did you experience the interaction?
   a) What would you do differently?
2. What are your thoughts on the graphical design?
   a) What would you do differently?

Debriefing questions: Nordnet customers

1. Do you think the three different types of notifications are useful?
   a) If not — what is lacking? Or what is excessive?
2. Do you think the information presented in the app is relevant?
   a) If not — what do you wish to be different?

9.3.5 Results

Experienced Android Wear Users

The three subjects easily and quickly found and understood how to navigate through the matrix. The data presentation was perceived simple and sleek and with warm and welcoming colors. Despite their lack of knowledge on stock trading, all participants could easily interpret the parameters.

Nordnet Customers

LINC members formed the Nordnet Customers, as all test subjects recruited from LINC but one either were Nordnet customers or had been at some point. It was clear the factor of inexperience with Android Wear created confusion. However, focus laid on the presented data. The subjects were unanimous regarding the parent pages (i.e., the current price change) however they had various opinions on which data should be presented on the second level. Indicators that were mentioned are listed below, in no particular order.

- Order book
- Stock market index
- Revenue
- Enterprise value/market value
- Order volume

They also agreed the three different push notifications were all both necessary and useful. They could not think of any other desirable notifications they would want on the watch, though one proposition was to add a “Buy stock” action button in the Alarm notification flow.

“The simplicity charms” is a citation taken from the test session with LINC and captures this master’s thesis perfectly.

Summary

As far as the design goes, no changes were necessary to be made; both test groups understood the hierarchy quickly as well as they interpreted the data correctly and confidently. Moreover the way the data was presented in circles was highly appreciated. Due to the short execution times for all subjects, no table over the different expenditures was necessary as it would not present any revealing data.

The final user study on LINC brought insight into the extent of which different Nordnet customers trade. Depending of which purpose they trade, different information is desirable on the watch, meaning that due to the before stated issue with the limited screen size, the data has to be personalizable. The push notifications were well received and no additional notifications are added.

9.3.6 Conclusion

Due to changes in the Android Wear SDK the interaction in the implemented MVP was forced to change, the matrix was reversed and double tap was replaced with long press. Despite these changes the design and the flow pattern of the MVP were well received by the test subjects.

During the user evaluation it was detected that several subjects accidentally closed the app while swiping from the left to the right in the stock list. This was perceived as time consuming and annoying which led to the decision to only allow exiting through a long press instead. Further changes were decided not to be made.

The simplicity of the design is the key word which gets to summarize this chapter.

The interaction with the final MVP prototype can be watched on the YouTube link below: https://youtu.be/QZCarN5V14U and Figure 9.8 shows a picture of what the app looks like on the wrist.

Figure 9.8 Nordnet smartwatch app on Moto 360

10 Discussion and Conclusions

10.1 Discussion

10.1.1 Constraints

The major limitation in this thesis has been the Android Wear OS, which suffers from a lot of teething problems. The OS is very unstable and the SDK is unfinished, it was changed several times during the project. Due to these changes the navigation of the app had to be reversed in the final MVP. If one deviates from the design principles of Android Wear, it is very difficult or impossible to develop an app. There are no similar apps on the market today, which has been a challenge when it comes to the implementation of the MVP. There has been zero to very little help to get from the Internet and literature, making the development troublesome.

Even though the user studies proved that the standard flow pattern of the notifications was deficient and felt unnatural, it was kept in the final MVP in order to strive for consistency. Of the same reason a long tap (which follows the design principles of Android Wear) was implemented to navigate home in the final MVP, even though several test subjects wanted to double tap instead.

10.1.2 Future improvements

Before the app can be released on the market it has to be synced with the phone app, meaning that the notifications are pushed from there and the data is updated in real-time.

When closing the app by covering the light sensor on the watch or by clicking on the physical button on the side, the watch will remember where in the interface the user was before exiting. The next time the app is opened it will show that view, which may cause problems navigating and orienting through the stock list. Before being released on the market the app should therefore be modified to always show the first stock in the list when opened.

Possible additions could be to add points (a number used to compare different stocks) to the first level, as viewed in the phone app (Figure 5.1), as well as extending the list of stocks with currencies and commodities. One major issue was to determine exactly which data would be displayed on the second level, as different traders apparently want different data. The best solution would be to make this customizable.

Another improvement of the app could be support of context card, i.e. that a card is automatically created when the user most likely needs it. When a user walks by an H&M shop a card showing the topical stock would be created automatically.

10.1.3 Obstacles

An obstacle that arose pretty early was the limiting screen size, causing the designers to having to compromise between own ideas and thoughts, and the stakeholders', who envisioned a smartwatch app containing all the information included in the phone app.

10.1.4 Related Work

One of the conclusions Botani and Sörling have reached is that graphic displays and images are helpful tools. However, most importantly, constrain the amount of information to include. They also concluded that due to the small screen, taps are easily misplaced in the interface, and recommend designing apps without too many interaction choices. McDowd emphasizes the importance of selecting the right amount of (relevant) information. In short, their conclusions converge with the writers of this thesis' design choices and thoughts throughout the entire process.

10.2 Conclusion

To repeat the goal with this thesis, it was to create a product so user-friendly that it might inspire Nordnet customers to purchase a smartwatch, which was achieved judging by the test subjects in the last iteration, who were quite intrigued by the app. Another goal was to create an app so easy to use it only takes five seconds to retrieve the sought-after information, which was accomplished.

Android Wear is in constant change, a common symptom with new software and technology. Constant improvements are made to the OS, making it better and easier to use by each update. The hardware used in this thesis suffered from a lot of teething problems, due to their young age. New smartwatches are however released every so often, forcing the technology companies to continually produce better products, resulting in a consistent drive forward, meaning there is a future in wearables to take part of. As for Jayway, they should try being a part of that future.

Finally to summarize this thesis, the answer to the quote coined by Google; "What couldn't we do on the phone, that we can now do on the wrist?" is a *quick overview*.

11 Bibliography

Aktieskolan, ‘Stop loss’, http://www.aktieskolan.se/pages/stoploss.php, 2009, (accessed 14 May 2015).

Botani, Ranian, Sörling, Kristian, Smart design för auktionsapplikationer på smartklockor : Att uppnå användbarhet [Smart Design for Auction Applications on Smartwatches], 2014, Södertörns Högskola, http://www.diva-portal.org/smash/record.jsf?pid=diva2%3A784352&dswid=6612.

Burns, Matt, Tech Crunch, ‘Pebble Nabs $15M In Funding, Outs PebbleKit SDK And Pebble Sports API To Spur Smartwatch App Development’, 2013, http://techcrunch.com/2013/05/16/pebble-nabs-15m-in-funding-outs-pebblekit-sdk-and-pebble-sports-api-to-spur-smartwatch-app-development/, 16 May (accessed 12 March 2015).

Canalys, ‘Over 720,000 Android Wear devices shipped in 2014’, 2015, http://www.canalys.com/newsroom/over-720000-android-wear-devices-shipped-2014, 11 February, (accessed 6 March 2015).

Edmunds, Holly, *Focus Group Research Handbook*, Chicago, IL: McGraw-Hill, 2000.

Gould, John D., Lewis, Clayton, ‘Designing for Usability: Key Principles and What Designers Think’, *Communications of the ACM*, Volume 28, Number 3, March 1985, http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.84.8860&rep=rep1&type=pdf, (accessed 25 March 2015).

Jordan, Timothy, Google Developers, *An Introduction to Android Wear*, [online video], 2014, https://www.youtube.com/watch?v=Bl4Qne-RpcM&feature=youtu.be, (accessed 2 February 2015).

Keizer, Gregg, Computer World, ‘Apple Watch first day pre-orders top 1.2M in U.S.’, 2015, http://www.computerworld.com/article/2909744/apple-watch-first-day-pre-orders-top-12m-in-us.html, 14 April, (accessed 20 April 2015).

Lamkin, Paul, Wearable, ‘Smartwatch timeline: The devices that paved the way for the Apple Watch’, 2015, http://www.wareable.com/smartwatches/smartwatch-timeline-history-watches, 10 March, (accessed 12 March 2015).

Marshall, Gary, Tech Radar, ‘Before Apple Watch: the timely history of the smartwatch’, 2015, http://www.techradar.com/news/wearables/before-iwatch-the-timely-history-of-the-smartwatch-1176685, 17 April, (accessed 20 April 2015).

Martin, Chris, PC Advisor, 'What is a smartwatch? Wearable technology explained', 2014, http://www.pcadvisor.co.uk/buying-advice/gadget/3498629/what-is-smartwatch/, 23 January, (accessed 5 March 2015).

McDowd, Kal Benjamin, Life IS a Sport: How the Nike+ FuelBand Gets It Right & Represents the Evolution of Design for Wearables, 2012, Department of Informatics, University of California, Irving, http://www.ics.uci.edu/~bmcdowd/papers/McDowd_Life_IS_A_Sport.pdf, (accessed 12 June 2015).

Norman, Donald and Draper, Stephen. *User-Centered System Design: New Perspectives on Human-Computer Interaction*. Hillsdale, NJ: Lawrence Erlbaum Associates, 1986.

Petre, Marian, Price, Blaine A., Rawassizadeh, Reza, 'Wearables: Has the Age of Smartwatches Finally Arrived?', *Communications of the ACM*, Volume 58, number 1, January 2015, http://www.researchgate.net/profile/Reza_Rawassizadeh/publication/269410374_Wearables_Has_the_Age_of_Smartwatches_Finally_Arrived/links/54a3d1730cf267bdb90454fd.pdf, (accessed 12 June 2015).

Preece, Jennifer, Rogers, Yvonne, Sharp, Helen, *Interaction Design beyond human-computer interaction,* New York, NY: John Wiley & Sons, 2002.

Ramachandran, Sanjeev, Device Magazine, I'm Watch Gives an Android Twist to Your Wrist, 2011, http://www.devicemag.com/2011/11/05/i%E2%80%99m-watch-gives-an-android-twist-to-your-wrist-video/, 5 November, (accessed 10 March 2015).

Rubin, Jeffrey, Chisnell, Dana, *Handbook of Usability Testing: How to Plan, Design, and Conduct Effective Tests*, 2nd edn., Indianapolis, IN : Wiley Publications, cop. 2008.

Schwaber, Ken, *Agile Project Management with Scrum (Developer Best Practices)*, Redmond, WA: Microsoft Press, 2004.

Shneiderman, Ben and Plaisant, Catherine, *Designing the User Interface: Strategies for Effective Human-Computer Interaction*, 5th edn., Reading, MA: Addison-Wesley Publ. Co., 2009.

Smartwatch Group, 'The History of Smartwatches', 2013, http://www.smartwatchgroup.com/history-smartwatches/, (accessed 5 March 2015).

Vatanijalal, Siavash, Array, 'Smarta klockan Pebble snart betydligt smartare', 2013, http://array.se/nyheter/smarta-klockan-pebble-snart-betydligt-smartare/, 6 November, (accessed 9 March 2015).

Appendix A

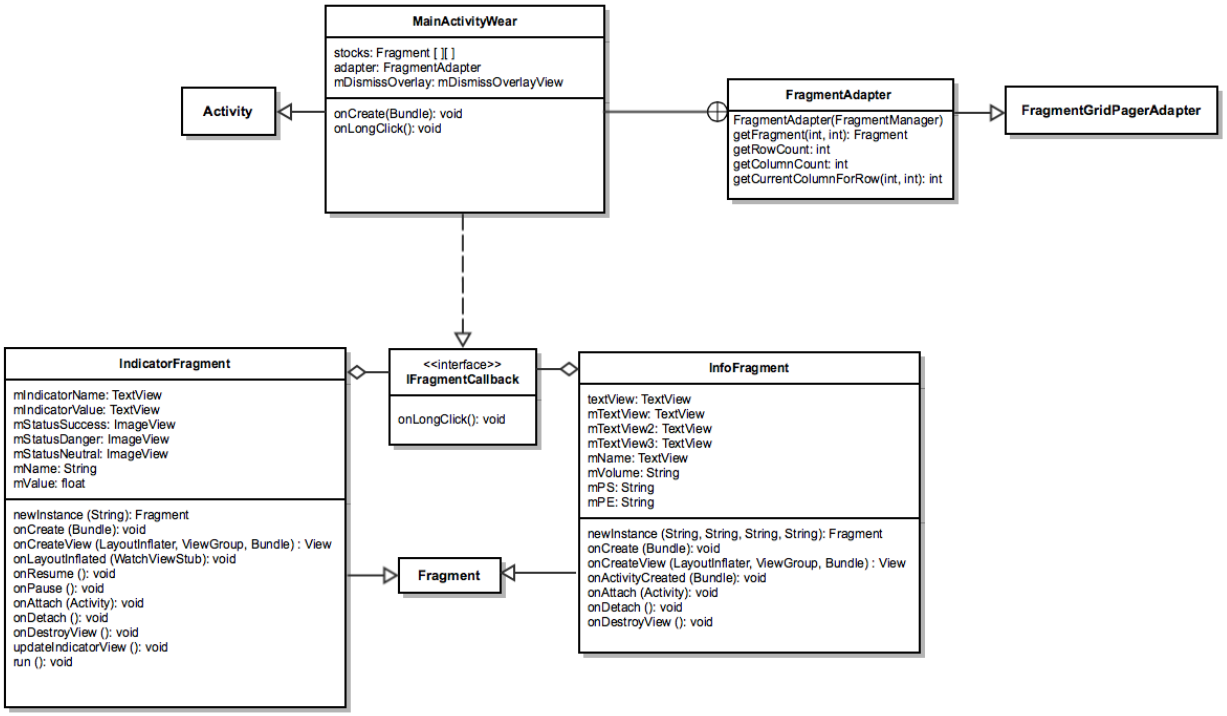

Figure A-1: UML diagram for the smartwatch app