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A mobile application for flight safety
The CrewAlert

Master of Science Thesis in Interaction Design

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Cover:
The CrewAlert logotype.

Abstract

Up until today crew schedules among commercial aviation are regulated by rules referred to as flight time limitations or FTLs. These regulations are now being revised to make room for a more scientific approach to manage fatigue among flight crew.

This master thesis describes the development of an iPhone application that has the intention to raise the awareness of fatigue among flight crew and inform about the ongoing research within the area of fatigue risk management systems (FRMS). The application mainly targets commercial airline pilots. The pilots use the application for entering their recorded sleep and work schedule and in return get an estimated alertness graph, which is calculated by the Boeing alertness model. The estimated alertness graph is a visualization of how duties and sleep affect fatigue among pilots according to their schedule.

During the development of the application, usability experts at Jeppesen performed a heuristic evaluation and a questionnaire was sent out to a number of airline pilots for evaluation, which also is included in the report.

Sammanfattning

Fram tills idag har arbetsscheman för flygbesättning inom kommersiell flygtrafik reglerats av flygtidsbegränsningar även kallat FTLs. Dessa regler ses nu över för att göra plats för mer vetenskapliga metoder och synsätt för att hantera trötthet bland flygbesättning.

I denna rapport beskrivs utvecklingen av en iPhone applikation vars syfte är att väcka uppmärksamhet bland flygbesättning och upplysa om forskningen som pågår inom fatigue risk management systems (FRMS). Applikationen som utvecklats riktar sig främst åt piloter. Syftet med applikationen är att låta piloterna mata in sin faktiska sömn och arbetsschema. Med hjälp av detta kommer applikationens integrerade modell, Boeing alertness model, att beräkna och visualisera en trötthetsgraf. Grafen som visas utav applikationen är en visuell representation av en uppskattad trötthetskurva som beräknats utifrån det inmatade arbetsschemat och sömnen från användare.

Under utvecklingen av applikationen utfördes även en heuristik evaluering utav användbarhetsexperter på Jeppesen. Utöver detta skickades även ett användarformulär ut till ett antal piloter runt om i världen, och resultatet från dessa finns även beskrivet i rapporten.

Acknowledgements

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1. Introduction

Up until today crew schedules among commercial aviation are regulated by rules referred to as flight time limitations or FTLs. Basically these are rules, which limits the number of hours the flight crew are allowed to fly or be at work during a period of time. These rules are intended to be used as a simple method for accounting and mitigate the risk of crew fatigue.

One of the problems with these rules is that they have changed very little since they first were introduced and differ slightly between different parts of the world [1]. Even though new scientific data in the field of fatigue has been introduced, the FTLs still haven't been updated accordingly. The biggest problem with the FTLs is the illusion of safety it fabricates, meaning as long as the flight crew does not exceeds the FTL restrictions the flight is considered as a safe flight. On the other hand flying outside of the limits is regarded as unsafe.

These regulations are now being revised to make room for a more scientific approach to manage fatigue among flight crew [2]. Fatigue risk management (FRMS) has been derived by combining risk management systems and knowledge from the scientific field of fatigue and is one possible answer to handle fatigue from a more scientific approach. Whereas the FTLs have not changed very much since it first was introduced and have very little connection to the science, the FRMS is intended to have a close relationship with the research area of fatigue.

The intention with FRMS is to either partially or even totally replace the current FTLs as a tool to regulate crew fatigue. In previous work it has been demonstrated that a correctly implemented and maintained FRMS should lead to a much better result of handling fatigue then using the FTLs [3]. The FRMS has not only been demonstrated to be safer, but also adds beneficial operational flexibility. FRMS does not use the usual time limitations, but instead uses an alertness approximation based on scientific data together with crew schedule. This alertness approximation is derived from a mathematical model, which predicts the risk of fatigue based on previous and future sleep and work hours.

FRMS does not only bring additional operational flexibility but also improves the productivity and efficiency among the airlines. By using FRMS instead of FTLs the difference between safe and unsafe flights are no longer as black or white. According to the FTLs, in some cases when a flight gets delayed become considered as unsafe even though the flight crew is not feeling tired at all. As an implication of this, the airlines will have to replace the effected pilots and this might not only be inconvenient and costly for the airline companies, it might also delay the flight even more and thereby also affect the passengers.

The FTLs has been used for a long time now and a reason for that is that they are fairly simple to understand. The reason behind them being revised is because they are rather incomplete.

1.1. Background

In this section, an introduction of Jeppesen and BAM is presented.

1.1.1. Jeppesen

Elrey Borge Jeppesen founded Jeppesen in 1934. It all started with that Elrey, who worked as a pilot, began to gather information for drawing aeronautical charts. Initially it was thought that he would use these charts himself, but the books did not go unnoticed. Other pilots quickly raised interest about Elrey's product so he started to sell book charts.

Today, Jeppesen has been working in the field of aviation for 75 years helping flight staff making it safer and more efficient to travel by aircrafts. Jeppesen has more than 3000 employees worldwide and is headquartered in Denver, Colorado, USA. Jeppesen is a subsidiary to Boeing, which has been involved in this master thesis as well. In 2006, Jeppesen acquired Carmen Systems. The main activities today are to provide software for crew and fleet planning for airlines and railway operators. By using their optimization algorithms and software they help the client to find the most efficient solutions.

1.1.2. Boeing alertness model

The model that CrewAlert uses is called Boeing alertness model (BAM). Alertness prediction in BAM is based on the openly published Three Process Model of Alertness by T. Åkerstedt et.al [4].

1.2. Purpose

The objective of this master thesis is to design and realize an iPhone application that mainly targets flight crew. One goal with the application is also to raise the awareness about fatigue among flight crew and inform about the ongoing research within the area.

The purpose of the application is to let flight crews enter their work schedule and get an estimated value of what their alertness is going to be at any point in time in the future. In order to do this, BAM is going to be integrated into the application.

1.3. Specification

In this section, some of the requirements that were agreed upon with Jeppesen before the work started with the application are presented. These requirements were seen as "must" requirements and are requirements that had to be implemented into the application. The complete list of requirements can be found in appendix B.

1.3.1. Non-functional requirements

Throughout the project the emphasis will be on the following non-functional requirements:

- Easy to use with an attractive look. This prototype must become very appealing to pilots in terms of look and feel.
- There must be high performance in the interaction.
- The application should be a fully functional proof-of-concept application.

- The application should be of such quality to gain acceptance from app-store.

1.3.2. Functional requirements

The functional requirements of the application are listed below. The user should be able to:

- Get a visualization of crew-entered schedule and predicted fatigue (with a confidence interval of 95%) with highlighting of fatiguing situations.
- Easily enter and modify their crew schedule, including start of duty, end of duty, time- zone changes, number of landings and nap opportunities.
- Enter a set of personal data such as gender/age/weight/habitual sleep length/diurnal type/sleep onset/wakeup.
- Easily enter actual sleep / awake periods and parameters of sleep-onset and wakeup.
- Easily enter and modify self-assessed alertness tests.
- Update the application without losing their schedule/history/personal data.

1.4. Dictionary

Duty – A duty refers to a duty day. A duty can contain multiple activities of different types for example flight or standby.

Sleep journal – Sleep journal is a period of time where the person have recorded awake and sleep time. Where no sleep period is defined inside the sleep journal it implicates that the person has been awake.

Sleep period – Sleep period is a period of time inside a sleep journal where the person has recorded sleep.

2. Methods

In this section, the methods used in this master thesis project are described.

2.1. Overall method

The overall methodology used in this master thesis has been agile development [5]. Briefly, what characterizes agile development is that you work in short iterations where at the end of each iteration there should be executable software that can be tested and evaluated before next iteration starts. The length of the iterations has been two weeks throughout the project. When you work with planning the next iteration it is important to not only see the immediate future but also always keep track of where you are in the project as a whole since the project timeframe cannot be adjusted.

The advantages of working with agile development are many. The short iterations combined with the frequent deliveries of a product makes it possible to start testing early and often in the process. This helps to work out a lot of mistakes early in the process instead of having to make costly changes later on. The frequent iterations also allow you to change a requirement that was not good enough or unnecessary. This puts less demand on getting all the requirements perfect from the beginning, which is a very difficult task. Another advantage is that you have a close cooperation with the users or customers, in this case the internal reference group at Jeppesen, giving the advantage that the customer is aware of what happens within the project and can follow the progress from close up.

2.2. Pre-study

To collect information about the field and similar iPhone applications a pre-study was conducted. The pre-study was partly focused on learning terminology used within the field of aviation. The second part of the pre-study was focused on the iPhone Human Interface Guidelines [6] to get better understanding of the iPhone OS environment and of how the different graphical user interface (GUI) components are recommended to be used to create a good GUI. The third part of the pre-study was to look at a lot of different iPhone applications for inspiration and good GUI solutions. The main focus was on applications within the travel genre on the App Store. The App Store is an online store where users can browse and download applications for the iPhone and the iPad.

2.3. Brainstorming

Brainstorming is a method frequently used in development work. The method is useful to come up with many new ideas [7]. While carrying out the method the focus should not be on finding the best ideas but rather finding as many as possible. Only after the brainstorming session it is time to go through, sort and discuss the ideas that were presented during the session to choose which ones to proceed with.

2.4. Prototyping

Prototyping is used for developing an incomplete representation of the final application [8]. Prototyping is a good method to use in iterative steps to create

and evaluate designs to eliminate early design flaws. A prototype could be anything from simple sketches to a fully functional application. Another good reason to use prototyping is that the users or customers can have difficulties to express what they want in terms of design and functionality. If they have a prototype to relate to it could make it easier for them to discuss different solutions.

Low-fidelity prototyping is an easy and cheap way to quickly create a simple prototype to test broad concepts. In this case the low-fidelity prototype was made of paper also known as paper prototyping. An advantage with this approach is that it is quick and easy to try out a lot of different designs and ideas.

High-fidelity prototyping is the opposite of low-fidelity prototyping. A high-fidelity prototype should be quite close to the final product in terms of details and functionality. A disadvantage is that it takes longer time to make the detailed prototypes but instead you get better understanding of what the final product could look like. In this case detailed digital prototypes were created.

A prototype of the applications navigation flow between the different views was created to give a better overview of how the navigation between the views of the application would look like. This is a good way to see if any of the functionality is hard to reach or if the navigation between the views is not intuitive enough. Since iPhone applications are view based it is also a great help to see which screens that is needed and how they are connected when to plan the structure of the application.

2.5. Heuristic evaluation with experts

Heuristic evaluation is a method, developed by Jakob Nielsen [9]. The method is used entirely for finding usability problems in a GUI. A heuristic evaluation is carried out by evaluators, in this case GUI experts at Jeppesen, which examine the interface to see if it compliance with the "heuristics" [10]. The list of heuristics that was used is presented below. These are ten general principles for interface design.

- Visibility of system status
- Match between system and the real world
- User control and freedom
- Consistency and standards
- Error prevention
- Recognition rather than recall
- Flexibility and efficiency of use
- Aesthetic and minimalist design
- Help users recognize, diagnose, and recover from errors
- Help and documentation

Heuristic evaluation is performed individually. Each evaluator sits down and analyzes the interface. The reason for doing it alone is that others who do the same evaluation should not influence you. After everyone has made the test they

sit down and go through what everyone has found. The output from this method is a list of usability problems where each problem refers to a specific "heuristic".

2.6. Questionnaire

The user evaluation was conducted as a questionnaire. The idea with a questionnaire is to collect information of the respondents [11]. A questionnaire consists of a series of questions, for example, such as multiple-choice questions or more open questions.

The advantage of a questionnaire is that it is a low-cost data collection method that could either be a quantitative data collection method or qualitative data collection method. Another benefit is to be able to reach many people when you easily can send questionnaires via the Internet.

A disadvantage of using the questionnaire is that you could end up with a low response rate. Another disadvantage is that you have no control on how the person responds or even if the right person responds for that matter. From an interaction design point of view, it is also a shame that you cannot collect data or comments based on observation.

3. Realization

This section begins with a brief explanation of iPhone development followed by the realization of this project's various parts.

3.1. iPhone development

iPhone is a smartphone, which is a mobile phone that offers more advanced and faster connectivity than a basic mobile phone. A common feature on these phones is that the user can install applications. For example, on the App Store there are now 225 000 applications available for download [12]. An iPhone application could be anything from an RSS reader to a puzzle game. iPhone's operating system was named iPhone OS which recently was changed to iOS when iOS 4 was released [13]. iOS gives the iPhone a couple of nice features including multi-touch events, accelerometer and advanced graphic support. These features plus a large amount of users make it interesting to develop for the iPhone.

To start developing you need to download the iPhone SDK [14] which includes iPhone OS, Xcode developer tools and documentation to get started. A parenthesis is that you need a computer that runs OS X to be able to run the development tools. The code is written in the editor Xcode and the language is Objective-C. Objective-C is an object-oriented addition to C. Therefore it is possible to use both Objective-C and C in the code.

Included in the Xcode developer tools are Interface Builder also referred to as IB that is used for creating user interfaces and Instruments that is used for performance analysis. An application is composed by different views that you navigate between. A view is built-up by different GUI components. Two components that often can be seen in applications is the tab bar at the bottom and the list view in the middle (see figure 1). The tab bar is used for navigation between different views. The list view is used to display a lot of data that can be divided into sections.
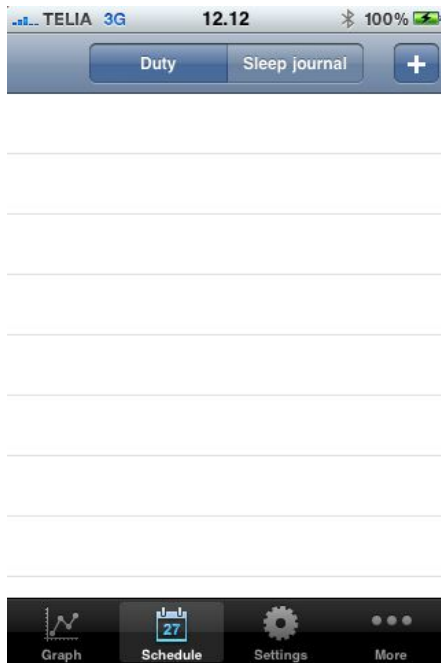
Figure 1. Screenshot of the schedule view.

3.2. Prototyping

In this section, it is presented how prototypes of the application were developed together with examples of different prototypes.

3.2.1. Low-fidelity prototypes

A quick and easy way to create prototypes is paper prototyping. The first iteration, the first two weeks, was devoted to a pre-study but also to develop paper prototypes. Paper prototypes are not so detailed but were used primarily to convey a concept of what the overall views could possibly look like and a starting point to discuss ideas. Figure 2 shows some of the paper prototypes that were made for the different views.
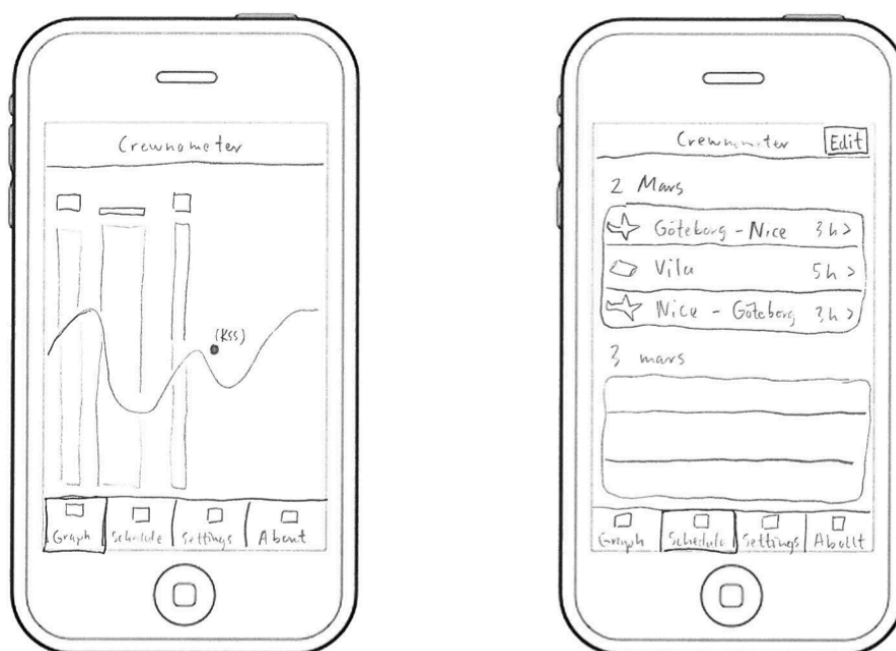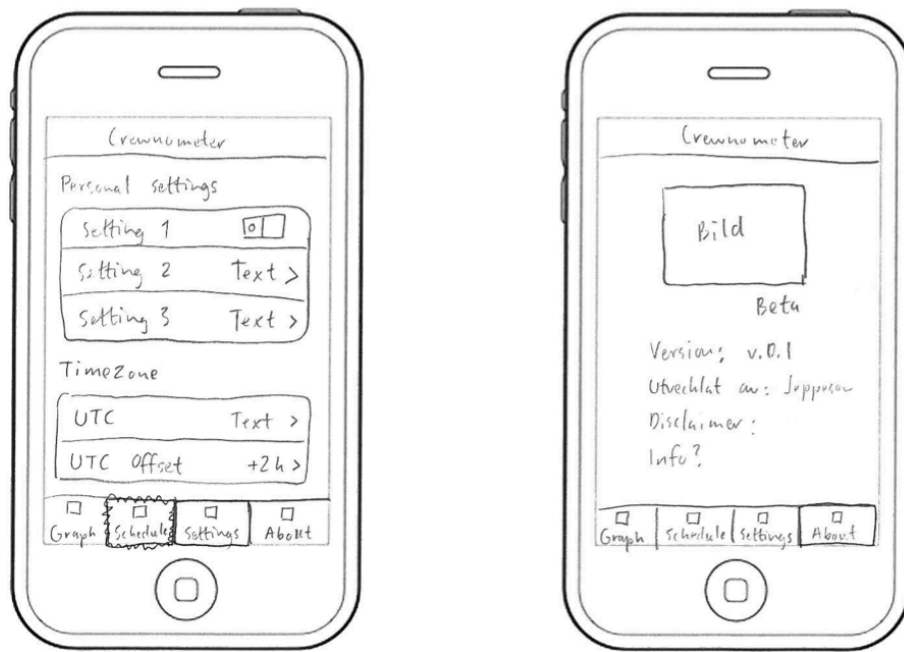
Figure 2. Paper prototypes.

3.2.2. High-fidelity prototypes

The second iteration was devoted to produce detailed digital prototypes. This was done using OmniGraffle [15] and a downloaded package of GUI components for the iPhone. Digital prototypes take longer to create but the advantage is that they can be used to discuss details in a completely different way than with paper prototypes. Plus it gives a better idea of what the final product might look like.

The digital prototype and the navigation flow were presented for a pilot at an early stage in the project to determine if there was something that needed to be changed. It was thought that there would be one alarm level to mark the level of alertness. It was found that pilots were accustomed to always get warnings regarding FTLs in three steps. Thus it was changed to three levels in the form of green, orange and red.

Figure 3. Detailed digital prototypes.

3.2.3. Navigation flow

While the digital prototypes were developed, a large sheet with a proposed navigation flow was created as well. The navigation flow was created from the digital prototypes with arrows between the different views to represent the navigation flow. With the help of the navigation flow it was easier to see that no undue views remained and always have the minimum possible number of clicks between the views. It became very clear that the graph view and the schedule view was tightly linked. Both of the views presents the same schedule information but in different ways. In order to smoothly carry out the same tasks (add, edit and delete of duties and sleep journals) in the graph view as in the schedule view without switching view, it became clear that shortcuts were

needed in the form of different touch events. In figure 4 you can see the navigation flow. The grey striped arrows represent touch events.
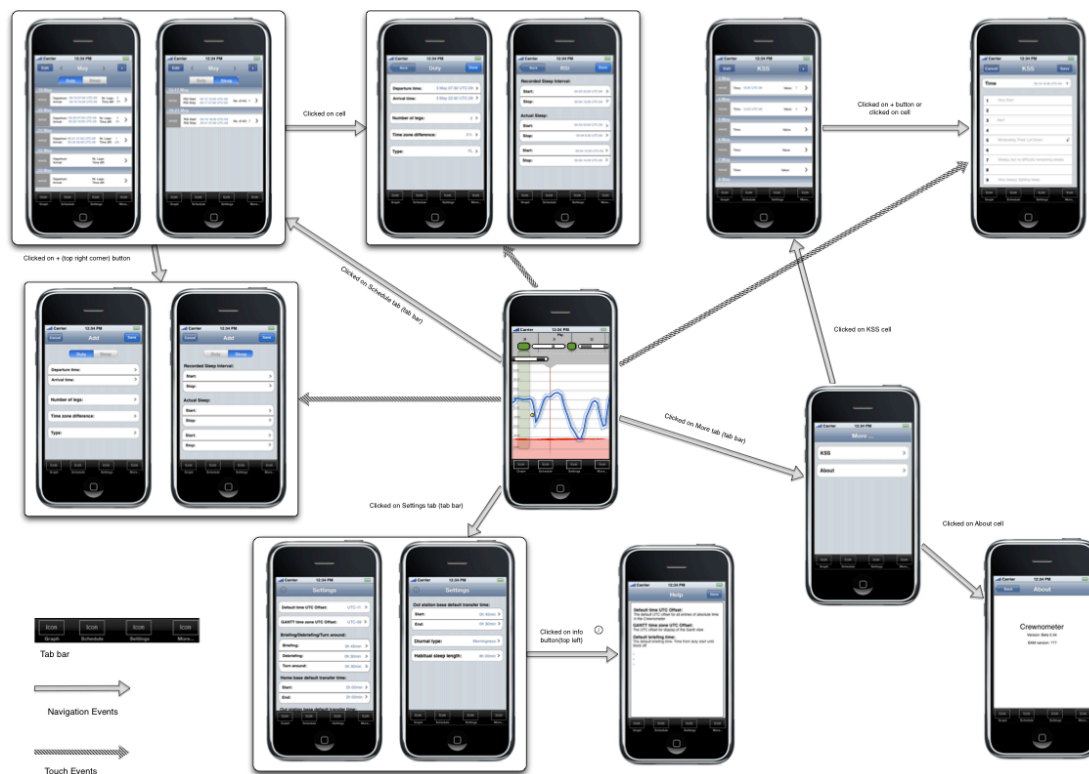
Figure 4. Navigation flow.

3.3. Heuristic evaluation with experts

The GUI experts at Jeppesen conducted the expert evaluation. Each expert who participated carried out the evaluation individually. While they tested the application they filled in a list with errors that violated the "heuristics". After all the experts had carried out the evaluation they presented all the usability errors they had found for us personally. The expert evaluation was conducted in mid-implementation phase. Until then, we had developed a decent application to test on, but far from complete. There was also good amount of time left to make changes based on the outcome of this evaluation. It is known that the sooner you are able to detect usability defects the better, because it often takes less effort to correct them at an early stage. The feedback from the experts is presented below.

General feedback

- No possibility to import data
  It takes a long time, for example, to enter duty-days for a month.

- More help texts
  There are many terms, especially in the settings view, and not all are obvious, there should be more help texts or a help view. Other feedback on this was to use the same language as the pilots.

- Error prevention and validation

It is important to help the user by warning them before entering incorrect data, and not allowing them to insert incorrect data.

- Formatting text
  Inconsistent formatting of existing text font, size and color.

Feedback on the graph view

- Double-tap zoom
  Pinch zoom was implemented. Another way to zoom on the iPhone is by double tapping. To not confuse the users it should be possible since it is considered to be iPhone standard behavior to be able to zoom that way.

- What is the date?
  It should be shown more clearly what date range the graph view is displaying data for.

- Add duty or sleep journal with touch event
  The time should be initiated according to where the user clicks on the screen.

- Landscape mode
  A person expected that if he turned his iPhone, the application would switch to landscape mode in particular because it would have been a good way to see more information on the screen simultaneously.

- What is clickable?
  The clickable objects are maybe a bit to small. Try to work more to make them look more clickable.

Feedback on the schedule view

- Switch between the schedule view and the graph view quickly
  One expert suggested that after you added a duty that you could jump to the most recently added duty, or already added duties, instead of having to find a specific duty yourself in the graph view.

- Alertness information
  Instead of simply displaying alertness in the graph view, then why not show it in the schedule view as well to give the user more information than departure and arrival times.

3.4. Work with an art director

During the project, an art director (AD) was assigned to help out with the look and feel of the application. The work started of with an initial meeting where it was drawn up guidelines on the graphic profile for the application. The idea was to follow Jeppesen's visual identity and use colors produced by their color palette. But at the same time not make too many changes to the colors on the standard GUI components, so the application still looks clean and simple.

The cooperation has functioned as such; proposals for the different views have been developed in terms of color, shape and typography. The proposals have been presented for the AD who has commented on them. This is followed by a discussion about the proposals until a good solution was agreed upon. Overall, it has been an instructive and fun collaboration. It has been very good to have a sounding board that has a good eye for color, design and typography to share and discuss ideas with.

3.5. Questionnaire

In order to evaluate the application, a questionnaire was sent out to pilots from a number of different airlines (see appendix C). The document that was sent out consisted of two parts. The first part consisted of a couple of tasks that should be carried out by the user. The tasks were created with the intention that all functionality of the application is covered, and as a backup if someone missed to use any of the touch events is given a hint about this at the end of the usability study. The content of the tasks is also designed as a scenario to make it more realistic for the pilots. The second part of the document is a questionnaire that starts with a general question if the user has previous iPhone experience or not and then followed by questions about the different tasks and views. On some questions you respond by putting a rating while others are free text. The feedback from the pilots is presented below.

3.5.1. Overall rating of the application's look and feel

The application's look and feel got good ratings. It were actually no comments on the user interface appearance.
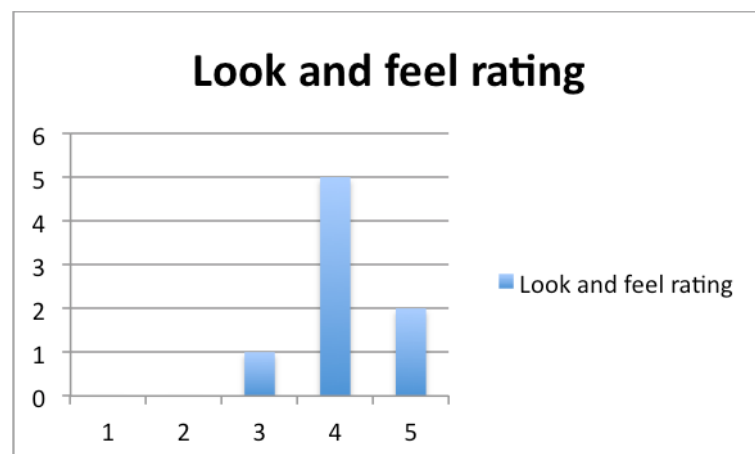
Figure 5. Overall rating of the application's look and feel.

3.5.2. Overall rating of the application's usability

The application's usability got okay ratings. Among the comments made concerning usability, it was a desired functionality to increase ease of use to be able to import the schedule. Examples of other comments that were mentioned by more than one person are that some had trouble understanding all the elements in the graph view. And that some had problems with adding / removing sleep periods.
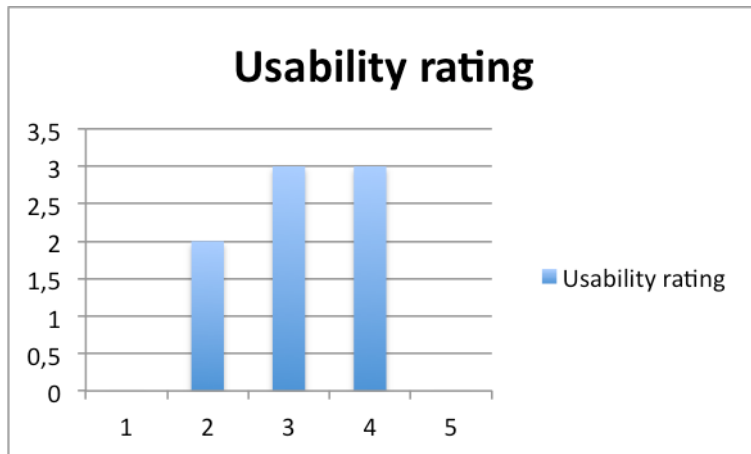
Figure 6. Overall rating of the application's usability.

3.5.3. How usable would the application like this be to you as a pilot?

Another interesting aspect with the application is if the pilots felt that it is an application they want to use as pilots. The application got okay ratings in terms of how useful the pilots thought it would be for them. Among the comments about the usefulness of the application for pilots it was suggested to have a list of airports in addition to UTC offsets and a suggestion of an alarm function that uses local time.
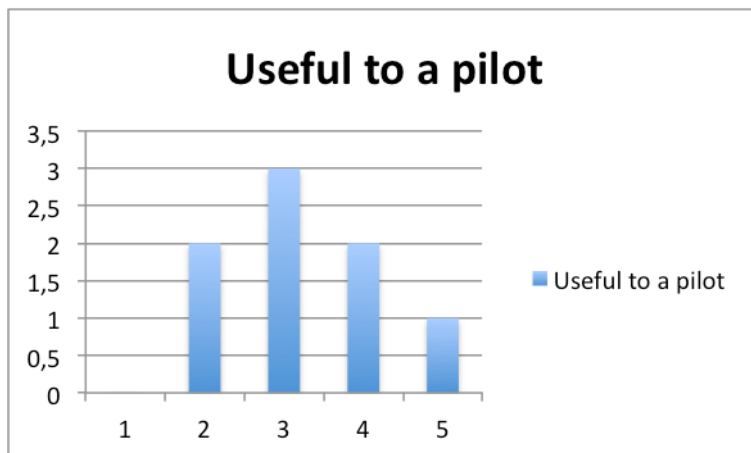
Figure 7. Overall rating of how usable the application was perceived by the pilots.

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4. Result

This section will describe the application that was developed based on the specifications given from the start, the pre-study conducted at the beginning and the expert and user evaluation performed during the development. The application is primarily designed for flight crews as a tool to help avoiding, and warns about, upcoming fatigue. When the pilot has entered his flight schedule, the application will display a predicted alertness graph for any point in time according to the schedule. The application could also be used by pilots to experiment with sleep. For instance, they can test and see how a four-hour sleep will affect their alertness compared to a six-hour sleep before the next flight.

The application is divided into four different tabs; graph, schedule, settings and more (see figure 8). These four tabs are described below. The views are not presented in tab bar order, but instead in an order that introduces all the concepts that are needed to understand the graph view, which is presented last.
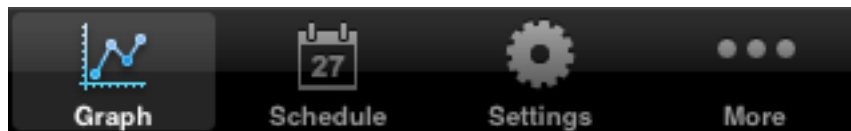
Figure 8. The application tab bar.

4.1. Settings view

Before start using the application the user needs to configure the application according to his/her personal needs and preferences. Some of the parameters found here are used to make a good alertness assessment while others are telling the application how the information should be displayed. The parameters could be divided into three different categories. The first category is parameters used by the alertness model. The second category is parameters that control how information is displayed. The third and last category is general information about the user.

Used by the alertness model
- Home base time zone
- Diurnal type
- Habitual sleep length
- Transfer times
    - Bed to departure (home)
    - Arrival to bed (home)
    - Bed to departure (hotel)
    - Arrival to bed (hotel)

Used by the application to display information
- Default time base
- Graph time base
- Alertness limits

User and model information
- Weight
- Age
- Gender
- Position
- Alertness model

Figure 9. Screenshots of the settings view.

There are seven different settings parameters that affect the alertness model. The home base time zone indicates for the model where the user's home is located and where his/her sleep pattern is adapted. Diurnal type tells the model if the user is a morning- or evening person. Diurnal type is selected from five different options:

- 1 = extreme eveningness
- 2 = eveningness
- 3 = intermediate
- 4 = morningness
- 5 = extreme morningness

Habitual sleep length describes the number of hours of sleep the user needs to wake up and feel rested. The last four parameters used by the model are transfer times. These four parameters control the time needed by the user to travel between the bed and the flight's departure or arrival.

There are three parameters which control how the information is going to be presented within the application. Default time base decides what time base that is going to be used as default when creating a new duty, sleep journal, sleep period or Karolinska sleepiness scale (KSS) value [16]. Graph time base controls what time base the graph view should be displayed in. Alertness limits are used to highlight duties that go below a certain level of alertness, which is defined by these parameters.

The third and last category of parameters affects neither the model nor the application. The reason behind these parameters is not only to see who is using the application but also in a near future to help validate the alertness model.

The parameter called alertness model is not possible to change at this point. The intention for this parameter is to be able to switch between different alertness models in the future.

4.2. Schedule view

The second tab in the application is referred to as the schedule view. This view is supposed to work as a calendar where the user can create, read, edit or delete activities.

This view is designed to display two different types of activities. The user can select whether it should list all of his/her currently stored duties or sleep journals. The user can easily switch between displaying duties or sleep journals by clicking on either the duty or the sleep journal button at the top of the screen. Duties and sleep journals are handled differently, and for simplicity's sake they are described individually.

4.2.1. Duty

When entering the schedule view and duty is selected the user is presented with all of his/her currently stored duties as a list sorted by date (see figure 10). In addition to when each duty is set to depart and arrive and what time base the times are given in, the user is also presented with details about each duty such as the number of legs associated with the duty, the time zone difference between the location of the departure and the location of the arrival. There is also an indicator displaying the status of the duty in terms of alertness. The indicator displays one out of three different colors depending on the lowest estimated alertness value during the duty. Green tells the user the duty is okay from an alertness point of view. Amber indicates that the duty has broken the first of the two alertness limits. The third color is red and warns the user that the duty has broken the second alertness limit. These alertness limits are the same limits that are defined in settings.
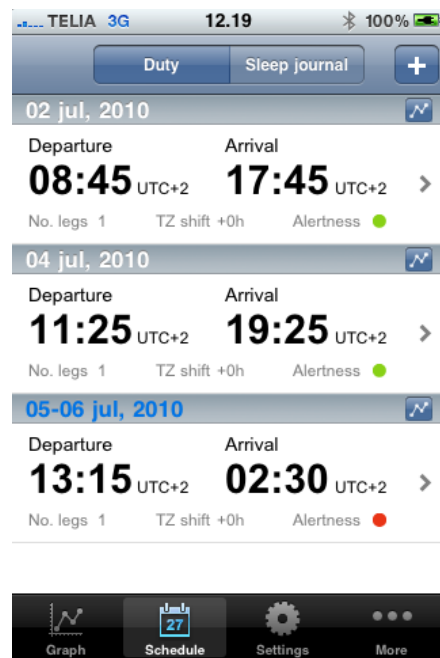
Figure 10. The schedule view with duties.

By clicking on any of the listed duties the user gets directed to a more detailed view where all available information about the selected duty is displayed (see figure 11). At this point the user can decide either to just look at the information presented or to edit any of the information by clicking on the cell containing the information he/she wants to change. The information available for the user to edit:

- Departure time
  - Time base used for departure time
- Arrival time
  - Time base used for arrival time
- Number of legs
- Time zone shift
- Type
- If the duty ends at home base
- Notes

Figure 11. A detailed view of a duty.

From this view the user is also able to delete the selected duty by clicking on the delete button at the bottom. To make sure no duty gets deleted by mistake a confirmation box will appear once the user clicks on the delete button. Once the user confirms the delete dialog the duty will be deleted.

4.2.3. Sleep journal

If the user enters the schedule view and selects to display sleep journals all his/her currently stored sleep journals will be displayed in the table view (see figure 12). The only difference between this list and the list displayed when duty is selected is the information given about each journal. For each sleep journal the user will be presented with information regarding the start and end time of the sleep journal and the time base the start and end time is given in. The user will also see how many sleep periods that are associated with each sleep journal.
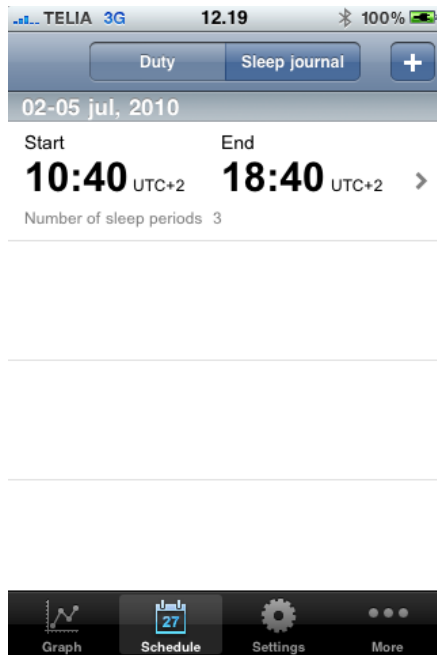
Figure 12. The schedule view with sleep journals.

If the user would like to see all available information regarding a specific sleep journal, or would like to edit or delete the journal, the procedure will be the same as for duties. By clicking on any of the sleep journals the user will be directed to a detailed view of the sleep journal (see figure 13). This detailed view differs somewhat from the detailed view for duties. The information available for the user within this view is:

- Start time of the journal
  - Time base used for start time
- End time of the journal
  - Time base used for end time

List of sleep periods associated with the journal
- Start time for the sleep period
  - Time base used for start time
- End time for the sleep period
  - Time base used for end time

Figure 13. A detailed view of a sleep journal.

From this detailed view the user is able to either change the start or end time for the selected sleep journal, or change any of the start or end times of the sleep periods associated with the sleep journal. By clicking on the edit button at the upper right corner of the view the user will also be able to either add additional sleep periods to the selected sleep journal or edit or delete already existing ones. If the user would like he/she could delete the entire sleep journal by clicking on the delete button at the bottom of the view. By clicking on the delete button he/she deletes the entire sleep journal as well as all of the sleep periods associated with sleep journal.

4.2.3. Add a duty or sleep journal
The schedule view is not restricted to only edit or delete already existing duties and journals. The users are also able to either create new duties or sleep journals from this view by clicking on the plus button at the upper right corner. Depending on if duty or sleep journal is selected at the top of the view the user will be directed to a view looking exactly the same as the detailed view. By filling out all the necessary information for a new duty or sleep journal and clicking on save the user creates a new activity. This activity will then be visible in the schedule view.

4.3. More view
The forth tab found at the bottom right side is referred to as the more view (see figure 14). Due to the limited amount of space on the tab bar, the more tab is used to access additional functions and information that do not fit on to the tab bar. The tab bar is limited to five tabs. To use a more tab is a great way of support future features. At this point the more tab is used for accessing the KSS self-assessment tests and the about view.
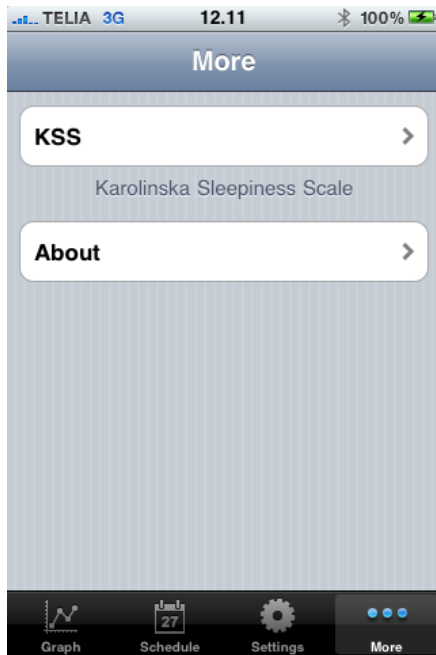
Figure 14. The more view.

4.3.1 Karolinska sleepiness scale

When entering the KSS view, the user gets presented with a list of his/her currently stored KSS assessment tests (see figure 15). For each KSS test listed within this view the user is presented with information about when the test was conducted and the estimated alertness value.
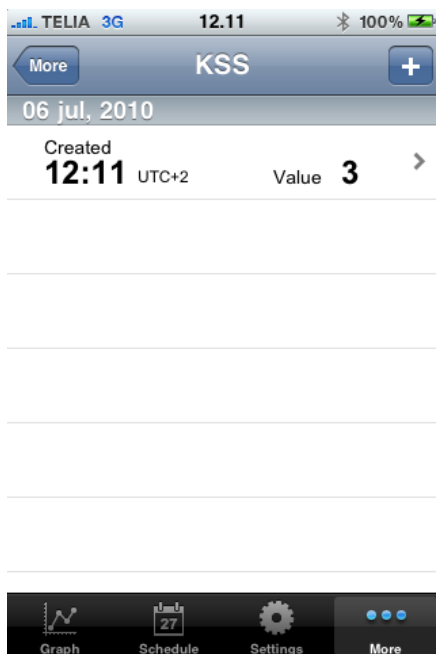
Figure 15. The KSS view.

The user is able to conduct a new KSS assessment test by clicking on the plus button at the upper right corner of the view. The user is then presented with nine descriptive alertness values. The user chooses the value he/she thinks correlates the best to how he/she felt the last five minutes before the time the test is conducted. When the user has selected a value he/she simply clicks on the

save button at the upper right corner to save the KSS test and returns to the view where all the tests are listed.
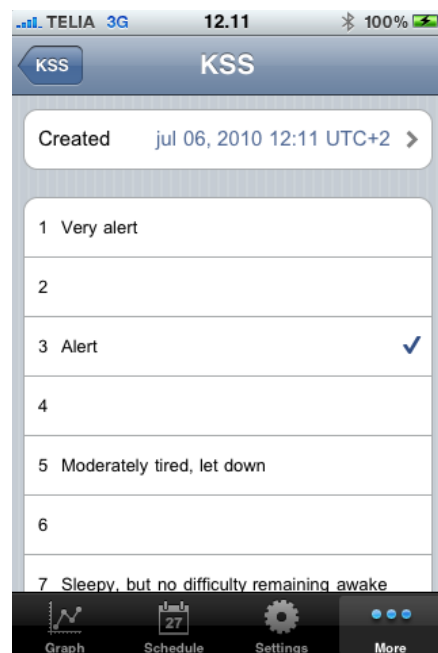
Figure 16. A detailed view of a KSS.

By clicking on an already stored KSS test the user is directed to a view (see figure 16) where he/she is able to change either the alertness value or the timestamp for the selected KSS test.

4.3.2 About

The about screen (see figure 17) is used as a way of accessing information about the application such as which version of the alertness model is being used and the application's legal agreements.
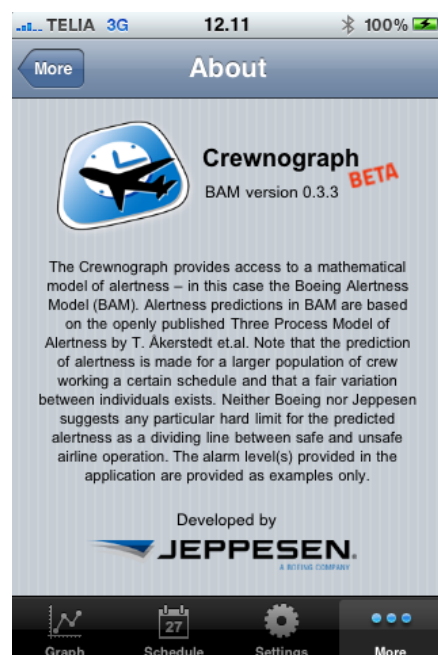
Figure 17. The about view.

4.4. Graph View

The first view the user will face when starting the application, which also can be accessed from the first tab at the bottom left side, is the graph view (see figure 18). This view could be considered as the heart of the application. This is where the user can see the predicted alertness graph estimated by the alertness model. The predicted alertness values are presented as a graph, where the y-axis is the alertness value and x-axis is the time line.
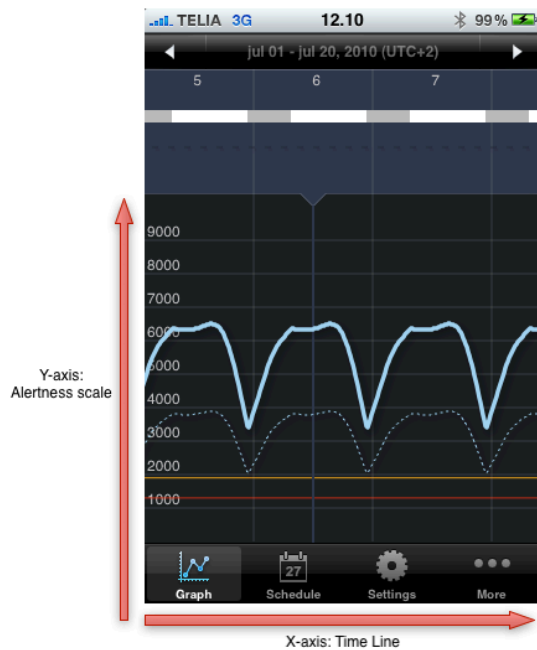
Figure 18. The graph view.

The graph view could be divided into two different sections, one upper section and one lower section (see figure 19). The upper section displays information regarding the users work schedule and sleep. The lower section contains information about the users predicted alertness. These two sections are described in greater detail below.

Figure 19. The graph view with the two different sections highlighted.

4.4.1. Upper section

The upper section is constructed out of five different elements and a time line. The user manages three out of five elements; the other two are derived from the work schedule and the alertness model. The five elements are:

Managed by the user
- Duty
- Sleep journal
- Sleep period

Derived from the work schedule
- Sleep opportunity

Derived from the alertness model
- Predicted sleep

Duty

Duties are one out of three elements that are controlled by the users. By looking at a duty displayed in the graph view the user can see basic information about the duty such as the time of the departure and arrival with the help of the time line located above the duty object. By looking at the width of the duty object the user can also estimate the duty duration. Depending on if the alertness graph breaks any of the alertness limits during a duty, the duty will change color accordingly (see figure 20 and 24).

Figure 20. Different coloring of a duty.

Sleep journal

Sleep journals are the second element that is managed by the users. The sleep journal is visualized in a similar way as duties (see figure 21). By looking at the sleep journals the user can extract similar information as from duties, the start and end time for the sleep journal and the sleep journal's duration.

Figure 21. The graph view with a sleep journal.

Sleep period

Sleep periods are the third and last element controlled by the user. From looking at the sleep period object the user can extract the same information as from the sleep journal. What differentiate sleep periods from sleep journals are not only the significance, but also how they are handled. In contrast to sleep journals, sleep periods cannot be placed anywhere. The sleep periods need to be placed within a sleep journal (see figure 22).

Figure 22. A sleep journal with a sleep period.

Sleep opportunity
Sleep opportunities are derived from the work schedule and visualized as white line in the upper section. A sleep opportunity indicates where the user, according to the parameter defined in settings and the work schedule, should have the possibility to go to sleep.

Predicted sleep
The predicted sleep objects are produced from the alertness model and visualized as short grey areas within the sleep opportunity. The alertness model is only allowed to predict sleep inside of a sleep opportunity. The user is not able to directly manipulate any of the sleep predictions.

4.4.2. Lower section
This lower section of the graph view contains several different components. These components are:

- Alertness graph
- Confidence interval
- Alertness scale
- Alertness limits
- KSS assessments

Alertness graph
The most significant and central part of the application is the alertness graph. This graph is the graphical representation of the output from the alertness model. The graph is a visualization of the users alertness over a defined period of time. Low values in the graph indicate that the alertness model has predicted that the user will be tired.

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Confidence interval

The doted line below the alertness graph is a confidence interval of the estimated alertness graph. The alertness graph is an average for a population and the confidence interval shows the user where 90% of the whole population will have a higher alertness value.

Alertness scale

The scale used by the alertness model is referred to as the CAS scale. This is a scale ranging 0-10 000.

Alertness limits

As previously mentioned in the section describing the settings view, there are two different limits. These two alertness limits are visualized onto the graph view as a red and an amber line. These lines are used as tools to help the user to see when the predicted alertness values starting to drop close to or break the alertness limits.

KSS assessments

All of the KSS assessments conducted by the user are presented as purple dots onto the alertness scale (see figure 23). The value selected for each KSS assessment is translated into the alertness scale. Depending on the value selected for each KSS assessment the purple dots are inserted accordingly to the CAS scale.

Figure 23. A KSS assessment.

4.4.3. Touch events

The graph view supports several different touch events. Most of these touch events are shortcuts for functionality available from the schedule view, but there are also a couple of touch events solely designed for the graph view. All of these touch events are listed and described below:

Create a duty or sleep journal

As shown in figure 19 the upper section is divided into two sections as well by a dashed line. The upper section is where the duties are presented. The lower section is where the sleep journals and sleep periods are presented. By double tapping on an empty space on either the upper or lower section a new duty or sleep journal is created. The touch event does not only recognize in which section the double tap occurred, but also where on the time line it occurred. This is used as a starting value when creating a new duty or sleep journal from a touch event.

Edit a duty or sleep journal

If the user would like to edit an already created duty or sleep journal instead of creating a new, he/she only has to double tap on a duty or a sleep journal. When the user has double tapped on a duty or sleep journal he/she will be presented with a detailed view of the selected duty or sleep journal.

Highlight a duty

By single tapping a duty, the user is able find out what the lowest estimated alertness value is for the selected duty. When single tapping a duty, the duty object will change shape and drop down to the lowest alertness value during the duty (see figure 24). At the same time as the duty drops down, a tooltip associated with the duty will appear from the top of the screen. This tooltip displays information about the duty such as departure and arrival time and number of legs. If there is a note associated with the duty, this will also be presented within the tooltip.

Figure 24. A highlighted duty with different colors and tooltip. Please note the difference in height between the duties.

Zoom

The pinch zoom gesture is commonly associated with the iPhone and is also supported by the graph view. By using the pinch zoom the user is able to zoom in/out to either see the schedule for an entire week or see one day in greater detail (see figure 25). The zoom works slightly different from the zoom usually used within the iPhone applications. When performing the pinch zoom gesture on the graph view, only the time line axis will change.

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Figure 25. Minimum and maximum zoom.

4.4.4. Navigation controller

The graph view could be seen as a "time window" where the user can see 20 days at the time. When the user enters the graph view, he/she will be presented with his/her schedule centered on the current date. Out of these 20 days presented, 15 of these days are displaying his/her upcoming schedule, and five days are the past five days that just have occurred.

At the top of the graph view there is a navigation controller allowing the user to move the "time window" back and forth in time (see figure 26). By either clicking on the arrow to the left or to the right the user moves the "time window" 15 days back or forward on the time line. The reason behind only moving the "time window" 15 days instead of 20 days, which is the size of the "time window", is to avoid any splices in the time line. By using this method, there is always going to be an overlap when navigating back and forth on the time line using the navigation controller.
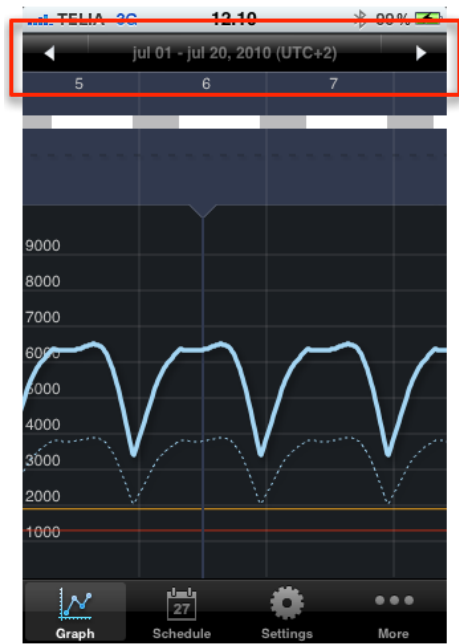
Figure 26. The graph view with the navigation controller highlighted.

4.4.5. Design motivation

The reason that the graph view looks like it does is that we have taken inspiration from Jeppesen's planning software. In the planning software the flights are presented as green squares in a horizontal line. Like duties are presented in the graph view. This way people who in one way or another are familiar with the planning software should recognize the layout when they use the application. It should also be added that there are pilots who have this experience. At first, all the duties were colored green but during the project two alarm levels were introduced. It was then natural to retain the green color to indicate that a flight was key, and orange and red to make the user aware of his/her alertness level is getting to low.

The dark background in the graph view is an adaptation of the pilots to recognize themselves from the data system Electronic flight bag (EFB) used in the cockpit. The reason that EFB has a dark background is that the screen should not dazzle pilots during use. Then one can question whether pilots at all should use an iPhone inside the cockpit. So mostly it's about capturing the feeling of a cockpit monitor.

In order to get certain elements to be highlighted more clearly, or as Robert Spence writes "pop out". To get an element to "pop out" can be done in various ways, for example by manipulating the orient, shape or color so that a particular element stands out [17]. We have tried to use bright colors that break against the dark background and therefore attract the users' attention. It is for this reason that the graph has the color light blue. On the contrary, for the KSS dots the color is very dimmed so that they should not take so much attention. All colors that can be found in the graph view, except the orange and the red color, are taken from a palette developed by Jeppesen to reinforce the feeling that the application is a Jeppesen product.

The reason for not sleep journals and sleep periods are combined with the sleep opportunity and predicted sleep is because you want to show the difference on what is input from the user and what is data from BAM.

4.5. Changes made after the evaluations
After summarizing the feedback from the heuristic evaluation (section 3.3) and the questionnaire (section 3.5), several improvements have been made. In this section, the changes made after the evaluations are presented.

4.5.1. Heuristic evaluation
The overall changes we have done are to create a unified user interface, error prevention and more help texts. Lets start with the changes for the uniform user interface. For a while the views looked very different in terms of font, color and positioning of text. The reason for this was to test what looked good or not. To make the user interface more consistent, we made a series of changes. First of all we changed font according to Jeppesen profile manual. The idea behind the formatting of departure and arrival times for duties and start and stop times for journals is to try creating a feeling of flight schedules. For the other cells, we have observed how it usually looks like in Apple´s own applications in order to keep it clean and simple.

In the application you often insert date and time. According to the feedback from the experts, we implemented error prevention and validation. The first case is to prevent the user from trying to insert invalid date and time. To alert the user that the selected dates on the screen at the moment are wrong the text color is changed to red. For example when the user have selected later departure time than arrival time. The second is to validate data before it is saved so that a duty does not overlap another duty. If the user tries to save a duty that overlaps another duty a type of pop-up will notify the user that he/she needs to change the input data.

A third improvement was to add more help texts. It was primarily in the settings that were in need of this. In the settings view there are a few settings that can be a bit difficult to understand, so therefore we added a help text just below each cell with a brief explanation.

Changes in the graph view
In the graph view, we have made it clearer what "time window" is shown by adding the date interval as a title in the navigation controller at the top of the screen. The remainders of the improvements are in some way associated with touch events. Touch events to add and see details of duties and sleep journals were implemented. Since it is possible to zoom with the double-tap in many applications we implemented it after a remark from one of the experts. We also worked with the duty to try to make objects more clickable by making them slightly larger and added shadow underneath to make them stand out.

Changes in the schedule view
As the graph view and schedule view contains the same information, but visualizes it in different ways, one of the expert thought that it should be easier to change between the two views. Another thought was that there should be

some kind of alertness information in the schedule view as well. The solution to this was partly to put a button in the list of duties. By clicking on the button the user is directed to the selected duty in the graph view. Alertness data is displayed in the form of a dot in the schedule view, which is colored green, orange or red depending on the predicted alertness level for a certain duty.

4.5.2. Questionnaire

Too see the lowest level of alertness of a duty it is sufficient to single-click on the duty. Some thought it was too little information displayed about the duty on the graph view. Since the duty objects are not that big we thought it was not so appropriate to write out information in them. A variant to solve this was to print information when you have zoomed in to a certain level, then you simply have more surface area to print on. Instead it became a form of tooltip that appears when you single-click a duty. The tooltip shows the most important information for the duty and it is just a click away.

Another small change that was added to the graph view, was to print out which UTC the graph view displays at the moment. This is to facilitate so you do not have to remember what you put in or have set in the settings view. And that makes it easier to read the graph view, or see if you need to adjust the graph view UTC to correlate where you are in reality.

5. Discussion

In this section, thoughts about the results, future work and our work are discussed.

5.1. Results

One of the non-functional requirements of the application from Jeppesen was that it would be a fully operational proof of concept iPhone application, and the second non-functional requirement is that the application would be of such quality that it would be approved if submitted for approval by Apple for posting it on the App Store.

If you are going to discuss results from the above two requirements we think we have achieved a good result. As of today, we have a fully functional application, apart from as yet unknown bugs, which also meets all of the "must" requirements in the specification. The requirement that the application would be approved for the App Store is more difficult to give a yes or no answer to. Due to legal issues we have not had the possibility to send the application for approval. We have done what we could to make sure we do not violate any obvious restrictions in Apple's User Interface Guidelines and there are no calls to private methods in the code. In addition to that, the application behaves stably for the most part. All of that are things that lean toward an approval.

The application was well received by the pilots who tested it in the user test. It was nice that the application received high ratings in terms of look and feel, because a lot of time and effort have been spent to create and refine the interface. What is not as good are the lower grades of the usability. To raise these scores, we believe we should implement the functionality to import schedules. It probably would have led to users being able to focus on playing with sleep or other settings instead of having to manually add several duties first. And with that shift of focus, we believe that the pilots hopefully would perceive the application as more useful for them.

5.2. Future work

Since CrewAlert is a fully functional proof-of-concept application, there are plenty of ideas for further work. The features we wanted to raise in this report are focused on features that could be implemented to improve the current application, rather than adding new functionality.

First on the list is the import of schedules. From a user perspective it would have been easier to just log in in order to get the schedule downloaded to the iPhone, instead of manually adding the entire schedule. This is something both pilots and experts have pointed out in the respective evaluations. A class to import data is written, the only thing missing is a back-end server that supports this.

The next two changes concern the graph view. The first change is to implement support for landscape mode. Landscape mode would be a great feature, because then the graph view would be able to visualize a longer part of the schedule at

the same time. The reason this is not implemented in the current version of the application is unfortunately due to time constraints. The second change is to implement so that the graph view is rendered while you scroll forward or backward in time instead of today where you navigate in time by clicking on the arrow to the right or left.

Some of the pilots who responded to the questionnaire were well acquainted with the FRMS and thus had no problem understanding the concept of the application or the elements of the graph view. Then there were pilots who were not as familiar with the area and according to their feedback, it seemed that they had trouble understanding parts of the concept and terminology. Therefore, we believe that it would be good with some kind of "getting started" help the first time you start the application. The "getting started" help could potentially consist of a couple of screens where you briefly describes some of the functionality, BAM, FRMS, and the elements in the graph view with text and images. If you want to go through the "getting started" help again it should be available under the more tab. Hopefully, this will facilitate to get started with the application.

If you look at the future work from a Jeppesen perspective, it is mainly a function that is desired and it is to be able to export data. The reason for this is that the data in the application can be used to continue the development and tuning of BAM. This is to get even better predictions in the future.

Last but not least, it would be interesting to make a version that is tailored for the iPad.

5.3. Our work
Work during the project has gone well. We have held our initial time plan (see appendix A), except that a week has been rescheduled one week forward or backward. A part that was modified from the basic plan was that we planned user studies with pilots in person. That was unfortunately not how it turned out. It was not possible to obtain meetings in person with pilots who were scattered across the world and working for different companies. The alternative was to carry out a questionnaire so the time we had put aside for the user study was shorter than scheduled.

Working with an agile thinking and two-week iterations has worked well. The planning of each iteration together with the internal reference group at Jeppesen has done that we all the time have had clear goals to work toward each iteration, which has facilitated the process. Focus has been on, at all times, to identify and work on solving the most crucial aspects of the project first. It may seem that it feels natural when you read it, but is nevertheless an important thing to remember.

If we were to change something we have done in this master's thesis, it would be to have the opportunity to sit down next to and see when a pilot uses the application instead of collecting comments with a questionnaire. We think it would have been better to do the user studies in person, and then we probably had received more information and learnt more about conducting a user study.

6. Conclusion

We have managed to check off all items of the "must" requirements, as well as a number of additional requirements lower on the list. Two of the overall non-functional requirements that were included in the specification were that the application would be a fully operational proof of concept application and that application would be of such quality that it could be released on the App Store. We are pleased with what we have achieved in this project and because Jeppesen believes that the application is good enough and are working to release it on the App Store, we feel that we have met these two general requirements.

The approach with two-week iterations, which we have used through the project, has worked well. If we would have the opportunity to change something in the project, it would be to conduct a user study of pilots in person. We believe that it would have given us even better feedback and thus helped us to develop an even better application.

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Appendix A – Planning report

Project description

Jeppesen Systems develops crew and fleet scheduling software for the airline markets. Jeppesen and Boeing pursue a flight safety initiative addressing crew fatigue. The purpose of this master thesis project is to develop an iPhone application which lets the flight crew enter their work-schedule and predict coming fatigue. To make a good assessment of forthcoming fatigue a proprietary model, developed by Jeppesen, for predicting alertness from a user entered schedule will be integrated into the application. Situations where the predicted alertness is lower then wanted, the application should highlight this for the user. Not only do we want the application to help the user to predict forthcoming fatigue, but we also want the user to be able to make a self-assessment test or assess their alertness through a Psychomotor Vigilance Task (PVT) test or by a Karolinska Sleepiness Scale (KSS) assessment. These self-assessment tests is, if possible, going to be sent to a server for future validation of the model parameters.

Even though the current aviation rules is a bit outdated and have changed very little since the 1940's, its not our intention to try to replace these with our application. This application is suppose to act more as a tool to raise the awareness of fatigue and help the flight crew to schedule their sleep in such way that they will feel as fresh and alert as possible when he/she is going to work.

Objective

The main objective is to create a functional application with additional functionality which allows the users to enter their schedule and get a visualization their predicted alertness. In order to view the project as a success there are certain non-functional and functional requirements that should be accomplished.

Non-functional

Throughout the project the emphasis will be on the following non-functional requirements:

- Easy to use with an attractive look. This prototype must become very appealing to pilots in terms of look and feel.
- There must be high performance in the interaction.
- The application should be a fully functional proof-of-concept application. The application should be of such quality to gain acceptance from app-store.

Functional

The functionality of the application is listed below. The user should be able to:

- Get a visualization of crew-entered schedule and predicted fatigue (with a confidence interval of 95%) with highlighting of fatiguing situations.
- Easily enter and modify their crew schedule, including start of duty, end of duty, time-zone changes, number of landings, nap opportunities.
- Enter a set of personal data such as gender/age/weight/habitual sleep length/diurnal type/sleep onset/wakeup.
- Easily enter actual sleep / awake periods and parameters of sleep-onset and wakeup.
- Easily enter and modify self-assessed alertness tests.
- Update the application without losing their schedule/history/personal data.

These requirements should be seen as "must have" functionality. If there is time left there are additional "should have" functionality that can be implemented.

Method

Pre-study

During the pre-study phase we will analyze the (Boeing Alertness Model) BAM-model and how Jeppesen works with their existing systems to get a better understanding of the field. We should also look at how the GUI visualizes its information and behaves in different situations.

As preparation before we start making any sketches of the GUI we should browse the App Store to search for inspiration by looking at existing apps with interesting solutions to problems we might be facing. An important step is also to read and understand the user interface guidelines written for the iPhone. To gain knowledge about how different standard GUI components works and how they should be used.

To prepare for the implementation we should begin by making a risk assessment to highlight tasks that might become difficult to implement. These highlighted risks should be our first task to find a implementation solution for.

Design

To come up with ideas for the GUI, scenarios for how the user could interact and how different functions is performed we will use brainstorming and scenarios of use. Ideas from these sessions will later on be translated into paper prototypes to quickly be able to create a mockup that can be evaluated in a early stage. To plan and get a better understanding of the navigation flow of the application, detailed GUI mockups will be used to create storyboards.

Implementation

When it's time to start implement we will use rapid prototyping. By using rapid prototyping with two weeks cycles we will be able to get feedback throughout the implementation. One of the benefits with this method is that prototypes created by this method have a high fidelity with the final product.

Evaluation

An internal reference group has been put together by Jeppesen. This group will give feedback on GUI and usability throughout the whole development process. We will hopefully also have an external group of pilots from Boeing that we could use to get more feedback on the application's usability. Furthermore we will maybe be given the opportunity to send our work for evaluation to the usability experts at Boeing.

When we have a runnable application which includes most of the important functionality, we will start conducting more extensive evaluation test for the application. For these tests we will continue to work with our internal reference group and we will also try to get a couple of external pilots to participate that haven't been in contact with the application before.

Time-plan

Together with Jeppesen we have decided to divide the first half of the project into six iterations, where each iteration lasts for two weeks. At the end of each iteration we will deliver and present our progress since the last iteration to our supervisors and the reference group. In this way we will be more in control of what has to be done in order to finish this project in time and not fall behind the schedule. At the same time it lets our supervisors follow our progress and make sure we are moving in the right direction or point us in the right direction if needed.
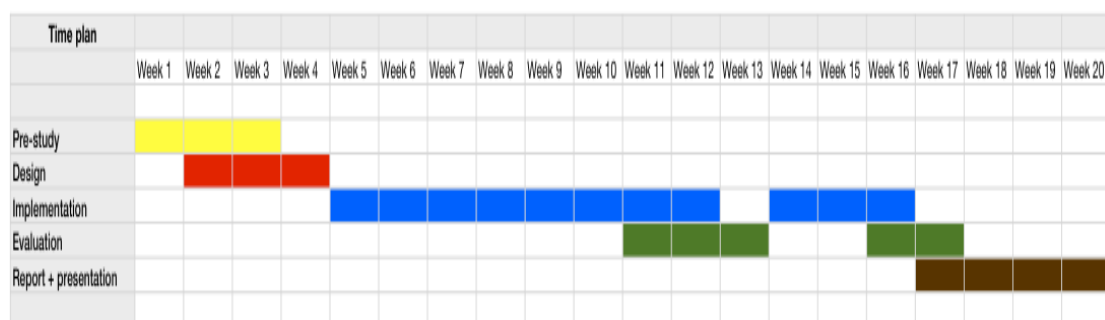
Figure 1. A graphical representation of the time-plan.

Appendix B – Requirements

Overview
The Crewnometer is a mobile proof-of-concept application for crew to help them foresee low alertness situations. The application shall let crew enter their work-schedule and predict coming fatigue. The application shall integrate with our proprietary model for predicting alertness from a user entered schedule. Low alertness situations shall be highlighted to crew. Crew shall be able to take a self-assessment or assess their alertness through PVT. If time permits the application shall be extended to support mitigation advice and suggested sleep to avoid future fatiguing situations.

The application shall send back the user's self-assessments and PVT measured alertness to a server for future validation of model parameters.

An internal reference group will review the designs and application and you will use interviews, storyboarding and rapid prototyping to advance the application between reference group meetings.

Non-functional requirements
- Extreme ease of use and attractive look. This prototype must become VERY appealing to pilots in terms of look and feel.
- There must be high performance in the interaction
- The application should be a fully functional proof-of-concept application. The application should be of such quality to gain acceptance from app-store.
- The application must indicate on the logotypes and about screen that it is a beta and proto-type version with no liability for miss-predictions.
- The application should be possible to deploy without selling it through the app-store. We will have to start with a normal SDK but then we need to investigate how an enterprise SDK can be used.

Requirements

Must:
- A screen that illustrates the predicted alertness and predicted/actual sleep over time using both BAM, other information regarding the individual, as well as the activities on the roster, Touch screen functions for zoom and scroll.
- An indication of alertness prediction confidence interval (95%) (Parameterized as we do not know the precision yet. Possibly returned by the model if the model can calculate deviation)
- A possibility of easily create/read/update/delete (CRUD) activities on the roster at any point in time of the types defined in CAPI (OF, SB, GD ,FL ,DH ,SIM, ...)
- No overlaps should be allowed (Should: except for augmentation "naps" during flight)

- Ability to CRUD actual sleep (night sleep and naps)
- Ability to indicate awake-intervals so that the model does not predict sleep where the pilot says he was awake.
- Ability to set personal data such as gender/age/weight/homebase/habitual sleep length/diurnal type/sleep start(release -> sleep opportunity) / sleep-end (wakeup -> report). Different times for homebase and outstation.
- Sleep opportunities are derived from crew schedule and parameters regarding sleep-start / sleep-end
- A possibility to upgrade the application and BAM (model binary and recommended parameters) without losing internal data (parameters and schedule + history).
- Actual BAM version should be possible to investigate for the user.
- The user must be able to take a KSS self-assessment. The KSS value should be indicated on the GANNT view.
- Ability for the user to CRUD a "measurement" at a point in time on the KSS scale.
- An "alarm" level could be set that appears like a line (or gradient area) on the prediction in the future that will serve as the "company limit" below which you should not operate. When the predicted alertness goes below the line during an active flight that flight will be high-lighted somehow to clearly show that this is a flight "you should not operate"

Should:
- Dealing with all of UTC/UTC+offset(and/or Localized reference timezone) time when CRUD and viewing schedule?
- Model parameters should be possible to change on an advanced parameters tab (only for internal / demo use)
- Possibility to add naps / rest on flights (crew augmentation)
- Possibility to push information back to Jepp/Boeing somehow (on user request/approval) of collected assessments and parameters, schedule information, actual sleep/awake etc.. Feed should be on format possible to parse by AMTB.
- A unique identity (or serial number) of each installed App so that potential data uploaded from the device can be linked to other uploads from the same device.
- Some incentive making for the user to push information, perhaps the only way to upgrade BAM or the applications?
- Input format to load (and possibly store) a crew schedule as a small xml-snippet. If xml file is large schedule, let user set time-interval of data to load (duties touching interval).
  - If it is hard to store information client side we could offer server side storage to an account with local cache. This then solves part of the "upload incentive". Usage for analysis and further model improvement is then part of EULA.

Could:
- Provide prevention/mitigation advice regarding caffeine intake, meals and light exposure.

- o This would require an expert-system hierarchy reasoning about several factors such as model-predictions, coming schedule etc, time-zone-changes, time awake, time left to rest, ... to model mitigation advices.
  - o This would also require collecting and categorizing advices from sources.
- Built-in 5-minute version of PVT measurement. CRUD on all information (time, PVT result)
- Use GPS to detect time zone transitions?
- Functionality to optimize alertness at a given (by the user) future point in time (not longer than 48h out?). The Crewnometer would then, starting from the now line, convert predicted sleep intervals to "suggested" sleep intervals in such a way that the prediction in the point becomes as high as possible. Some search algorithm testing sleep lengths in a binary search "shaking" them down from left to right...?
- Allow for user to enter lights off/on as cursor for recording sleep. Personal setting for sleep/wake onset to be used for actual sleep start/end.
- Ability to CRUD a sleep quality value to a sleep instance.
- "Receptor app" that receives the information pushed back from clients, processes them, and stores in data base (or file repository) used by AMTB.
  - o Simple httpd script receving and storing data in a safe way.
  - o Requires IT/IS to setup virtual machine and firewall forward.
  - o Data accessible, sorted and rated and fed to AMTB test-case hierarchy
- A description elaborating on how this App could/should be ported to the platform NOT chosen (iPhone or Android)
- Also run on iPad?
- Access to help-documentation with advice etc. Best practice (and worst?) that cannot be transferred in the "automated" mitigation advice.

Won't:
- Use internal accelerometers to mimic a real actigraph.
- Use proximity sensor (or similar) to register light exposure.

Appendix C – Questionnaire

Welcome to the usability study for the iPhone Crewnograph application. The application will let you enter a duty and sleep pattern and it will predict your alertness at a given point in time. The version in your hand is not connected to a scheduling system so you will have to enter all your schedule details. To simplify the task only whole duties (time between report and release) are entered.

The exercises are intentionally not described in detail. Instead, try to find your way through the system and write down what you feel is intuitive and non-intuitive. Once you have learned the application, how easy do you think it is to use?

If you encounter anything strange or non-intuitive, make a note of it, and then report it in the attached form.

Start the application
Start the application

Settings
Change the application settings so that it suites your personal needs. It is important to have a correct Home base time-zone.

Create a duty
Enter a one-day (no overnight) duty from HEL to AGP (Malaga and back). The duty reports 25th May at 06:45 (homebase time) and releases 18:20 (homebase time) at homebase and consists of two legs.

Try to read from the graph what your estimated alertness will be for the duty you just created.

Create a trip with overnight
Create the first duty in the trip. It reports at homebase 27th 14:15 (UTC) and ends 28th 00:25 (UTC) in NRT (TZ = UTC+9).

Create the return duty. It reports 29th 01:00 (UTC) and ends 29th 12:50 (UTC) at your homebase.

Create a Sleep journal
A sleep journal lets you tell the model when you slept or was awake. The journal can be in the past or in the future, telling the model when you plan to sleep or be awake.

Create a Sleep journal for the period between 25 May 05:00 and 27 May 12:00 where you know you actually slept between 25 May 22:30 - 26 May 06:30 and 26 May 23:45 - 27 May 07:25

Can you see your actual sleep in the graph?

Edit actual sleep
You slept really bad the night after the AGP trip and want to edit your actual sleep. Change the sleep period which starts 25 May 22:30 to 26 May 02:30 – 06:30.

How is the graph changed?

Delete actual sleep
The sleep entered in the journal before the duty to NRT would make you very tired. Remove the last sleep period entered above and change the journal end-time to 26 May 10:00. What sleep pattern does the alertness model propose?

Go to the graph view and inspect your changes

Sleep deprivation

When you come back from NRT you plan to attend a bachelor party. Create a Sleep journal for the period between 29 May 18:00 and 30 May 23:00 where you didn't sleep at all.

How tired would you be the day after?

Delete recorded sleep interval

Delete the same sleep journal you added above

Give KSS assesment

One of the goals of the application is for the user to report and keep track of fatigue. Take a KSS (Karolinska sleepiness scale) self assessment. Select a value which corresponds to how alert/sleepy you have felt on average during the last 5 min.

Edit a duty

What would happen if the AGP trip on the 25th got delayed by two hours?

What if it was delayed by four hours?

What if the duty to NRT got delayed by one hour?

Touch events

The application supports touch events in addition to using the menus. Have you used any touch events? Try out the ones you haven't used yet.

- Try to scroll the screen

- Try to pinch zoom

- Single-tap a duty

- Create a duty by double tapping where you want to insert a duty

- Edit existing duty by double tapping a duty

- Change graph-window time-period by using the white navigation arrows

You have now completed the basic tasks in the study and should be able to enter any schedule. Feel free to play around. One idea can be to enter your last or coming set of flight duties.

Once ready, please fill out the form on the next page.

Feedback form

iPhone experience

Do you own an iPhone?   ___ Yes   ___ No

Settings

Was the help text enough to understand the different settings?   ___ Yes   ___ No

If no, what was hard to understand?

Other comments:

How do you rate the setting screen? (1-Worst, 5-Best)   _ 1 _ 2 _ 3 _4 _5

Schedule

Did you encounter any problems when you created/edited a duty?

Did you encounter any problems when you created/edited a Sleep journal or Sleep period?

Other comments:

How do you rate the schedule screen? (1-Worst, 5-Best)   _ 1 _ 2 _ 3 _4 _5

Graph

Was it hard to understand the information displayed?   ___ Yes ___ No

If yes, what was hard to understand?

Did you try to use touch events before you were told to in the instructions? ___ Yes ___ No

What touch events made most sense?

Which one was least intuitive?

How do you rate the graph screen? (1-Worst, 5-Best)   _ 1 _ 2 _ 3 _4 _5

KSS

Was it hard to find where to create a KSS self assessment?   ___ Yes ___ No

If yes, why?

Other

Anything you find working very well while using the application?

Anything you find working bad while using the application?

Was it hard to understand the use of different UTC offsets/time bases? ___ Yes ___ No

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Is there any functionality you think is missing/would like to have?

What is your overall rating of application look and feel? (1-Worst, 5-Best) _ 1 _ 2 _ 3 _4 _5

What is your overall rating of application usability? (1-Worst, 5-Best)   _ 1 _ 2 _ 3 _4 _5

How usable would an application like this be to you as a pilot? (1-Worst, 5-Best)

_ 1 _ 2 _ 3 _4 _5

What is missing in this application to make this application usable to you as a pilot?

Thanks for your participation!

Appendix D – Questionnaire results

CREWNOGRAPH USABILITY STUDY

ANN

JEPPESEN.
A BOEING COMPANY

Feedback form

iPhone experience
Do you own an iPhone?   ___ Yes ✕ No

Settings
Was the help text enough to understand the different settings?   ✕ Yes ___ No

If no, what was hard to understand?

Why different Default time base and home base time zone, did not understand.

Other comments:

How do you rate the setting screen? (1-Worst, 5-Best)   _1_2_3 ④ 5

Schedule
Did you encounter any problems when you created/edited a duty?

No

Did you encounter any problems when you created/edited a Sleep journal or Sleep period?

No

Other comments:

How do you rate the schedule screen? (1-Worst, 5-Best)   _1_2_3_4 ⑤

Crewnograph Usability Study • Page 3 (5)

JEPPESEN.
A BOEING COMPANY

CREWNOGRAPH USABILITY STUDY

Was it hard to understand the use of different UTC offsets/time bases? ___ Yes ⊠ No

Is there any functionality you think is missing/would like to have?

What is your overall rating of application look and feel? (1-Worst, 5-Best) _ 1 _ 2 _ 3 ④ 5

What is your overall rating of application usability? (1-Worst, 5-Best) _ 1 _ 2 _ 3 ④ 5

How usable would an application like this be to you as a pilot? (1-Worst, 5-Best) _ 1 _ 2 _ 3 _ 4 ⑤

What is missing in this application to make this application usable to you as a pilot?

The graph for alertness level could show also hours when zooming in, not just days.

Thanks for your participation!

ANM

CREWNOGRAPH USABILITY STUDY

Graph

Was it hard to understand the information displayed?   ___ Yes X No
If yes, what was hard to understand?

Did you try to use touch events before you were told to in the instructions?   X Yes ___ No
What touch events made most sense?

   1 touch on duty

Which one was least intuitive?

   Changing the window from the white arrows
   did not work so well (not sensitive enough or too small
   arrows)

How do you rate the graph screen? (1-Worst, 5-Best)   _1_2_3_4(5)

KSS

Was it hard to find where to create a KSS self assessment?   ___ Yes X No
If yes, why?

Other

Anything you find working very well while using the application?

   Quite intuitive solution. If I had an iphone it would
   have been even easier!

Anything you find working bad while using the application?

CREWNOGRAPH USABILITY STUDY

Feedback form

iPhone experience

Do you own an iPhone?   X Yes ___ No

Settings

Was the help text enough to understand the different settings?   X Yes ___ No

If no, what was hard to understand?

Other comments:

Some settings could be explained more detailed
eg. Diurnal type, Alertness limits (meanings.)
Otherwise simple to use.

How do you rate the setting screen? (1-Worst, 5-Best)   _1 _ 2 _ 3 ④ 5

Schedule

Did you encounter any problems when you created/edited a duty?

No

Did you encounter any problems when you created/edited a Sleep journal or Sleep period?

No

Other comments:

Easy to use. Logic similar to other iphone
applications.

How do you rate the schedule screen? (1-Worst, 5-Best)   _1 _ 2 _ 3 ④ 5

JOONAS

CREWNOGRAPH USABILITY STUDY

Graph

Was it hard to understand the information displayed?   ___ Yes X No

If yes, what was hard to understand?

Time line above the graph is scaled a
bit tight. Zoom in/out option would be
nice with time too,

Did you try to use touch events before you were told to in the instructions?   ___ Yes X No

What touch events made most sense?

Which one was least intuitive?

How do you rate the graph screen? (1-Worst, 5-Best)   _1_2_(3)_4_5

KSS

Was it hard to find where to create a KSS self assessment?   ___ Yes X No

If yes, why?

Didn't know what is KSS though..

Other

Anything you find working very well while using the application?

The application itself works properly and is
easy to use. Schedules and settings were
simple enough.

Anything you find working bad while using the application?

Even it is working fine, the graph section
could be somehow more informative..

JOO MAS

CREWNOGRAPH USABILITY STUDY

Was it hard to understand the use of different UTC offsets/time bases?   ___ Yes _X_ No

Is there any functionality you think is missing/would like to have?

What is your overall rating of application look and feel? (1-Worst, 5-Best)   _ 1 _ 2 _ 3 (4) 5

What is your overall rating of application usability? (1-Worst, 5-Best)   _ 1 _ 2 (3) 4 _ 5

How usable would an application like this be to you as a pilot? (1-Worst, 5-Best) _ 1 _ 2 _ 3 (4) 5

What is missing in this application to make this application usable to you as a pilot?

Thanks for your participation!

CREWNOGRAPH USABILITY STUDY

Feedback form

iPhone experience

Do you own an iPhone?   _x__ Yes ___ No

Settings

Was the help text enough to understand the different settings?   _x__ Yes ___ No

If no, what was hard to understand?

Other comments: I would like a feature to help with summertime. In the wintertime we use utc+1 and in the summertime we use Utc+2 for rostering.

How do you rate the setting screen? (1-Worst, 5-Best)   _ 1 _ 2 _ 3 _4 x_5

Schedule

Did you encounter any problems when you created/edited a duty? NO

Did you encounter any problems when you created/edited a Sleep journal or Sleep period? No

Other comments: The sleep input is very important for the looks on the graph.

How do you rate the schedule screen? (1-Worst, 5-Best)   _ 1 _ 2 _ 3 _4 _5

CREWNOGRAPH USABILITY STUDY

Graph

Was it hard to understand the information displayed? ___ Yes _x__ No

If yes, what was hard to understand?

Did you try to use touch events before you were told to in the instructions? _x__ Yes ___ No

What touch events made most sense? I tried to play with the program. It's straight forward, but you need to know some theory behind it, before it makes sense. Therefore some added text in a file or on a note page in the program would be helpful for those not going to the frms-seminar.

Which one was least intuitive? I don't see it this way.

How do you rate the graph screen? (1-Worst, 5-Best) _ 1 _ 2 _ 3 x_4 _5

KSS

Was it hard to find where to create a KSS self assessment? ___ Yes _x__ No

If yes, why?

Other

Anything you find working very well while using the application? The program is working well. I would like the option, like in the eu-ops program, that you can add passive transfer on the same input line(duty input), instead of adding a new duty. Maybe a color on the graph, where you recommend "best sleep" before duty? Just a thought.

Anything you find working bad while using the application? No! I asked for upload of roster earlier☺

CREWNOGRAPH USABILITY STUDY

Was it hard to understand the use of different UTC offsets/time bases?   ___ Yes   _x__ No

Is there any functionality you think is missing/would like to have? Recommended best sleep period before duty☺, This would be good for long haul east-west pilots. In order to sell to pilots, they need something fast they can see they can use and get something out of. Otherwise it's a nice toy or tool.

What is your overall rating of application look and feel? (1-Worst, 5-Best)   _ 1 _ 2 _ 3 x_4 _5

What is your overall rating of application usability? (1-Worst, 5-Best)   _ 1 _ 2 _ 3 x_4 _5

How usable would an application like this be to you as a pilot? (1-Worst, 5-Best) _ 1 _ 2 _ 3 x_4 _5

What is missing in this application to make this application usable to you as a pilot? A pilot needs to see the result quickly in order to get deeper into it. Therefore using it as a sleep planer or an instrument to be alert of periods when he or she drops to much in awareness level is good. I will write to you, when I get to use it some more. I'm on summer holiday at the moment.

Best regards Lars Bækgaard, Captain

Thanks for your participation!

CREWNOGRAPH USABILITY STUDY

Feedback form

iPhone experience

Do you own an iPhone?   _X__ Yes ___ No

Settings

Was the help text enough to understand the different settings?   ___ Yes _X__ No

If no, what was hard to understand?

NEEDED TO LOOK UP A FEW THINGS LIKE DIURNAL AND BAM. STILL NOT SURE WHAT TYPE OF METRIC THE ALERTNESS LEVELS ARE TRYING TO USE SO I GUESSED 2400 C AND 1300

 W

Other comments:

How do you rate the setting screen? (1-Worst, 5-Best)   _ 1 _ 2 _ 3 X_4 _5

Schedule

Did you encounter any problems when you created/edited a duty?

NO, PRETTY STRAIGHT FORWARD

Did you encounter any problems when you created/edited a Sleep journal or Sleep period?

NO, PRETTY STRAIGHT FORWARD

Other comments:

How do you rate the schedule screen? (1-Worst, 5-Best)   _ 1 _ 2 _ 3 X_4 _5

CREWNOGRAPH USABILITY STUDY

Graph

Was it hard to understand the information displayed?   ___ Yes   X___ No

If yes, what was hard to understand?

FAIRLY INTUITIVE

Did you try to use touch events before you were told to in the instructions?   _X__ Yes   ___ No

What touch events made most sense?

TOUCHING ACTIVITY AND ZOOMING IN AND OUT

Which one was least intuitive?

N/A

How do you rate the graph screen? (1-Worst, 5-Best)   _ 1 _ 2 X_ 3 _4 _5

KSS

Was it hard to find where to create a KSS self assessment?   ___ Yes   _X__ No

If yes, why?

Other

Anything you find working very well while using the application?

I LIKED THE GRAPH, BUT IT COULD BE MUCH MORE HELPFUL IF IT INCLUDED JUST A BIT MORE INFO: LIKE TURNING YELLOW OR RED IF I'M ACTUALLY BREAKING CREW REST OR IF MY ALERTNESS LEVEL IS BOTTOMING OUT.

Anything you find working bad while using the application?

JUST THE DEFINITIONS: A BETTER HELP FUNCTION MAYBE (OR JUST SIMPLER REQUESTS FOR INFO IN THE SETUP)

CREWNOGRAPH USABILITY STUDY

Was it hard to understand the use of different UTC offsets/time bases?   ___ Yes   _X__ No

Is there any functionality you think is missing/would like to have?
AS STATED ABOVE: CAUTIONS AND WARNINGS TURNING YELLOW AND RED

What is your overall rating of application look and feel? (1-Worst, 5-Best)   _ 1 _ 2 X_ 3 _4 _5

What is your overall rating of application usability? (1-Worst, 5-Best)   _ 1 _ 2 X_ 3 _4 _5
4 FOR SCHEDULING, 2 FOR FLIGHT CREWS = 3 AVE

How usable would an application like this be to you as a pilot? (1-Worst, 5-Best) _ 1 X_ 2 _ 3 _4 _5

What is missing in this application to make this application usable to you as a pilot?
CHECK OUT THE C-17 DUTY DAY CALCULATOR IPHONE APP BY MilitaryLounge.com

IT HAS A FEW THINGS THAT MIGHT BE HELPFUL TO CREWS…

Thanks for your participation!

CREWNOGRAPH USABILITY STUDY

Feedback form

iPhone experience

Do you own an iPhone?   ___ Yes   _x__ No

Settings

Was the help text enough to understand the different settings?   __x_ Yes   ___ No

If no, what was hard to understand?

Other comments:

How do you rate the setting screen? (1-Worst, 5-Best)   _ 1 _ 2 _ 3 _x4 _5

Schedule

Did you encounter any problems when you created/edited a duty?

Scroll ba not visible so delete duty found by accident. Same for every screen, so it's probably iPhone style and got used to it soon.

Did you encounter any problems when you created/edited a Sleep journal or Sleep period?

No

Other comments:

How do you rate the schedule screen? (1-Worst, 5-Best)   _ 1 _ 2 _ x3 _4 _5

CREWNOGRAPH USABILITY STUDY

Graph

Was it hard to understand the information displayed?   ___ Yes   _x__ No

If yes, what was hard to understand?

Did you try to use touch events before you were told to in the instructions?   _x__ Yes   ___ No

What touch events made most sense?

Scrolling up/down/left/right

Which one was least intuitive?

At first thought that "more" screen" should always revert to "basic" view of KSS, advanced settings, about. But later found out that double tap is probably (again) basic iPhone style and works well.

How do you rate the graph screen? (1-Worst, 5-Best)   _ 1 _ 2 _ 3 x_4 _5

KSS

Was it hard to find where to create a KSS self assessment?   ___ Yes   __x_ No

If yes, why?

Other

Anything you find working very well while using the application?

Graph screen

Anything you find working bad while using the application?

slow response of navigation arrows in Graph screen.

CREWNOGRAPH USABILITY STUDY

Was it hard to understand the use of different UTC offsets/time bases?   __x_ Yes   ___ No

You should put Graph view time base visible in the graph screen and make adjustment from there.
Then it is easy to see and change according to your current layover station.

Is there any functionality you think is missing/would like to have?

Alarm to wake up at the end of inserted sleep period. This should be visible on the graph view also.
Small clock or similar. And if you see also the time base directly from the graph screen you're in local
time and see at what time is your alarm. Even in Europe layovers we have to always check that alarm is
in local time and how it compares to what time (UTC, home base) but with this functionality that I
propose all problems would be solved. The pick-up time from the hotel is always local time and you
could then easily adjust your sleep with crewnometer with this functionality. Feel free to use this idea.

What is your overall rating of application look and feel? (1-Worst, 5-Best)   _ 1 _ 2 _ 3 x_4 _5

What is your overall rating of application usability? (1-Worst, 5-Best)   _ 1 _ 2 x_ 3 _4 _5

How usable would an application like this be to you as a pilot? (1-Worst, 5-Best) _ 1 _ 2 _x 3 _4 _5

four ir five would be the usability with the enhancents that I proposed.

What is missing in this application to make this application usable to you as a pilot?

0-10000 alertness scale is maybe not the most easy to use/comprehend. I think human brain only
differentiates about 3-5 levels and therefore I critizice the KSS scale too. Actually I think that graph view
should show KSS scale in order to calibrate your feeling to suggested alertness. Now you're producing
0-10000 to pilot and ask him to evaluate between 1-9 in KSS scale. Should these scales be matched?
Then pilot would see from graph how he/she should feel according to "model", but actual feeling could
be then inserted and the model calibrated accordingly. Or have you separated these two on purpose?

Thanks for your participation!

CREWNOGRAPH USABILITY STUDY

Feedback form

iPhone experience

Do you own an iPhone?   **No**

Settings

Was the help text enough to understand the different settings?   **Yes**

If no, what was hard to understand?

Other comments:

How does weight affect BAM?

How do you rate the setting screen? (1-Worst, 5-Best)   **4**

Schedule

Did you encounter any problems when you created/edited a duty?

Did you encounter any problems when you created/edited a Sleep journal or Sleep period?

Other comments:

Why both a Sleep Journal and Sleep Periods?

Why not only Sleep Periods?

Does Sleep Periods work differently compared to the built-in sleep, which seems to be based on the Habitual sleep length in the Settings page?

How do you rate the schedule screen? (1-Worst, 5-Best)   **5**

CREWNOGRAPH USABILITY STUDY

Graph

Was it hard to understand the information displayed? **Yes**

If yes, what was hard to understand?

The difference between the continous thick white line and the dotted line

Did you try to use touch events before you were told to in the instructions? **Yes**

What touch events made most sense?

Single-tap a duty

Which one was least intuitive?

Double-tap to create a duty

How do you rate the graph screen? (1-Worst, 5-Best) **5**

- What is the basis for the selection of date periods on top of the pages?

- How could the alertness level ever become above 7000? (even 20 hours of sleep does not give alertness above 7000)

KSS

Was it hard to find where to create a KSS self assessment? **No**

If yes, why?

There should be an info that the self assessment is shown as a blue romb in the graph

Other

Anything you find working very well while using the application?

Adding flight schedules

Anything you find working bad while using the application?

Not being able to delete a Sleep Period without deleting the whole Sleep Journal

CREWNOGRAPH USABILITY STUDY

Was it hard to understand the use of different UTC offsets/time bases?   **Yes/No**

Slightly difficult due to the text in the example about NRT (better to use flight time than Arr time in UTC)

When using HEL in the example, there should be an info about HEL being UTC+2

Is there any functionality you think is missing/would like to have?

- Not possible to delete a Sleep Period!

- Seems to be no difference in influence on fatigue/alertness by Ground duty, Standby, Training compared to Flight duty?

- There seems to be a built-in sleep function that influence alertness without user input of Sleep Periods?

What is your overall rating of application look and feel? (1-Worst, 5-Best)   **5**

What is your overall rating of application usability? (1-Worst, 5-Best)   **4**

How usable would an application like this be to you as a pilot? (1-Worst, 5-Best) **3**

What is missing in this application to make this application usable to you as a pilot?

- Transfer times in Setting should be "to check-in" instead of "to departure"

- There should be a Setting for planning time (or time from check-in to DEP)

- There should be a Setting for check-out time

CREWNOGRAPH USABILITY STUDY

Feedback form

iPhone experience

Do you own an iPhone?   __X_ Yes   ___ No

Settings

Was the help text enough to understand the different settings?   ___ Yes   __X_ No

If no, what was hard to understand?

Never found the help text!

Other comments:

How do you rate the setting screen? (1-Worst, 5-Best)   _ 1 _ 2 _ 3 _X4 _5

Schedule

Did you encounter any problems when you created/edited a duty?

No

Did you encounter any problems when you created/edited a Sleep journal or Sleep period?

Yes

Other comments:

I was unable to enter a predicted sleep period on a hypothetical deadhead trip. The pop-up said "Start or stop value outside the sleep journal".

How do you rate the schedule screen? (1-Worst, 5-Best)   _ 1 _ 2 _ 3 _X4 _5

CREWNOGRAPH USABILITY STUDY

Graph

Was it hard to understand the information displayed?   ___ Yes __X_ No

If yes, what was hard to understand?

Did you try to use touch events before you were told to in the instructions?   ___ Yes ___ No

What touch events made most sense?

Didn't actually follow the instructions and didn't use touch events.

Which one was least intuitive?

How do you rate the graph screen? (1-Worst, 5-Best)   _ 1 _ 2 _ 3 _X4 _5

KSS

Was it hard to find where to create a KSS self assessment?   ___ Yes __X_ No

If yes, why?

Other

Anything you find working very well while using the application?

Entry of personal data and the basic Sleep Journal.

Anything you find working bad while using the application?

As mentioned above, entry of non-standard sleep periods. There must be a way, but it was not obvious or intuitive to me.

CREWNOGRAPH USABILITY STUDY

Was it hard to understand the use of different UTC offsets/time bases?   ___ Yes   __X_ No

Is there any functionality you think is missing/would like to have?

What is your overall rating of application look and feel? (1-Worst, 5-Best)   _ 1 _ 2 _ 3 _X4 _5

What is your overall rating of application usability? (1-Worst, 5-Best)   _ 1 _X 2 _ 3 _4 _5

How usable would an application like this be to you as a pilot? (1-Worst, 5-Best) _ 1 _ X2 _ 3 _4 _5

What is missing in this application to make this application usable to you as a pilot?

The ability to insert non-standard sleep periods of opportunity into the schedule, and be credited for them. This is fundamental and there is probably a way to do it, but it was not obvious to me. If the app could perform this basic function I would score it much higher. Even as is, I believe it has great potential.

Thanks for your participation!

CREWNOGRAPH USABILITY STUDY

Feedback form

iPhone experience

Do you own an iPhone?   ___ Yes   X No

Used Ipod touch

Settings

Was the help text enough to understand the different settings?   X Yes   ___ No

If no, what was hard to understand?

Other comments:

- Built in a short questionnaire to determine diurnal type automatically. Users may not know how to determine it otherwise.

-

How do you rate the setting screen? (1-Worst, 5-Best)   X 3

Schedule

Did you encounter any problems when you created/edited a duty?

Yes:

1. Pilots to not use AM/PM, it should be a 24 hour clock.

2. Putting in a month worth of schedule is quite cumbersome. Idially a batch import of a roster system output (excel?) should be possible so you don't have to put lengthy schedules in by hand. At least there should be the option to enter a schedule by using airport (IATA) codes, rather then time zones.

Did you encounter any problems when you created/edited a Sleep journal or Sleep period?

No

Other comments:

How do you rate the schedule screen? (1-Worst, 5-Best)   X 2

CREWNOGRAPH USABILITY STUDY

Graph

Was it hard to understand the information displayed?   No

If yes, what was hard to understand?

Did you try to use touch events before you were told to in the instructions?   No

What touch events made most sense?

Double tapping to edit a duty

Which one was least intuitive?

How do you rate the graph screen? (1-Worst, 5-Best)   _ 1 _ 2 X3 _4 _5

KSS

Was it hard to find where to create a KSS self assessment?   No

If yes, why?

Other

Anything you find working very well while using the application?

Anything you find working bad while using the application?

CREWNOGRAPH USABILITY STUDY

Was it hard to understand the use of different UTC offsets/time bases?   ___ Yes   ___ No

Is there any functionality you think is missing/would like to have?

What is your overall rating of application look and feel? (1-Worst, 5-Best)   _ 1 _ 2 _ 3 _4 _5

What is your overall rating of application usability? (1-Worst, 5-Best)   _ 1 _ 2 _ 3 _4 _5

How usable would an application like this be to you as a pilot? (1-Worst, 5-Best) _ 1 _ 2 _ 3 _4 _5

What is missing in this application to make this application usable to you as a pilot?

1. See point on ease of schedule input, either through batch import and/or by using station codes.
2. The beta version stopped working before I could try this, but I don't think it is possible to add a sleep period within a duty period. It should be possible to do that, as on long range flight we sleep/rest for several hours during the flight.

Thanks for your participation!

CREWNOGRAPH USABILITY STUDY

Feedback form

iPhone experience

Do you own an iPhone?   X   Yes   ___ No

Settings

Was the help text enough to understand the different settings?   X   Yes   ___ No

If no, what was hard to understand?

Other comments:

How do you rate the setting screen? (1-Worst, 5-Best)   _ 1 X 2 _ 3 _4 _5

Schedule

Did you encounter any problems when you created/edited a duty?

The flights was one day before in the graph. IE Flight created on 17th is created on 16th in the graph.

Did you encounter any problems when you created/edited a Sleep journal or Sleep period?

Yes, the sleep proposal was very unreal (hard to believe sleep between 09:00 and 17:00)and I was unable to deleted or change it, The sleep log was empty even the sleep period was created as shown in the graph.

Other comments:

Its hard to read the time (hour) even when zoom in

How do you rate the schedule screen? (1-Worst, 5-Best)   _ 1 _ 2 _ 3 X 4 _5

CREWNOGRAPH USABILITY STUDY

Graph

Was it hard to understand the information displayed?   __X Yes   ___ No

If yes, what was hard to understand?

What means the dash line below the alertness line?

Did you try to use touch events before you were told to in the instructions?   _X_ Yes ___ No

What touch events made most sense?

The flights

Which one was least intuitive?

The sleep

How do you rate the graph screen? (1-Worst, 5-Best)   _ 1 _ 2 X 3 _4 _5

The scale was confusing. Why do you have up to 9000 if the hightes possible is 6500?

0 is reached to easy.

KSS

Was it hard to find where to create a KSS self assessment?   ___ Yes   X No

If yes, why?

Other

Anything you find working very well while using the application?

The screen movements and zoom works fine

Anything you find working bad while using the application?

Auto sleep function should can be set On or Off. I can´t erase sleep period (automatic one), the sleep period enter by myself was confusing, why is White and not grey ?

If I use zoom, Id´like tho see the hours (in number at some point)

CREWNOGRAPH USABILITY STUDY

Was it hard to understand the use of different UTC offsets/time bases?   ___ Yes   __X_ No

Is there any functionality you think is missing/would like to have?
Import data, and Notes didn´t work.

What is your overall rating of application look and feel? (1-Worst, 5-Best)   _ 1 _ 2 _ 3 _4 X 5

What is your overall rating of application usability? (1-Worst, 5-Best)   _ 1 X 2 _ 3 _4 _5
Autosleep is bad
How usable would an application like this be to you as a pilot? (1-Worst, 5-Best) _ 1 _ 2 X 3 _4 _5

What is missing in this application to make this application usable to you as a pilot?

**Recommended sleep time (Sleep start) for a given flight, and alarms to go bed and wake up .
Wake up time considering sleep cycles to reduce the sleep inertia. (if applicable)**

Thanks for your participation!

Thank You!!