

Master Thesis in Interaction Design

Designing an Analytical Tool for Strategic Railway Planning

Filtering and Visualizing Large Amounts of Information

Moa Haglund
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Göteborg, Sweden 2005



IT University
of Göteborg

CHALMERS | GÖTEBORGS UNIVERSITET

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Design av ett analytiskt verktyg för strategisk tågplanering

Filtering och visualisering av stora informationsmängder

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IT Universitetet i Göteborg

Göteborgs Universitet och Chalmers Tekniska Högskola

SAMMANFATTNING

Målet med denna magisteruppsats var att ta fram en prototyp som filtrerar och visualiserar stora mängder information. Den övergripande frågan var att hitta ett sätt att ge användaren en uppfattning om informationsmängdens status.

Uppsatsen skrevs på Carmen Systems i Göteborg som utvecklar, marknadsför och implementerar resursoptimeringslösningar för kunder inom tåg- och flygindustrin.

Forskningsfrågan grundades på ett problem som användarna upplevde på ett av Carmens planeringssystem. När en planering ska utföras måste först planen optimeras med all relevant information. Resultatet av en optimering blir en plan och diverse rapporter, ofta upp emot 25 till 30 sidor långa. Rapporterna innehåller information om kvalitén på planen. Dessa rapporter går planerna igenom varje gång ändringar gjorts i planen för att se hur resultatet har förändrats. Det är omöjligt att få en överblick vilket betyder att det tar lång tid att hitta rätt värden för att kunna jämföra och analysera resultaten.

Designen grundar sig på att användarna bara behöver veta vilken information som inte är bra, det vill säga planerna arbetar endast med problem, för att förbättra planen. Den information som inte är relevant måste därför filtreras bort för att planerna inte ska bli distraherade av för mycket information. Målet med designen är att planerna ska kunna dra slutsatser på planens resultat med en överblickbar visualisering.

Användarcentrerad systemutveckling användes i designprocessen. Inledningsvis gjordes en analys av användare och uppgifterna som de utför. Användarna har varit involverade i hela designprocessen, bland annat i en workshop där resultatet blev design för prototypen som implementerades och sedan utvärderades.

Rapporten är skriven på engelska.

Sökord: informationsvisualisering, användarcentrerad design, prototyp, filtrering, människa-datorinteraktion, interaktionsdesign

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ABSTRACT

The purpose with this thesis was to produce a prototype for filtering and visualizing large amounts of information. The comprehensive question was to find a way to give the user an idea of the status of the information.

The thesis was written at Carmen System in Gothenburg; who develops, markets, and implements resource optimization solutions for clients found primarily in the railway and airline industries.

The research question was based on a problem that the users experienced with one of Carmen's planning systems. Before the planners start working with a plan it has to be optimized with all relevant information. The result is an optimized plan and various reports, which often can be up to 25 and 30 pages long. The reports contain information about the quality of the plan. The planners review these reports each time a change is made in the plan to see how the results is changed. It is impossible to get an overview, which means it takes long time to find the right values to be able to compare and analyze the results.

The design is based on the fact that the users only need to know the information that is not good enough to be able to enhance the plan. The information that isn't relevant is filtered away so the user doesn't have to be distracted by too much information. The aim with the design is the planners should be able to draw conclusions of the results due to the overview of the visualization.

A user centred system development was used throughout the design process. By way of introduction an analysis of the user and their tasks were performed. The users have been involved during the whole development, amongst others in a workshop where the result became the design for the prototype that was implemented and later evaluated.

Keywords: information visualization, user centred design, prototype, filter, human-computer interaction, interaction design, UCD, HCI

PREFACE

This paper is a Master of Science Thesis Report in Human-Computer Interaction and Interaction design, written for the IT University, a part of Göteborg University and Chalmers University of Technology. The thesis consists of 20 credits, which is equivalent to 20 weeks of fulltime work.

This thesis was carried out by Moa Haglund and Mirsada Kasum at Carmen Systems AB, Gothenburg during the autumn 2004.

We would like to thank our supervisors at Carmen Systems, Christina von Dorrien and Lena Heed for all their support, patience, help and knowledge. We would also like to thank Olof Torgersson at the IT University who was assigned as our academic supervisor.

A lot of thanks to Bengt Gustafsson, Jan Nilsson, Sofia Lundqvist and Jonatan Gjerdrum at Green Cargo AB, without your help this thesis wouldn't have been possible.

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Thanks also to those who helped us but whose names are not mentioned.

Mirsada & Moa
Gothenburg, January 2005

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1 INTRODUCTION

In many situations the amount of data that needs to be analyzed is so large that it is impossible to get an overview of it. At the same time information is becoming more and more important to have an easy access to and being able to draw conclusions from it is crucial.

The IT company Carmen Systems, where this thesis was carried out, handles large amounts of data every day. Carmen Systems provides tools for crew management in the airline and railway industries. The tools support long-term strategic planning of the crew as well as short-term operational decision-making and the area that this thesis comprehends is the part where pairings¹ for the crew are prepared. The tool provides solutions of a crew schedule, which a strategic planner² analyzes and sometimes the amount of data can be tens of thousands of rows. The planner analyzes the results of the created plan in different reports and draws conclusions of how good the plan is. These reports are long and contain lots of information that is of no use for the planners, which makes it hard to get an overview of the information and to see problem areas. This background was the start of our thesis.

As we are very interested in the users' needs and requirements, the design process was done in a user-centred design approach. All through the thesis we worked together with one of Carmen Systems' customers, Green Cargo (GC).

GC is a Swedish railway cargo operator. The company is spread out over 100 different cities around Europe with 420 locomotives and they have around 900 locomotive drivers.³ Their biggest customers can be found in the wood, iron, paper and car industries. The Swedish railway net was built in the beginning of 19th century.⁴ Back then, the crew scheduling process was manual but it became more and more complex with the expansion of the railway net until it became too complex, over 150 years later. The transition from a manual process to a computerized happened just recently, during 21st century. There are still train companies that haven't gone through this transition.

This thesis will focus on the usability of the tool from the users' point of view, and based upon that, a prototype will be designed. The analytical tool should be company independent, meaning it should be as general as possible even though this prototype will be designed for the case of GC.

¹ A pairing is a number of day's work where you start and finish at your crew base.

² A strategic planner is the person whose task is to create pair for the crews.

³ <http://www.greencargo.com/>

⁴ <http://www.jarnvag.net>

1.1 Research question and goal

The problem that we want solve is to find a way to visualize large amounts of information and to facilitate the process of drawing conclusions from an overview.

This thesis will deal primarily with the question:

How to design an analytical tool for strategic railway planning that filters and visualize information from physical reports?

And the question statements:

- *How to filter the data so the relevant information can be separated and visualized?*
- *How to show the filtered information in an overview?*
- *How to give the user an idea of the status of the information?*

An empirical study was done with GC to find answers for these questions. The goal is to present a prototype of an analytical tool for the users which presents results of a crew schedule plan and reduces the time it takes to read, analyze and compare the information.

2 BACKGROUND

In this chapter, the background behind our thesis is presented. There is a description of the current work situation, its problems and the reason for our design approach.

2.1 The crew scheduling process

The crew scheduling process is a very complex task and includes two different parts, the crew pairing and the crew rostering process. The crew pairing process' goal is to man all flights or trains while minimizing the total number of working days and costs. Carmen Crew Pairing is a tool for creating, optimizing and maintaining crew pairings. A pairing is a number of day's work, where you start and finish at a crew base (see figure 1).

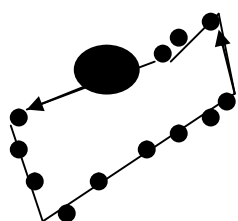


Figure 1. The figure shows a pairing with a train where the crew starts at a crew base and returns to the crew base at the end of the pairing.

A pairing is anonymous and can later be assigned to any crewmember with the Crew Rostering System. Pairings are built with the optimizer and can later be changed manually in the plan. The number of crew members can differ from company to company, which means that for some companies the system has to deal with tens of thousands of pairings and fewer for some. Timetables, vehicle rotation, crew data and rules are the input and pairings are the output (see figure 2). There are different kind of rules to follow, legality rules and quality and performance improvement rules. A legality rule must be obeyed at all times e.g. staffs needs minimum 10 hours of rest between duties. Quality rules can be common praxis to give quality of life or buffers for stability and can be broken to cover production. The government, the union and the railway company set these rules.

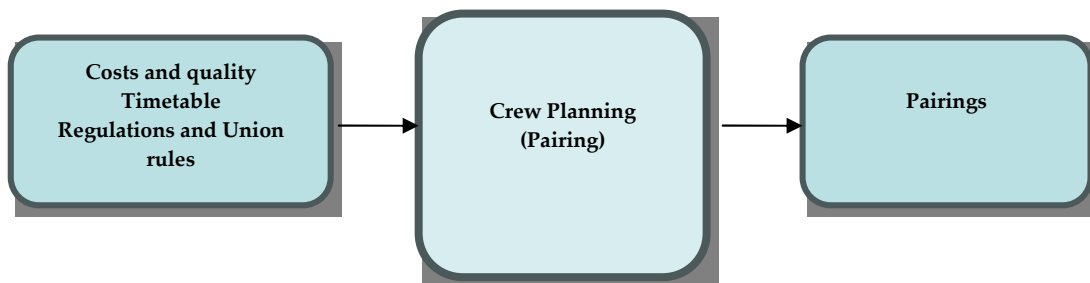


Figure 2. The crew pairing process, Carmen academy.

The schedule with the pairings (see figure 3) contains a large number of rows (depending on the size of the plan).

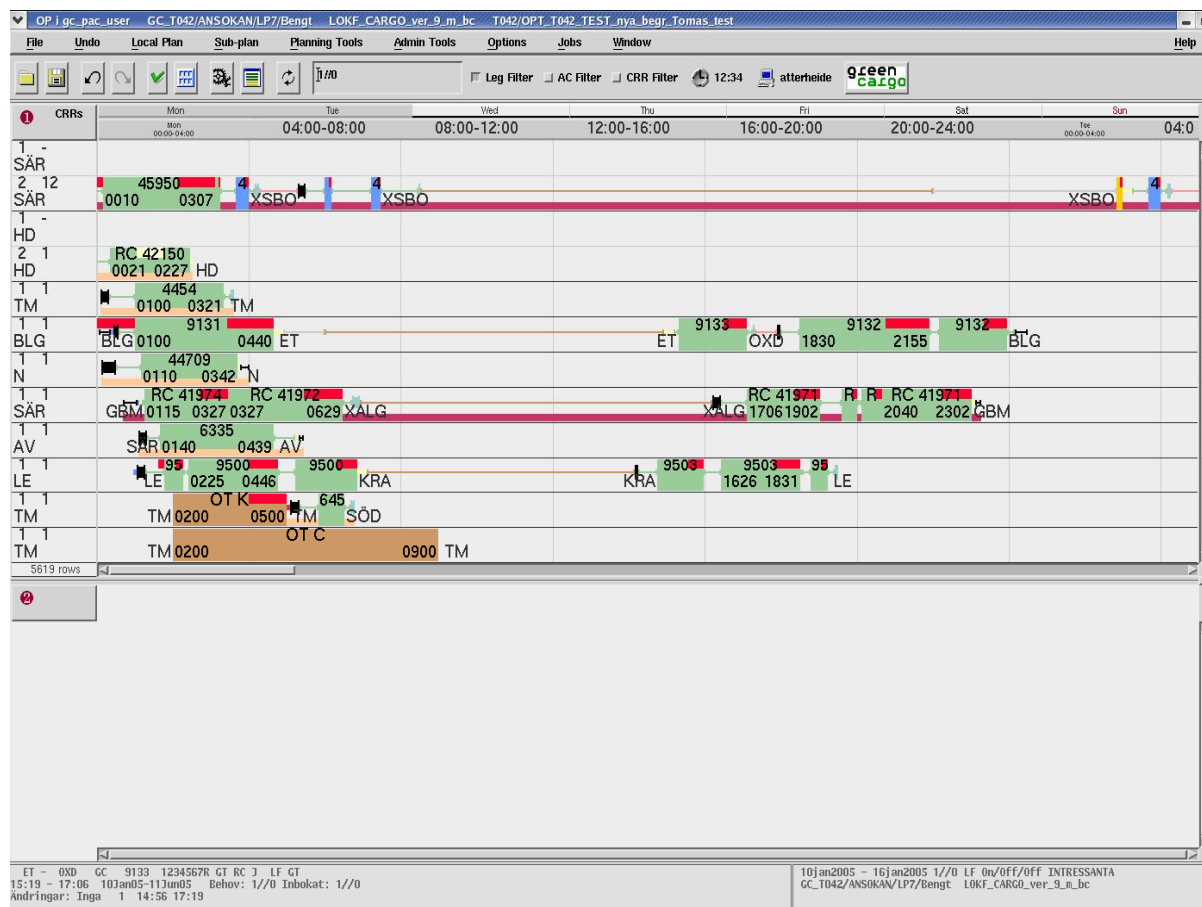


Figure 3. The Carmen crew planning system. One row in the plan represents a pairing starting and ending at a crew base with a number of stops on the way. The different colours are indicating events on the pairing such as stops, change of carriers, parking the train and so on.

The text reports *Cost and Penalties* and *Base Constraint* (see figure 4) are output that show information about the plan. As the marks show, not all information in the reports is useful. The information in *Cost and Penalties* is relevant to 18% and *Base Constraint* to 79%. After reviewing the results in the report, the planners return to the plan and searches for the row in the schedule where the changes need to be made.

Designing an Analytical Tool for Strategic Railway Planning

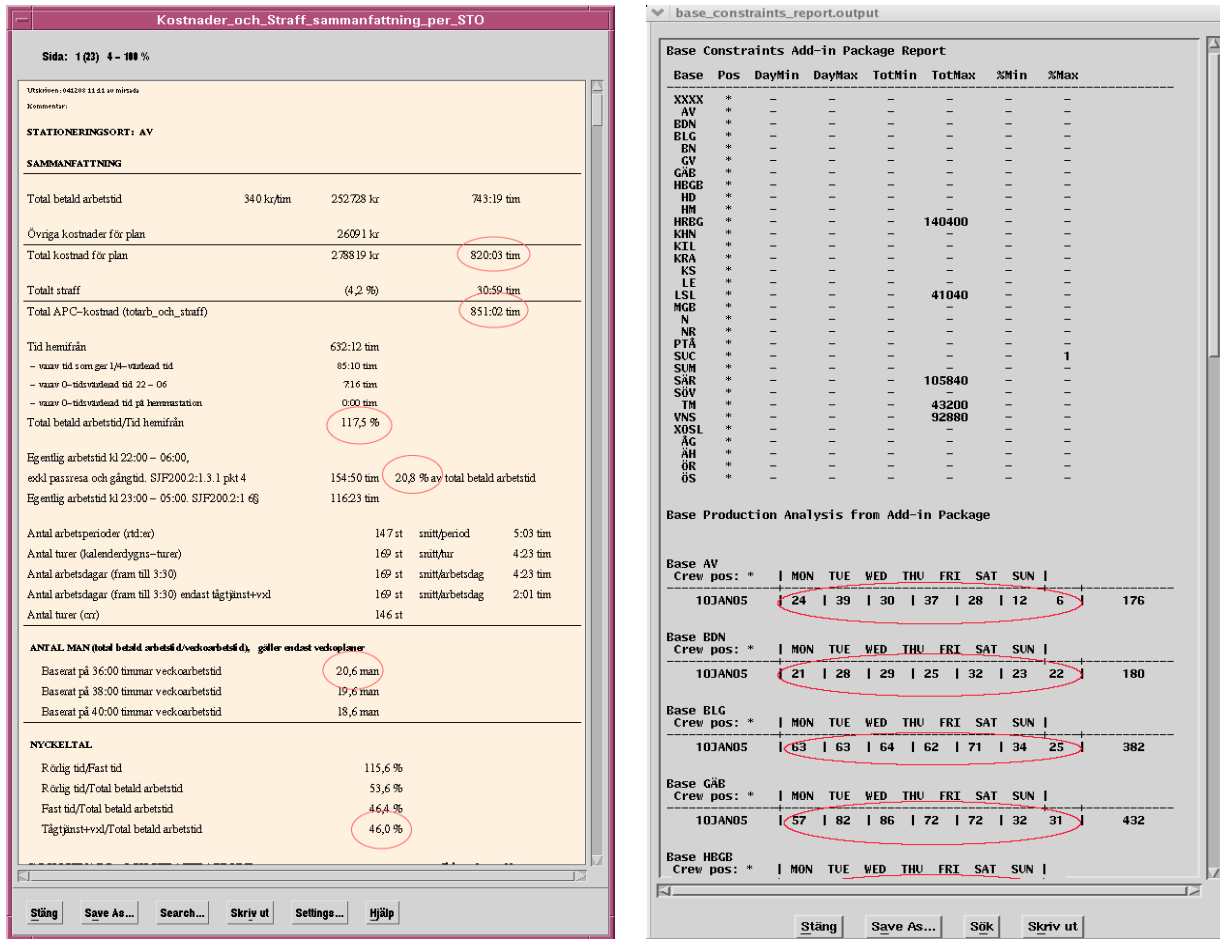


Figure 4. Cost and Penalties report to the right and Base Constraint to the left are the output from the plan. The values that the planner analyzes are marked. Cost and Penalties shows the information for one crew base and there are 25 crew bases for GC.

The planner needs to go through 25 pages of these reports since one side only keeps information about one crew man base. This means that it is impossible to get an overview of the result (see figure 5).



Figure 5. The reports for all crew bases of GC.

Carmen Systems has for a long time been in the front row of taking care of the crew management process and since a couple of years entered the railway market as well. The railway scheduling procedure contains more complex issues than the airline industry has. All of these problems have not been taken care of; Carmen simply uses the flight system interface on the railway system, which has resulted in a bad overview and a more complex analyzing process for the planners.

2.2 User centred design approach and participative design

To solve the problem and develop a system we chose to work with a user centred design process (UCD)⁵. The approach is both a philosophy and a process. It is a philosophy that places the person (as opposed to the 'thing') in the centre; it is a process that focuses on cognitive factors, such as perception, memory, learning and problem-solving et cetera as they come into play during peoples' interactions with things. UCD seeks to answer questions about users, their tasks and goals and then use the findings to drive development and

⁵ http://www.upassoc.org/upa_publications/ux_poster.html

design. It involves two fundamental elements - multidisciplinary teamwork and a set of specialized methods of acquiring use input and converting it into design. The differences between the UCD and the traditional approach (see figure 6) are that the latter focuses more on the technological aspects and less on the users. Our focus wasn't on the technological aspects; our aim was to develop an analyzing tool, which would satisfy the users. Another reason was that the application was going to be an innovation, which means that the new usage needed to be examined. Input from the users was also needed due to our lack of experience from the area. (Jokela, Iivari, Matero, and Karukka, 2003)

USER CENTRED DESIGN	TRADITIONAL APPROACH
User driven	Technology driven
Solutions focus	Component focus
Multidisciplinary team work vs.	Limited multidiscipline cooperation
Focus on external design	Focus on internal architecture
Specialization in user experience	No specialization in user experience
Focus on competition	Some competitive focus
Develop only user validated designs	Development prior to user validation
User view of quality	Product defect view of quality
Prime focus on user measurement	Limited focus on user
Focus on current and future customers	Limited focus on user measurement

Figure 6. Differences between user centred design and traditional approach.

The model used in this thesis is ISO 13407, which is a standard that provides guidance for the user centred design process. Of course we could have gotten the musts and the usage information from the users' supervisors or from Carmen, but this isn't good enough for us because we are of the same belief as Hackos & Redish: (1998)

“Users are people with different likes, dislikes, habits and skills, education and training that they bring into play whenever they work with a product. The better one knows the user the better will the design be for the user.”

2.2.1 Participative design

This design approach can be a part of the UCD approach as well as it can be used by its own. Participative design is a process where the designer and user are learning from each other. The user is a part of the design process and the designer a part of the usage situation. The design process is about creating new ways of working with design; these should have similarities with both the designers' and the users' daily work. This considers the use of both parties' abilities. Practical understanding is a kind of knowledge that should be taken very serious since the most important outlines in a work are often embedded in practise and hard put into words. In this thesis the participative design approach has been used since we didn't have any experience or knowledge of the users workplace and very little of the design process in reality. It was also comforting to have contact with the users, which resulted in a good understanding of their work. The users were widely involved in our work and design.

2.3 User centred design process

The design process used in this thesis is based on the ISO 13407 standard. This roughly means that the design process is divided into three phases: analysis, design and evaluation, (see figure 7). We present the theory of the different parts in the design process and the methods we chose to use in every phase.

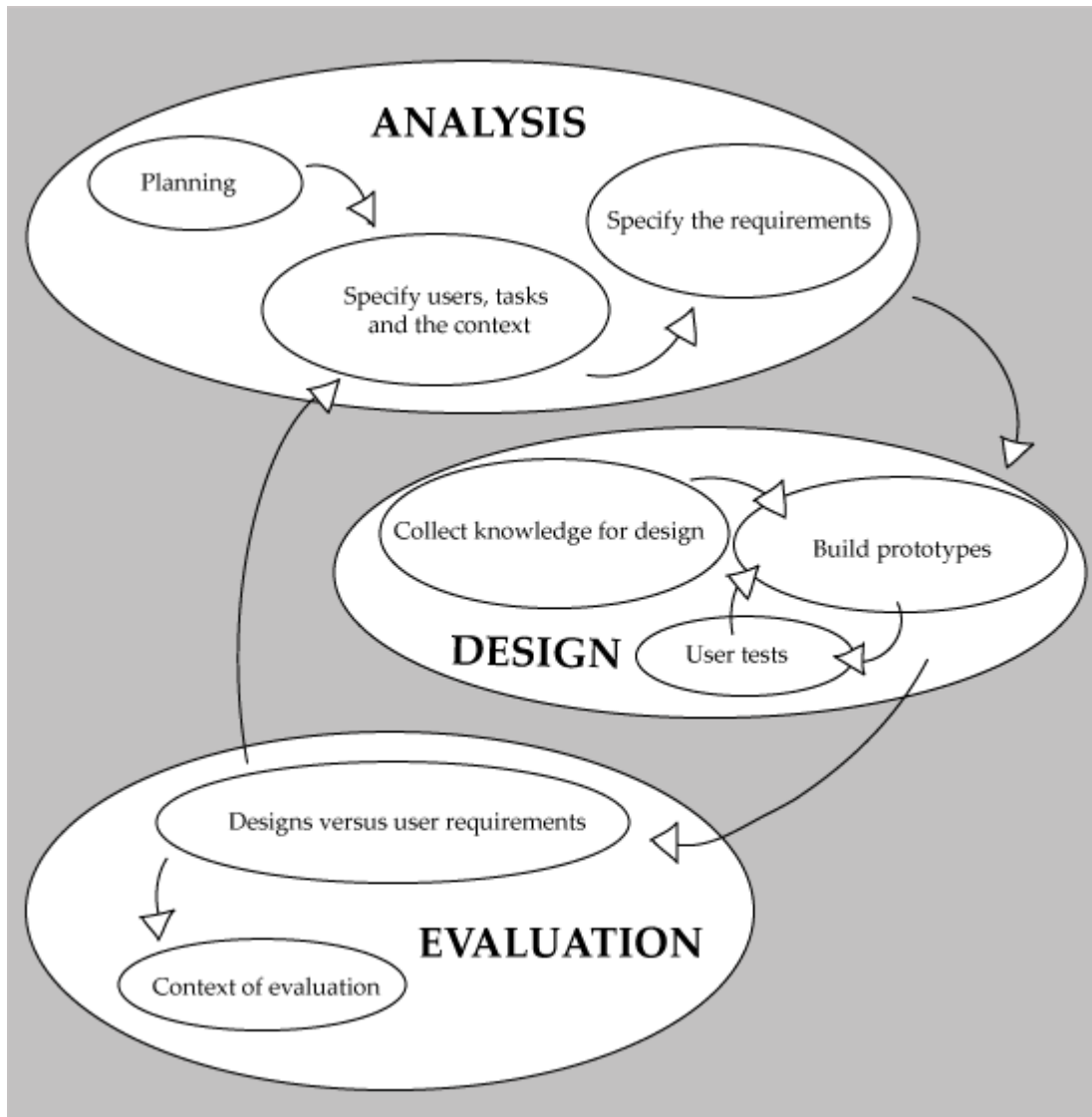


Figure 7. ISO 13407 design process⁶.

2.3.1 Analysis

The first step in the analysis is to plan the whole design process, both regarding the time aspect as well as setting goals for the project. It is also important to identify the problems and limit the area of interest. The design team needs to identify and analyze the users as well as identify and analyze the tasks that they perform. It's essential to set up the functional

⁶ www.usabilitynet.org

requirements and performance that the system should have. A lot of data gathering is performed from the current systems in use, the company, their competitors and from the users themselves

User analysis

A user analysis is performed to find out who the real users are of the system, what their situation and environment looks like. This analysis will help the designer to see the users' world on their own terms, rather than your own. (Hackos & Redish, 1998)

Task analysis

A task analysis is a process of sorting out what people actually do when they perform tasks; what activities they carry out, how they respond to different cues in their working environment and how they plan their activities. The task analysis should identify the actual users' behaviour that lead to goal attainment, rather than a 'normative' or prescriptive account of the task e.g. description in job description/ training manual. (Hackos & Redish, 1998)

The output from the user and task analysis will later on be the input to the requirements specification and also be the base for the design recommendation. Last but not least it will result into: a user profile.

Requirements specification

The requirements specification is a formal document, which consists of two different parts called the usability and functional requirements. The usability requirements are concerned with the users' satisfaction while the functional requirements are focused on what the system has to be capable of doing. (Preece, 1994)

This document is important to make sure no misunderstandings will come up later between the users and the designer. The designer can use it as a reference list and tick off the requirements when they have been carried out. With all this information a concept is developed for the new system.

2.3.2 Methods used

The information gathering methods used in the analysis phase are interviews, observations and literature and Internet searches.

Interview

There are three different forms of interviews according to Merriam (1994). First there is the interview with a very fixed structure, almost like a questionnaire. This interview is suitable if the interviewer is doing a larger survey with many respondents and needs to compare and measure the data collected. Furthermore there are interviews that work very much like a conversation, where the interviewer and the respondent discuss around different subjects. The one used in this survey is the third one, a semi-structured interview where the questions were prepared before the interview and a lot of discussion took place during each question.

Hackos and Redish (1998) says that the questions should be as neutral as possible. It is important not to put words in the users' mouth. The respondents might try to give the

answers that they think are wanted. The interviewer should be careful when using words that are value words, since the respondents might pick up these words and give answers that are slanted in the direction of those values. The biggest drawback with interviews is that the test person might tend to describe the work assignment and not the actual performance.

Observation

Observation as a method can be done both in a lab and in the users' natural environment. By studying the real user environment you experience users' behaviour and how activities are performed in a natural relation to the context. The observer can choose to observe with or without the test person's approval and knowledge. The differences between these two ways are that the latter makes the usage very natural when the observer doesn't disturb the test person. What might get lost in this situation is the knowledge about what actually implies the test person's actions since one cannot ask the person. A method that can be used stand-alone or together with the observation is the think-aloud-protocol. This can be used while the test person is conducting a certain given task or when using a system. During the usage the test person should describe thoughts and actions. This method leads to a broader perspective on the users' point of view and the observer can see things that might slip away during other analysis methods. (Hackos & Redish, 1998)

Literature and Internet search

The first step when conducting an Internet or literature search is to define a topic and its boundaries. The hard part is to find keywords that represent the topic well, but limiting the search criterion by language, geographical scope and publication dates work as good constraints. It is always a good practice to start with the most recent publications and work back from there. When using sources from the Internet and literatures it is essential to keep accurate, consistent and correct records.⁷

There are several scientific article sites on the Internet with search engines, e.g. www.acm.org and www.citeseer.com, both these sites have articles that have been published during a scientific conference which make them quite trustworthy during an argumentation. For more general information there are two other sites that are good starting points, www.google.com and www.susning.nu. Doing comparison with possible competitors is important and the Internet is a very good tool for this. However, using literature as references is often seen as more reliable source than the Internet.

2.4 Design

In the design phase there are two main steps, collecting knowledge for the design and setting concrete design solutions. A foundation based on reliable theory, which can back up the design, is preferred. In this phase it is most important to work in iterations between building prototypes and performing user tests to make sure that the goals are met.

⁷ www.shef.ac.uk/library/libdocs/ml-rs17.html

2.4.1 Methods used

The information gathering methods used in the design phase were Literature and Internet searches, scenarios and interviews. The methods used during the design process were pen and paper and interactive prototyping.

Scenario

A scenario is short fictional story with characters, events, systems and environments. The persons should perform a specific task in the system. The story should also include everyday events like colleagues asking questions, answering the telephone and/or having lunch etc. The method is a way to learn more about the users and to make sure that the design team has considered the different types of users, their needs and how their goals may be different. Last but not least this method is important for the design team to be able to predict new problems since all possible events are gone through. (Preece, 1994)

Prototypes

Hakims, Spitzer & Wise (2000) are of the opinion that a prototype can be classified according to the dimension of its fidelity and interactivity. The degree of the fidelity reflects the finished intended product. A low fidelity prototype is typically the first prototype done in contrast to a high fidelity prototype that usually refers to an alpha version of the final system, built using production tools, but lacking some features. There is something called medium fidelity as well, which means that just a few functionalities are implemented the whole way. This is sometimes referred to vertical prototyping. Horizontal prototyping is the opposite of the vertical one. It means that a broad spectrum of the product's features are implemented, but without extensive functionality behind each function.

Pen & paper prototyping

The first prototype made in this process was a paper prototype, which is a typical low fidelity prototype. It is one of the simplest ways of doing a prototype and to involve the user in an early stage of the design process. Negative surprises are thereby limited. The prototype can be used to gain insight into how the requirements are met and to perform simple tests where the user interacts with the prototype. The last point can otherwise be very time-consuming, discussing how the user would like to have it. It's a way to make sure that the design team has the same thought and aims about the design. (Hakim, Spitzer & Wise, 2000)

Interactive prototyping

With the help of computer tools a dynamic prototype can be created, which looks and acts like the system to come. Some stability might get lost and the test person can't use the system to its full extent, but it is a quick way to create a prototype instead of implementing the real system. Dynamic prototypes are often used for showing details in the design and the designer should be aware that the user might think that the prototype is definitive. If that scenario occurs it is very important for the designer to move the discussion to a higher level. One other aspect to consider according to Löwgren and Stolterman (1998) is to keep the language at the users' level and not talk in advanced programming terms.

Chauffeured prototyping is when a user sits next and watches while another person, usually a member of the development crew "drives" the systems. This is done to test whether the

interface meets the user's needs. This is done without having to implement real functions in the program. (Preece, 1994)

2.5 Evaluation

During the evaluation phase feedback is received from a specified group of users about the designs and prototypes, regarding the usability and confirming how the user requirements are met. Has the design team met the organizational goals and requirements that were set up at the beginning of the process? This is important to clarify in the evaluation phase. There are a few things that need to be considered regardless of which type of evaluation that is selected:

- The characteristics of the users who take part in the evaluation.
- The types of activities or predicted activities that the users will perform. These may range from tightly specified tasks, which are defined and controlled by an evaluator, to activities decided by the users.
- The environment of the study, which may range from a controlled laboratory situation to a natural work setting. If it is the latter, the study is known as a field study.
- The nature of the artefact being evaluated, which may be anything from a series of sketches to a working software prototype or a fully developed product.

2.5.1 Methods used

Because the whole design process focuses on the user, the evaluation methods that we wanted to use had to involve the proper users in the proper context. The methods used in the evaluation phase were Cognitive Walk-through, Heuristic evaluation and Co-operative evaluation.

Wizard of Oz

The Wizard of Oz method (Preece, 1994) can be used to evaluate a design that is not yet completed. The method gives the illusion that the system appears to be fully functional even if it's not. The test person has to follow a scenario and then only that scenario is implemented. Usually the test person can't tell during the test that the system isn't complete.

Heuristic evaluation

In the heuristic evaluation the test person does a systematic inspection of a user interface. The goal of the heuristic evaluation is to find the usability problems in the design so that they can be attended to as part of an iterative design process. (Nielsen, 1992) The principles used in this evaluation are Ben Shneiderman's Eight Golden Rules. (Shneiderman, 1992)

Cognitive Walk-through

In the cognitive walk-through, the sequence of actions refers to the steps that an interface will require a user to perform in order to accomplish a certain task. The evaluator steps through the action sequence to check for potential usability problems. Usually, the main focus of the cognitive walkthrough is to establish how easy a system is to learn. More specifically, the focus is on learning through exploration. Experience shows that many users

prefer to learn how to use a system by exploring its functionality hands on, and not after sufficient training or examination of a user's manual. The walkthrough is created to address this kind of exploratory learning. To do this, evaluators go through each step in the task and provide a story about why that step is good or bad for a user.

Co-operative evaluation

“Co-operative evaluation is a technique to improve a user interface specification by detecting the possible usability problems in an early prototype or partial simulation. It sets down procedures by which a designer can work with the sort of people who will ultimately use the software in their daily work. Together they are able to identify potential problems and solutions” (Monk, Wright, Haber & Davenport, 1993).

This is a technique for identifying usability problems in prototypes, products and processes. The technique encourages design teams and users to collaborate in order to identify usability issues and their solutions. Users work with a prototype as they carry out tasks set by the design team. During this procedure users explain what they are doing by talking or thinking aloud. An observer records unexpected user behaviour and the users' comments regarding the system. The observer also actively asks questions with respect to the users' intentions and expectations. This provides qualitative information concerning any difficulties that the users experience and also the features or interface elements which give rise to these problems. The method is applicable in the early phases of the design cycle once a prototype is available for evaluation or at a later stage when an existing product is to be further developed. The method provides a number of steps to follow to perform the evaluation. (Monk et al, 1993)

2.6 Information visualization

In this chapter information visualization is presented followed by different visualization strategies.

First it is important to clarify the differences there are between data and information. Data is pure fact that has not been worked or organized according to Eriksson and Wiedersheim-Paul (1997). Data becomes information when it gets a meaning or is put in a context. The number 10 doesn't say much but put in a context that number can be valuable to us and therefore its called information, for example there are 10 men working on Monday.

Many decisions that strategic planners make are based on information from numerous different resources. These resources often contain large amounts of information, which can be hard to present in an efficient way. The area of information visualization provides methods for addressing this problem using graphical representations that capture and reflect important aspects of the information.

Visualization is more than a method of computing. It is a process of transforming data into a visual form enabling the user to observe the information. On the computer science side techniques like computer graphics and imaging are used. Besides relying on visual

computing and displays it involves human beings. Thus, we need to take into account human perceptual and cognitive capabilities, human variations and task characteristics.

Information visualization is, according to Card, Mackinlay and Shneiderman (1999), defined as: "the use of computer-supported interactive, visual representations of abstract data to amplify cognition". Visualization increases processing resources and shifts cognitive processing burden to the human perceptual system, which can expand working memory and the storage of information by emphasizing recognition rather than recall. It reduces the processes of searching by grouping information together in a small, dense space. (Card et al, 1999)

We decided to follow Nigay and Vernier's (1998) visualization approach, where interaction design techniques consists of three different steps; study of navigation, ergonomic criteria and design rules (see figure 8)

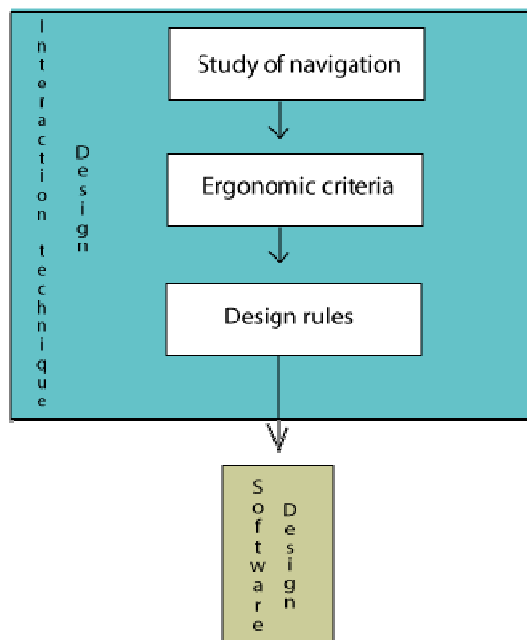


Figure 8. Nigay and Vernier's visualization approach (1998).

2.7 Navigational Techniques

The navigational techniques are important to consider when dealing with large amount of information (see figure 9). Many techniques are essentially a form of selecting a subset of the objects in a data table, which allow locating information, revealing patterns in the information and/or selecting the arguments of other transformation. Others techniques allow modification of data transformation. (Hornbaek, 2002)

DATA TRANSFORMATION	VIEW TRANSFORMATION
Selecting and visualizing different cases and variables.	Visualizing relations in detail while the context is presented.
Dynamic queries show relevant data for a certain selection made by buttons and sliders, which can be placed in different value ranges. The other data is then hidden.	Magic lenses select objects according to the X, Y position and apply functions on it. The detail view should be marked and movable on the overview.
Direct walk proceeds with linkages which means that the users have to click his way through the information, i.e. a web browser.	Direct selection refers to the set of schemes that have evolved for selecting and highlighting objects and groups of objects.
Using brushing a subset of data displayed can be marked and execute a specific operation with a pointing device. The operation can be select, hide, delete, highlight, etc.	Camera movement is used mainly in 3D space and changes the position of the observer, i.e. when the user sees the view from another angle to avoid occlusions.
Attribute walk gives the user a choice to select some cases and search for others with similar attributes i.e. www.google.com .	Overview + detail consists of one overview window and one view where the chosen/detailed data is represented.
Details-on-demand means a small set of objects that are shown to reveal more of their variables.	Zoomable user interfaces organize information in space and scale, using panning and zooming.

Figure 9. Table of visualization techniques, Card et al (1998) and Hornbaek et al (2002).

2.7.1 The chosen techniques

Our goal for the visualization is to keep a view of the whole data available, while pursuing detailed analysis of a part of it in some way. This is important according to Card et al (1999). It reduces searches, allows the detection of overall patterns, and helps the user in choosing the next move. A general heuristic starts with an overview, but should support detailed views quickly.

Overview + detail interfaces can improve subjective satisfaction and efficiency according to Hornbaek et al (2002). The interfaces can be shown one at a time or they can be shown at the same time on different parts of the screen. If they are shown at the same time, there is a trade-off for the amount of space to be devoted for both, which in turn affects the zoom factor. The design of the overview + detail visualizations involves careful trade-offs in the use of space.

Hornbaek et al (2002) conducted an experiment to find out whether interfaces with or without an overview window are better. The results showed that the interface with an overview scored higher satisfactory wise, while tasks were performed faster using the interface without overview.

Details-on-demand

The selected items are shown in a separated, more detailed way from the entire data set.

Dynamic queries

A way to query information is important, as it is difficult to find the wanted information just by looking at the information set. The dynamic query foundations are:

- A visual representation of the query and the results
- Rapid, incremental and reversible actions
- Selection by pointing
- Immediate and continuous display of results

The information set is displayed graphically on the screen and adjusting different types of graphical controls, which does the querying. The data is filtered with these adjustments and the result is visible on the screen. Combo boxes, sliders and buttons are all examples of query devices.

A slider is a rectangular region representing a range of values, with a sliding pointer inside that indicates or selects the current value. The range slider allows the user to select a sub range from a continuous range (Ahlberg, 1996). The user can manipulate its pointer and set the upper and lower boundaries of the wanted range.

Combo boxes allow the user to choose one or more items from a list. If there are more items than will fit in the drop-down list, a scroll bar will automatically be added.

2.7.2 Colors

Colours were used in the geographic view and given great importance. Colour consists of three different ingredients; hue, brightness and saturation. Hue tells which colour it is and the brightness tells how much white or black it is in the colour. Saturation is how much red it is in a red colour for example.

2.8 Ergonomic criteria

According to Nigay and Vernier (1998) it is very important to take ergonomic criteria into account. They abstract the characteristics of the user and her/his task and define suggestions for the user interface design. The definition of ergonomic criteria is a “bridge” between the users’ needs and tasks and the design (see figure 10).

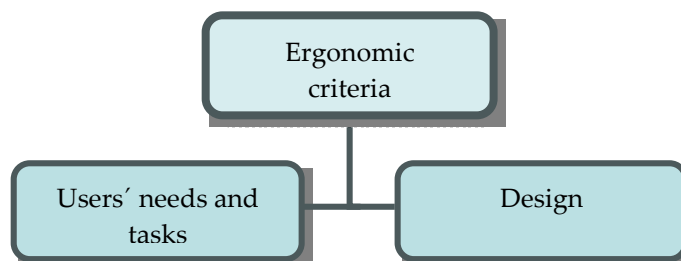


Figure 10. Ergonomic criteria, Nigay and Vernier (1998).

The most important ergonomic criteria for navigational techniques are interaction flexibility and interaction robustness.

2.8.1 Interaction flexibility

Interaction flexibility is the number of alternatives available for the users to exchange information with the system.

There are three things that contribute to the flexibility: representation multiplicity, adaptability and I/O reuse. *Representation multiplicity* is the definition on how many ways a user interface can represent itself, e.g. a screen or a loudspeaker. By *adaptability* Nigay et al (1998) mean that the user should have some ability to predict the next step in the navigation. When the user can use previous inputs or outputs as new inputs it is called *I/O reuse*. This facilitates a faster navigation and reduces the users' effort.

2.8.2 Interaction robustness

Interaction robustness is the successful achievement and assessment of a task when a user navigates. Observability, honesty and predictability are three properties that determine the robustness in a design.

By *observability* Nigay et al (1998) mean the possibility to have an understanding of the system's internal state while looking only at the graphical user interface. *Honesty* is a criterion to take into account when using distortion functions, meaning that the interface is manipulated in a satisfactory and clear way, not fooling or creating false images. The user's knowledge about what is going to happen is called *predictability*. It is important for the user to be able to determine what next step he/she needs to do to reach a certain goal.

2.9 Design rules

In this chapter techniques that simplify a design solution are presented. These rules were taken into consideration in the design.

2.9.1 Reducing a design to its essence

A good design is simple, bold and direct. To make sure that the essential of a design is noticed, insignificant information must be removed. Humans have the ability to add the information needed into an object and so the designers don't necessary have to provide this information.

2.9.2 Regularizing the elements of the design

When all the unnecessary information from the object is removed the remaining elements can be regularized to simplify the design even more. Regularity means that you reduce information by repeating elements according to a discernible rule, principle or rhythm. The visual complexity is taken away but the structure is enhanced which makes the human perception operate more effectively. Establishing a pattern allows the user to see the object on a higher level of abstraction.

3 ANALYSIS

In this chapter the core problem is first described, followed by our performance of the user analysis, the task analysis and requirements.

3.1 The work process

It took us a couple of weeks to get familiar with the crew pairing system and understand how the crew planning process works. We had meetings with the stakeholders to set goals for the project as well as to coordinate us.

The information gathering was besides a genuine literature and Internet study drawn from the users. This was conducted with the help of two face-to-face interviews, an observation at the users' workplace and a telephone conference interview.

3.1.1 Interview

The first meeting with the users was an introduction to the company. It took place at GC's head office in Stockholm with two managers and five planners. The main purpose with the first meeting was to hear the users' vision and thoughts about their "dream system" but also see how they worked in their natural environment with the current system. The interviews (see appendix A) were semi-structured and a recorder was used as a backup. The interviews took place while the planners were sitting in front of their computer and working with the system. Questions were asked about their understanding of the system. A lot of the questions came up during the interviews, e.g. "Why are you doing like this?" and "What happens if you do like this?" The interviews took about 30 minutes per respondent.

The most important feedback we got from these interviews was that the users in general were quite happy with the system in use today. They only complained about smaller bugs, which could easily be fixed by GC's own programmer. The managers had some suggestions for problem areas.

1. A geographic view of the traffic flow depending on different qualities at different points of time.
2. An analytical tool of the most frequently used non-interactive reports.

With this in mind we had a telephone interview with the two strategic planners that work at GC. The interview was semi-structured and the two planners were interviewed at the same time. The questions were quite similar to those in the face-to-face interviews (see appendix B). The strategic planners had been informed about our interview in advance so they were prepared and gave us quite a lot of feedback. The essence of the interview was that the planners were quite happy with the current system as the other planners were, but would like to have an analytical tool for the reports, precisely as the managers had asked for in the previous interview.

3.1.2 Observation

During the observation we sat next to a planner while he was working with the system. The planner was not given a certain task; instead we watched the normal everyday use. To be able to record our observations we used a modified FIT System approach.

FIT stands for Flexible Interface Technique and is a tool for recording observational data (see figure 11). The actual scene during observation is painted on the FIT template. Actions that are interesting can easily and fast be recorded by marking the spot in the "scene" on the Hand-Held computer. (www.smiledesign.ch)

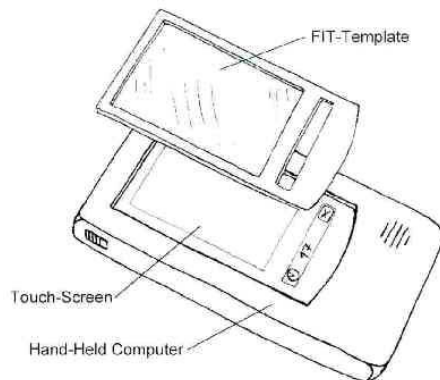


Figure 11. FIT System (www.smiledesign.ch).

The modification we made was that a physical photograph was taken of the user's work environment instead of a screen shot on a Hand-Held Computer. The photo was printed on an A4 paper and the actions were recorded manually with a pen.

The most important feedback we got from the observation and the think-aloud-protocol was an understanding about the environment, the users and the task/system that they worked with.

3.1.3 Competitors to Green Cargo

Looking for competitors we searched the Internet as well as visited two competitors, Swebus⁸ and SJ, who use systems similar to Carmen's products.

Interviews were conducted to planners at SJ and Swebus, in the same manner as to GC's planners. The output from the interviews was mixed; one planner at Swebus said that he wanted to have an analytical tool for important reports, whereas the planner at SJ was happy doing everything manually using a drawing tool called ÅngPS.

Deutsche Bahn (DB)⁹ is one of the biggest railway operators in the world and is also a customer of Carmen. After talking to some colleagues that work with DB, we concluded that their main problem is information overview and entering information into the system.

⁸ Swebus AB is a Swedish bus operator

⁹ Deutsche Bahn is a German railway operator, nowadays called Die Bahn

3.2 The Core Problem

During the analysis phase we recognized three main problems:

1. The lack of possibility to see where and when the traffic is at its busiest mode, which is important to be able to facilitate the decision-making during the planning process and create simulations.

Suggestion: A geographic view where the user should be able to see the traffic flow depending on different qualities at different points of time.

2. All data is today shown as static reports and they are about 25 pages long. This means that the planners have a hard time trying to get an overview of the information and to see areas where troubles occur.

Suggestion: An analytical tool to facilitate the procedure of analyzing the information in the reports.

3. To insert data is a complex task since there are many properties per station and stretch. The visualization of the properties is more or less none existing in today's system; the planners have to go through table after table to view them. This would be very useful for DB, since they have a large railway net.

Suggestion: An interactive graphic view to ease the insertion and visualization of information.

After some consideration and discussions with fellow colleagues, we decided to continue with problem number 2, an interactive analytical tool for non-interactive reports. The majority of the people that were interviewed mentioned this problem and therefore it felt as it would be of greatest use to everyone involved. It also seemed like the most interesting problem for us to solve.

3.3 User Analysis

The input to our user analysis came from interviews, observations and all literature and Internet searches done in the analysis phase. Interviews were conducted to find out what tasks the user performs and in what order. It was important since we didn't have any knowledge about the users' work. We also decided to observe the users while working in their natural context since they might not be able to tell us everything.

3.3.1 Users

The target group of this project are people working with strategic planning and management within the railway industry. It is a global target group with many different needs, contexts and requirements. Our aim with this thesis is to design an analytical tool, which will go well with the users at GC, but hopefully it will be general enough for other users as well.

These two groups at GC differ quite a lot from each other not only in profession and environment but also in the usage of the system.

The managers are in their early thirties and both genders are represented equally. They have higher education, usually MSc of Engineers or even a PhD. Previous to their employment at GC, about 2-3 years ago, they didn't have any domain knowledge.

The two strategic planners are men in their early forties with a background as locomotive drivers at SJ. They have both worked as strategic planners for almost 20 years and have the same user roles. Their domain knowledge is one of the best in the country dealing with GC's traffic.

The staff turnover at these positions is minimal; a new person is employed if an old employee retires or quit.

The user's motivation is high, due to three things:

1. The development is an extra feature and not a replacement of something that already exists. Therefore the user doesn't have to worry about losing or having anything changed that they are used to.
2. It makes it easier for the user to get a good overview of the current state.
3. The users are open minded and creative.

3.3.2 Environment

The user works during office hours and usually not more than 8 hours per day. The analytical tool will be solely used during work and as a helping tool. The managers are all sitting at the head office in Stockholm. They sit in an open landscape office with about 15 other people. The environment is busy and they have to deal with quite a lot of telephone calls that interrupt their work. The telephone calls are from other planners around the country whom they work together with. The two strategic planners sit outside Stockholm. They sit in separate cities and communicate daily through telephone, at least a couple of hours a day and even more in the end of a planning period.

The strategic planners are working with the planning of all railway traffic of GC, from earlier only a certain region in Sweden. The strategic planners experience their work to be relatively stressful, especially when approaching a deadline.

3.3.3 Relation to the system

The reports are not the main part of the system, but they are important after each change in the plan for the strategic planners. With the help of the reports, they can decide whether or not they have reached a good solution. They use the reports from once a day up to 7 or 8 times a day depending where in the planning process they are.

3.3.4 Differences

There are many differences in the user groups and this issue need special care. Our aim is to get the analytical tool to be as useful for the managers as for the strategic planners. While the two user groups differ from each other, the focus will be at the planners' needs and wants, due to the reason that the planners are the more frequent users (see figure 12).

Users	Age	Environment	Gender	Domain	Usage
Managers	30: s	Open office	Mixed	No	Presentation
Strategic planners	40: s	Close office	Male	Yes	Immediate work

Figure 12. An overview over the differences between the two user groups.

3.4 Task analysis

A task analysis is performed to find out the negative and positives sides with the current ways of handling the task.

The users' interest categories differ; the managers use the reports as presentation during economical reviews and to compare different periods with each other. The strategic planners use the reports in their immediate work. After each change in the plan, the reports are used to verify if the change was an improvement.

In the current system, there is no equivalence to the analytical tool that this project will develop. Today the procedure is carried out by text based reports. The users read these reports on the screen or as physical documents, which have been printed out for a meeting or such. Often they write down the information that they are working with.

3.4.1 The goal of the task

The ultimate goal of the strategic planners' work is to perform strategic plans, which are as optimized as possible. This should be done easy, convenient and with as few errors as possible.

3.4.2 The contains of the task

The daily planning procedure implies by a timetable and a vehicle rotation, which are combined to produce a plan. The problem is exponential which means that the optimizer can't find the best solution. GC doesn't use the optimizer tool as much as they could; instead the planners have to make changes manually. An optimization job can take 8-10 hours depending on the size of the plan. For making conclusions about the plan, the planners need to analyze two different reports, the *Cost and Penalties* and the *Base Constraint* report. *Costs and Penalties* is a 25 pages long report where each page represents a crew base.

It is a complex task to compare two or more reports with each other. With the system today this means

$$25 \text{ pages} \times \text{the nr of wanted reports being compared}$$

This is a lot of pages and facts for the user to keep track of and is certainly nothing to use in a presentation. The other report, Base Constraint shows how many pairings there are per weekday and is four pages long. These actions take a lot of time in effort as well as the comparison between plans is a complicated and time-consuming task. The planner needs to do 42 steps to receive all necessary information to be able to draw conclusions from the plan. Today they open two different plans and generate the reports that they keep side by side on

the screen to be able to compare. Otherwise they keep the numbers in their head or write them down. They read the report on the screen but they sometimes print them out when they are going to be showed to other employees. After the reports are reviewed, analyzed and closed, the planner returns to the schedule and continues with the changes

The procedure for the task

This part describes the procedure after changes have been performed and the planners analyze the results in the report.

1. Open the plan
2. Move the mouse over the window with the sub plan
3. Click on the middle knob of the mouse
4. Click *Open Report*
5. Choose *Costs and Penalties* or *Base Constraint* (see figure 13)
6. Click *Create and Show*
7. Analyze the interesting values
 - a. If not satisfied – make changes in the plan manually e.g. shortening pairings with long overnight stays, or starts an optimization job again. Satisfying pairings can be locked to prevent them from changing.
 - b. If satisfied – *save*.

This procedure is done until all numbers are satisfying.

The values that the planners go through are following:

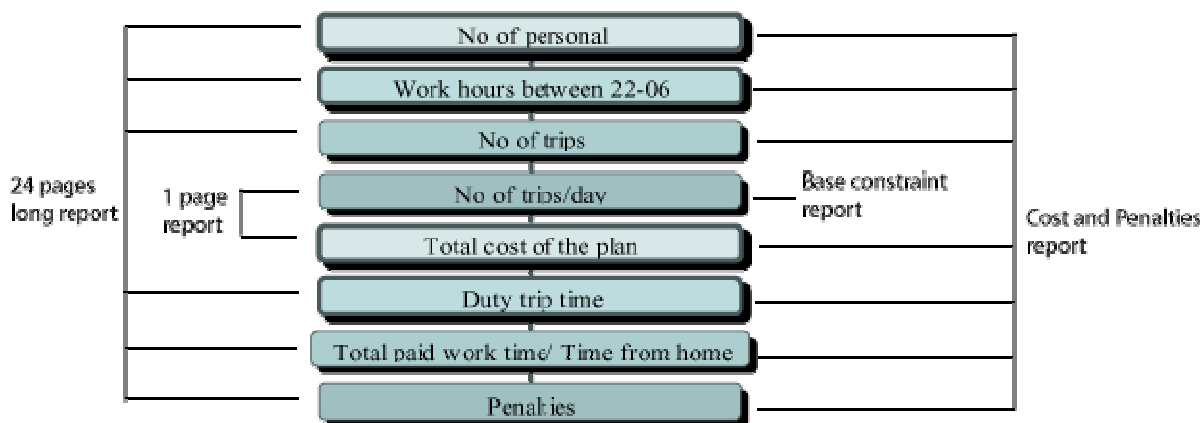


Figure 13. The work process for the strategic planners.

3.4.3 Scenario - A strategic planner at work

It's a week in September at a medium size freight company, GC, in Sweden. Their planning process is about 6 months from start until it should be finished. The planner John is in the first phase of the process. John is a 35 years old strategic planner since several years. The plan has to be finished in November.

Some optimization jobs have been done (see figure 14) during this process and the strategy is to adjust some problems in the plan. After the changes are made he analyzes the quality of the plan in the report *Costs and penalties*. Some costs are still too high so he makes some other

changes manually. He then analyzes the values that weren't satisfying in the new improved reports and decides to lock some solutions, if no better solution is found this will be a good solution to work further with. There are still a few changes needed on the plan but the plotter graphs and the feedback he got from the report said that it is a rather good plan. Plotter graphs that have a steep curve in the beginning result more often in a better solution, which is the case of plan 1. He continues with the plan until he feels satisfied. When the plan is finished and approved by the union, the standard week (the plan) is rolled out on a four-week plan, but until then he has a few months of work to do.

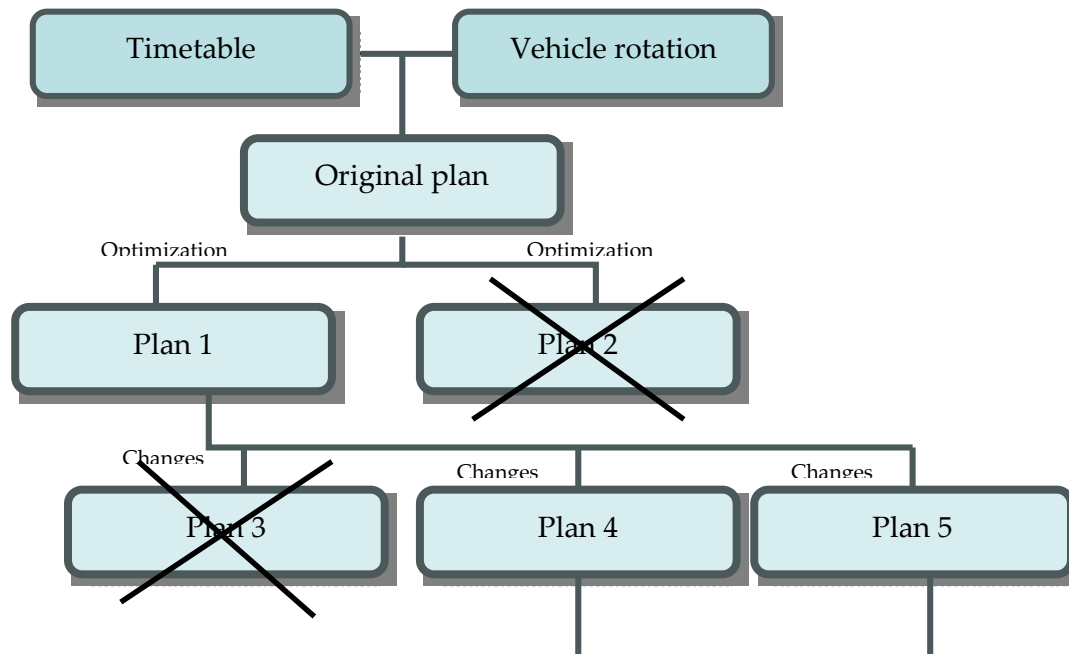


Figure 14. An ordinary planning procedure for a strategic planner.

3.5 Requirements

The requirement specification is split up into functional and usability requirements.

3.5.1 Functional requirements

The requirements placed on what functionality the system should offer is derived from the task analysis.

1. The analytical tool should present crew bases showing the results from the plan, to facilitate an overview. The values are:
 - a. Number of people, based on 36 hours working week
 - b. Working hours, 10pm–06am (exc. deadhead pairings and walking time)
 - c. Number of pairings per day
 - d. Train duty/Total paid working hours
 - e. Total costs for the plan for Sweden
 - f. Time away from home
 - g. Total penalty for Sweden

2. The analytical tool should present the crew bases more detailed for the users to choose the values for a closer analysis, “details on demand”.
3. The analytical tool should show all information in an alternative way to numbers.
4. The analytical tool should be able to present results from different plans at the same time to facilitate the procedure of comparing them.
5. The visualization by the analytical tool should be equivalent to the relevant information in the reports.
6. The user should be able to perform the actions mentioned above regardless of domain skills.

3.5.2 Usability requirements

The usability requirements are derived from the user analysis.

Learnability

After using the analytical tool three times the user should be able to correctly perform 90% of the available functions. It should be easy enough to learn that no handbook is necessary. The user will use the tool repetitive times, which means that the user will have the opportunity to learn some parts by trial and error. Of course this is not our aim, but it is an aspect that needs to be taken into consideration in our design.

Flexibility

The planner can choose to use the analytical tool or the written reports with the results from the plan. The analytical tool should however be a great improvement for the planners’ work and at least 75% should prefer the analytical tool to the written reports.

Throughput

The usage of the analytical tool should reduce the time by half the time it takes to read the details and compare the values in the written report.

Memorability

The user should be able to use the tool even after a long period of non-usage. It should be intuitive and based on a metaphorical usage, which makes people remember navigation (Nielsen, 1993). Our goal is that 90% of the users will be able to easily pick up the usage after a period of non-usage.

Attitude

After using the tool for the very first time three out of four users shall find it satisfying. By this we mean; the user shall feel that the analytical tool:

- Improves the overview of the details
- Makes it easier to compare details and results
- Is easier to work with than the reports

4 DESIGN

In this chapter the design development process and the collaboration with the users are presented.

4.1 The design base

In this chapter our design decisions and our development process is described. From the analysis phase the requirements are taken under consideration, which resulted in design decisions.

- A geographic interactive view, since GC is analyzing the results of a plan from crew bases in Sweden, we decided to use the Swedish map as a graphical base to present the visualization.
- Filter information and show the wanted results, not all information should be presented at the same time. The users only need to see the information that isn't *good*.
- The information should be presented in an overview to facilitate the analyzing. Since GC only have 25 crew bases it isn't necessary to use a zoom. The status of the data can be seen in the geographic view. But for example with DB, where the railway net is a lot bigger, it could be very useful with a zooming effect.
- The planners at GC can work with information without knowing the exact numbers; they only need to know whether the results are *OK* or *not OK*. This means that the use for details is not necessary in the first place, but the user shall be able to see the details when preferred. The detailed view should contain information for the chosen crew base or for a certain value for all the crew bases.

4.2 First prototype

The first prototypes created were paper prototypes and the purpose was mainly to concretize, externalize, and visualize our ideas to be able to discuss advantages and disadvantages round them. The focus on our design ideas was basically to be able to see the information of all crew bases in an overview. Different kinds of visualization techniques were tried out, for example: overview + detail, zooming and Fish-eye views. Shapes, colours and graphical objects such as charts and graphs were also tested and experimented with. We tried to think a bit ahead and to not get stuck in conventional design.

4.2.1 Workshop on the first prototype

The prototypes were presented and discussed with our two supervisors at Carmen and the workshop took place in a meeting room at Carmen. A lot of positive feedback was given to us, as well as some constructive critic and ideas. Discussions came up about how and when to visualize the values. Our opinion was to show the first three attributes and when the planners are satisfied with those, he could continue with showing only the final attributes.

An opinion was to rather show the first three attribute to determine whether to continue with the plan or not and then add the rest of the attributes. Another topic was whether the visualization should be shown only when the value is below the threshold value.

4.2.2 The results

The main point of this design proposal is that the geographic view should contain all information needed to make the decision if the plan is worth working further with. The visualization technique used is the one called overview + detail with features such as details-on-demand. (Card et al, 1999)

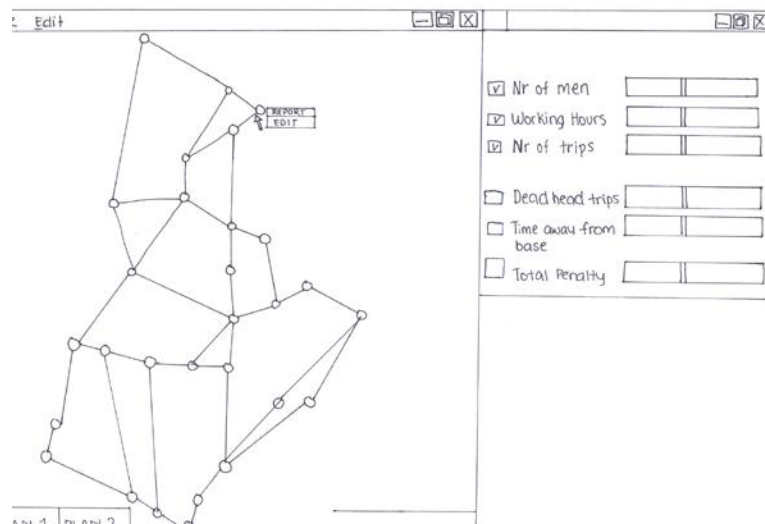


Figure 15. The first prototype.

- On the left side of the prototype is a geographic view with the crew bases in Sweden. The crew bases are dots and the strokes are the railway stretches between the crew bases. Another design proposal was to show the geographic view as a map over Sweden with the crew bases marked.
- When clicking on a crew base a menu with two different options appear in a list. The first option is *Report*, which is the report in its initial form but without the attributes that the planners never analyze. The planner can print it. The reports are shown down to the right hand corner. The other option is *Edit* where the user can change the threshold values for each attribute.
- On the right hand side of the prototype are the seven of the attributes from the *Costs and Penalties* report. They are presented in the same order as the planners analyze them in the report; *Number of men*, *Working hours*, *Number of pairings*, *Time away from home* and *Total penalty* and each attribute has a slide bar attached to it.
- The idea with slide bars is that the planners have to first feed in the threshold values of the certain attribute in the *Edit* view. Not only the threshold values needs to be set, a value for *bad*, *not OK*, *OK*, *good* and *excellent* needs to be described as well. The slide bar is

by default in the position of the threshold value of what the planners considers OK, which is the value that needs to be fulfilled to be able to work with the plan. If the threshold value of, for example, *Number of men* is not fulfilled for a certain crew base it will be shown at the crew base in the geographic view as a dot. When the threshold value is not fulfilled nothing is shown in the geographic view.

- The first three attributes tell if the plan is worth working further with or not, therefore are they ticked to start with. If the geographic view looks good the planner can tick the following boxes to see if they are fulfilling as well. When these are ticked the first three options are ticked off to minimize the information.
- If a dot is shown for *Number of men* at a certain crew base in the geographic view, the slide can be moved towards *Bad* to see when the dot disappears to be able to estimate its value.
- The *Total Cost of the Plan* is a result from the optimization for the whole plan and is not interesting to show for each of the crew base. There is no threshold value for that so the result is just shown as text and its dependant on how big the plan is.
- The menu list above the geographic view should contain choices such as *File-Open*, *Compare with*, *Save* and so on.
- The planners compare the numbers after changes have been made. This can be done in three ways; either two geographic views are shown next to each other with the comparison in a third view. The other way is to show the comparison in one view presenting the best result between the plans and the third is to just click *Compare* and a textbox of the name of best plan is presented.
- The area at the right hand corner is a space that could change due to the users' wishes. If a comparison is done the results might be shown here or detailed information about the result of crew base. This will be further investigated in the third prototype.

4.3 Second prototype

Based on the input from the workshop and an interview with the strategic planners, a new prototype was developed. Design rules were kept in mind and even if they come naturally we tried to explicitly think about them. A lot of new sketches were made when discussing the design and the first thought was to build a dynamic paper prototype but we realized that it would never be as interactive as a computerized version. We decided to develop the prototype on a computer, with the tool JBuilder and Java as the implementing language. The main purpose for this prototype was to be able to show functionality and interaction with the analytical tool and to start with the programming. The reason for developing this prototype was to evaluate it together with the users and for us to try different scenarios. Focus on getting the graphical user interface to look good and clean was put aside in this prototype.

The prototype created in this phase was a medium fidelity/vertical prototype with a few functionalities implemented. Thus, a couple of scenarios were implemented so we could present them to the planners. The purpose was not to let the planners use the tool by themselves, so called chauffeured prototyping.

We presented the prototype (see figure 16) as well as some other solutions that were discussed with the planners. The language in the tool is in Swedish since the users prefer it that way.

The geographic view in the prototype is a map over Sweden with the crew bases as blue dots. The crew bases aren't evenly spread around the country, which gives more concentrated gatherings with dots around certain areas. To solve this, the map was divided in three parts and made evenly in scale for each area.

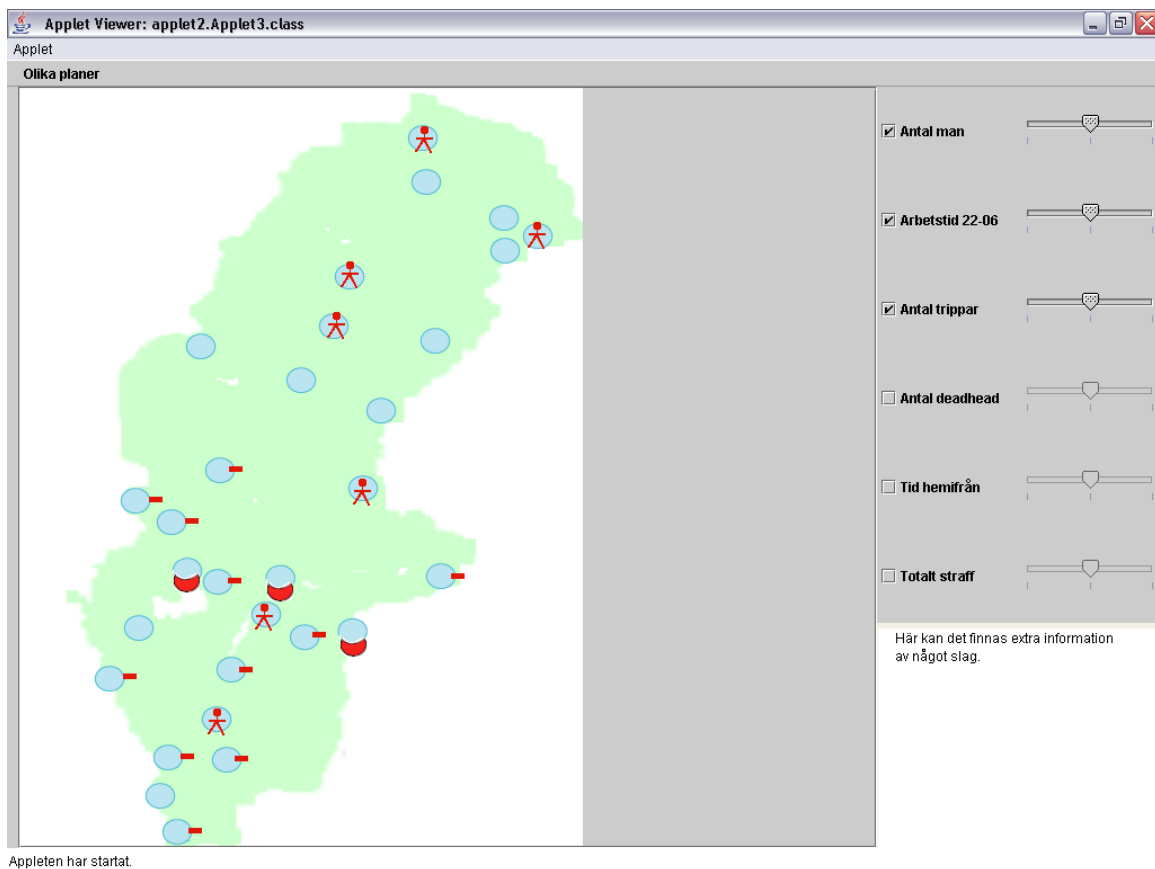


Figure 16. The second prototype.

4.3.1 Workshop on the second prototype

Two workshops were conducted on the second prototype. The first was made with our supervisors at Carmen and the purpose was mainly to go through the material and show them the prototype before the workshop with the real users. That workshop took place at GC's office in Gävle together with the two strategic planners and the manager from Stockholm. The prototype wasn't showed until the end of the workshop to give the planners

a chance to be a part of the design process. If the prototype was showed to soon the planners might think that we already decided about the design.

The presentation started by discussing the problem area, their work process today and our development so far. Even though we had been conducting many telephone interviews before this meeting, we received lots of new information regarding the work process and the values they analyze. The first activity for the planners was to come up with different ways to present the crew bases in a geographic view. The task for the planners was to think about how they see the crew bases in their minds and how they would want to see them. They suggested a geographic view instead of how it's seen today, which is a list with the crew bases ordered alphabetically. We presented some suggestions for them to consider; crew bases as dots ordered geographically, with the Swedish map as background, with the railway between the crew bases, with a dividing over Norrland, Götaland and Svealand or over the planners' different regions. (see figure 17)



Figure 17. The different designs for the geographic view

Further we discussed how the values should be visualized in the geographic view. All of the information from the workshop was gathered and discussed. The next day some unclear issues were dealt with together with one of the planners and the reason for this was that we didn't want to leave until everything was understood. A second interview with the planner also took place to learn about the task of comparison that was planned to implement in the third prototype.

Workshop and interview results

The results and ideas from the workshop are shown below. These later became input to the design of the third prototype.

The geographic view

- There should be a connection between the geographic view and the plan. When a user discovers that a crew base is *not OK*, it should be quick and easy to make the changes needed in the plan.
- The name of the crew base should be readable in some way.

Values

The values that the planners analyze changed a bit from earlier. The changes could depend on that it was the first time all three users were together when discussing and they gathered their usage. The symbols to present the different values were dealt with as well as the amount of how many threshold values are needed. The values they want to see and the symbols to them are;

1. *Number of men* as a stick figure
 2. *Working hours 10 pm-06am* as a half-moon
 3. *Number of Pairings/day* as a square
 4. *Effective time (Train duty)* as a locomotive
 5. *Total paid working hours/Time away from home* as a suitcase
 6. *Deadhead* as a bus
- *Total cost for the plan should* be presented in numbers for the whole plan and be related to the amount of leg time for it to be useful when comparing, which means it will be in per cent. A big plan is of course more expensive than a smaller one, that why it shows better in per cent.
 - *Total penalty for the plan* should be presented in numbers for the whole plan. A threshold value is not possible to set since it is correlated to the penalties switched on and some of the penalties are very expensive to get rid of. This should also be related to the amount of leg time.
 - *Total paid working hours/Time away from home* is difficult to give threshold values to since it should be as high as possible, the higher the better.
 - *Deadheads* should be correlated to the number of leg time because if it is a big plan there will be more deadhead time.
 - The threshold values should be *Not OK, OK* and *good*.
 - Since the threshold values changed from earlier the use of the slide bar lost a bit of its finesse. Another solution should be considered. *Not OK* should be the default value when reading in a plan, which means all solutions that doesn't meet up with the *OK* threshold is shown. If the higher solution is chosen the *OK* and *good* values will be shown.
 - The first two values, *Number of men* and *Working hours 10pm-06am*, are the most interesting and should therefore be activated by default.

Comparison

The comparison between two plans is very specific. One plan can be very satisfying considering a couple of values in almost every crew base, but very bad in one single value. This means that the planners need to see the numbers of all the crew bases in both plans to be able to see exactly how they differ and not just which one was better. When comparing results the planner doesn't analyze all the numbers of the value. He instead knows what

numbers might change and seeks for them. The satisfying results are locked in the plan and then he can do changes without losing them. At the end of the planning period the planners don't use the optimization tool that much. Instead they make the changes manually and lock them.

5 THE FINAL PROTOTYPE

Based on the workshop with the planners from Gävle, the work with the third prototype started. In this prototype everything that the planners wished for was considered combined with design principles and our decisions. The main area of interest in this prototype was to deal with the element of comparing results and how to feed in the threshold values (see figure 18).

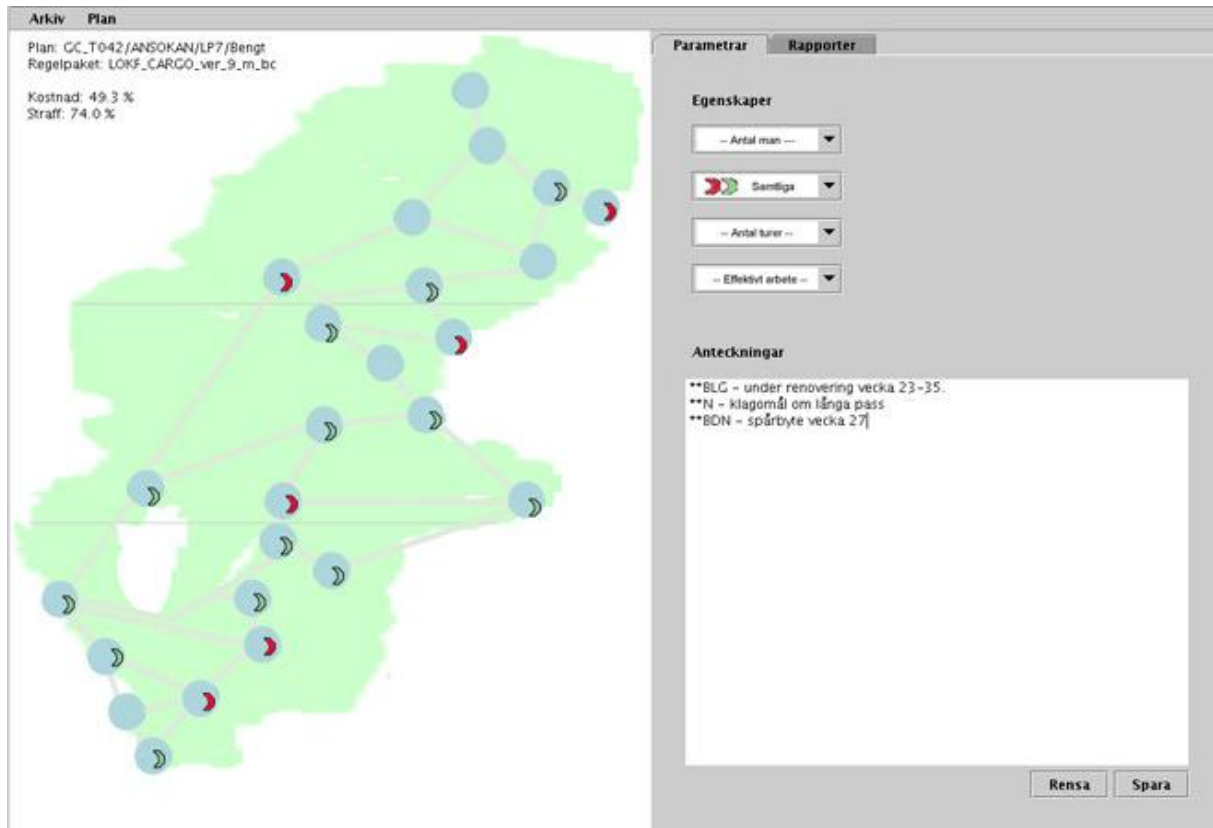


Figure 18. The third prototype, the parameter tabbed pane is visualized.

The user interface can represent itself two times, by the geographic view and by the numbers that is shown in the report. We choose to use common Windows standards to make it easier for the user to handle the system. The design is I/O reusable, all output in the tool can, if the user chooses, be new input. If for example a crew base turns out red, the user can work further with it or not. (Nigay et al, 1998)

5.1 Graphical user interface

The colours used in the prototype were taken from a colour chart used for Carmen's graphical interface. All colours used are web safe colours. The map is light green (#CCFFCC) which makes a good background colour. The green colour for the OK values (#669966) is rather pale since it shouldn't take too much of the users attention. The user should focus on

what's *not OK* in the plan and for that a red colour (#FF3333) was chosen with higher saturation than the green. A grey colour (#999999) was chosen for the bars.

Since the geographic view might be printed, the chosen colours differ in a grey scale for the user to be able to see the differences. The red colour is darker grey than the green colour, which also makes it suitable for people with colour-blindness.

5.1.1 Symbols

The text view to the right keeps two different tabs; the default one is where values are selected and visualized in the geographic view. The other tab contains tabs with numeric values of each crew base in geographic order.

The symbols changed a bit in the final prototype and were not evaluated. *Number of men* was in the second prototype a stick figure but it wasn't really pleasing. It felt like the colour of it didn't come out so well and it also felt a bit childish. Other options to use as symbol for *number of men* as well as for the other symbols were discussed and searched for. The most suitable one for *number of men* was a symbol with the shape of a shirt. The colour got more intense with this symbol. *The effective time* and *total paid working hours* were put together, since they are related to each other. That meant we got rid of the locomotive and the suitcase. Deadhead pairings were taken away from this prototype because that value was of interest for the managers and not the strategic planners. Not all users should have to see the same information, which means that different users can have different templates due to their interests. The values, number of threshold values and their symbols are listed below.

Number of men

Number of men is how much duty there is per crew base. The number isn't the same as the actual number of staff since there has to be a marginal if people get sick, are on vacation or on course. Three thresholds values; *not OK*, *OK* and *good*. The *not OK* value is 10% below the perfect value and *good* is 10% and over. The symbol is a shirt (see figure 19), which represents work.



Figure 19. *Number of men*, the red shirt represents *Not OK* values and the green represents *OK* values.

Working hours 10pm-06am

Working hours 10pm-06am should be as low as possible since the staff doesn't want to work too many night hours. Three thresholds values; *not OK*, *OK* and *good*. The *not OK* values are above 10 % of the *good* value and *OK* up to that starting from 10% below the perfect value. The symbol is a half-moon (see figure 20), which represents the night.



Figure 20. *Working hours 10pm-06am*, the red moon represents *Not OK* values and the green represents *OK* values.

Number of trips (pairings)/day

Number of trips is how many pairings there are per day during a week. The number of pairings per day can't be more than the *number of men* in duty for the plan. It both needs to be below the *number of men* and included two days off per man and week. They cannot work more than every other weekend but even better every third. The threshold values are therefore: *good* when the pairings aren't above the *number of men* at weekdays and below a third of the *number of men* at weekends. *OK* when they work every other weekend. *Not OK* when none of the above is fulfilled. The symbol is a T (see figure 21), which represents *trips*.



Figure 21. *Number of trips per day*, the red T represents *not OK* values and the green represents *OK* values.

Total paid working hours/time away from home and Effective time

Total paid working hours/time away from home and *effective time* are put together since they are related to each other. By this you can see how much of the paid working hours are actual *effective time*. This is shown with a bar (see figure 22) where *total paid working hours* is the whole bar, with three threshold values, *not OK*, *OK* and *good*. The *effective time* is shown in percent of *total paid working hours*. The ineffective time is derived from *total paid working hours* and the *effective time*.



Figure 22. *Total paid working hours/time away from home*, the red represents *not OK* values and the green represents *OK* values. *Effective time* is shown in percent as the grey bar where the bar is 100%.

5.1.2 Map

The map (see figure 23) was stretched some more to make room for the symbols for each crew base. The railway net was added since that was a wish from the users and because it is easier to visualize possible need of relocation of recourses between the bases.

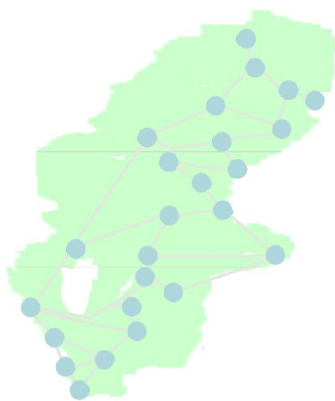


Figure 23. The map over Sweden with the crew bases.

5.1.3 Menus

There is a menu at the top of the page where you can choose:

- *Download a plan*
- *Change threshold*

The crew bases have a right click menu with the following options:

- The name of the crew base is at the top of the menu, not clickable
- Change the threshold values
- *View results*; the results for the crew base are shown.

5.2 Filtering

The filtering gives the user the opportunity to choose which data and level of thresholds to show in the geographic view. The user can see all four values at the same time but the thought is to analyze one value at the time. That is the same way that the planners work today. This means that not too much information is shown at the same time.

A decision was made to have the symbols next to the text in the combo boxes. This was done for a number of reasons. A mapping was needed between the symbols and the value to know that *number of men* is visualized with the shirt-symbol. Another reason is to eliminate any confusion with which colour shows what.

The first choice in the first combo box is *number of men*, which means that the combo box is off and nothing is seen in the geographic view. The second option is *not OK*, which means that all the values that don't pass the threshold for *OK* are shown. If the user wants to see all solutions (*OK*, *Good* and *not OK*) the choice *all values* should be chosen (see figure 24).



Figure 24. A combo box.

5.2.1 Change threshold

Each crew base has the possibility to change the threshold values by a left click at a crew base and select *change threshold* in the menu. A view appears with the values and queries to change the threshold (see figure 25).

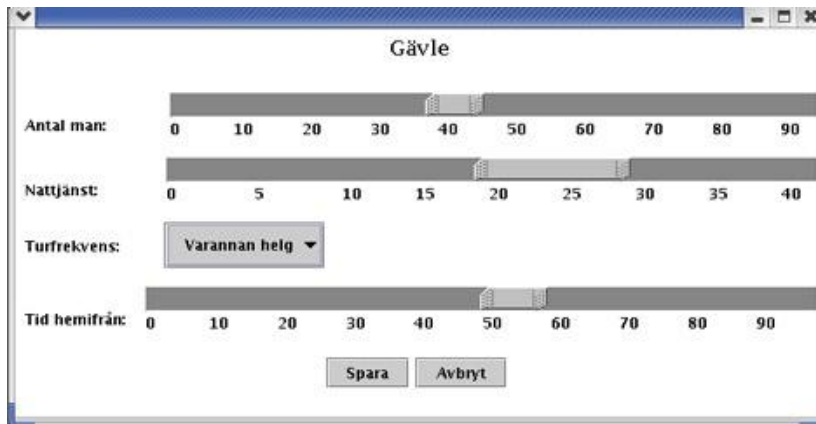


Figure 25. The sliders for changing the thresholds.

The user moves the slider to the wanted threshold values. The slider can both be dragged and made bigger in order to cover a larger scope. This can be done whenever there is a reason to change the values. The user should be able to save different threshold solutions for future needs, which means that the user can have *weekend thresholds*, *summer holiday thresholds* and so on. This was not implemented in the prototype but was discussed. With the query the user is able to set three threshold values:

- *Not OK* and under, is illustrated to the left of the slider
- *OK*, is the actual slider
- *Good* and above, is illustrated to the right of the slider

In this prototype the threshold values were given to us from the planners.

Trips per day are a special case; the most important issue to consider is how often the crew members work on weekends. It was therefore more suitable with a combo box to choose the values; every weekend, every other weekend and so on.

5.2.2 Connection with the plan

When satisfied with viewing the results in the analytic tool, the users double click on the crew base (or marking several) that they want to work further with and automatically ends up in the plan starting with the first row in the plan of the actual crew base, showing all lines where the crew base is involved. This makes it easier for the planners when for example a solution for a crew base is *not OK* and they want to solve the problem in the plan. When returning to the tool there is a button that makes it possible to update the plan. If a number of crew bases are selected they will be shown in different windows in the plan.

5.3 Comparing results

The task of comparing results didn't really occur as we assumed, which lead to some changes in the design. The major change was that the users don't read through all the values in the report after changes have been made. A scenario could be that they are trying to minimize the *number of men* in a certain or couple of crew bases and after some changes have been made they analyze *number of men* of the crew bases in the report to see how it changed.

For the design of the tool this means that they need to see the new results in numbers and compare these with the number generated before the change. The values are divided in separate tabbed panes so the user can only look at one value at a time with the crew bases listed in geographic order (see figure 26). The default value is only the results from the current plan. If the users want to compare with results from earlier plans, they have to download the other plan to do the comparison.

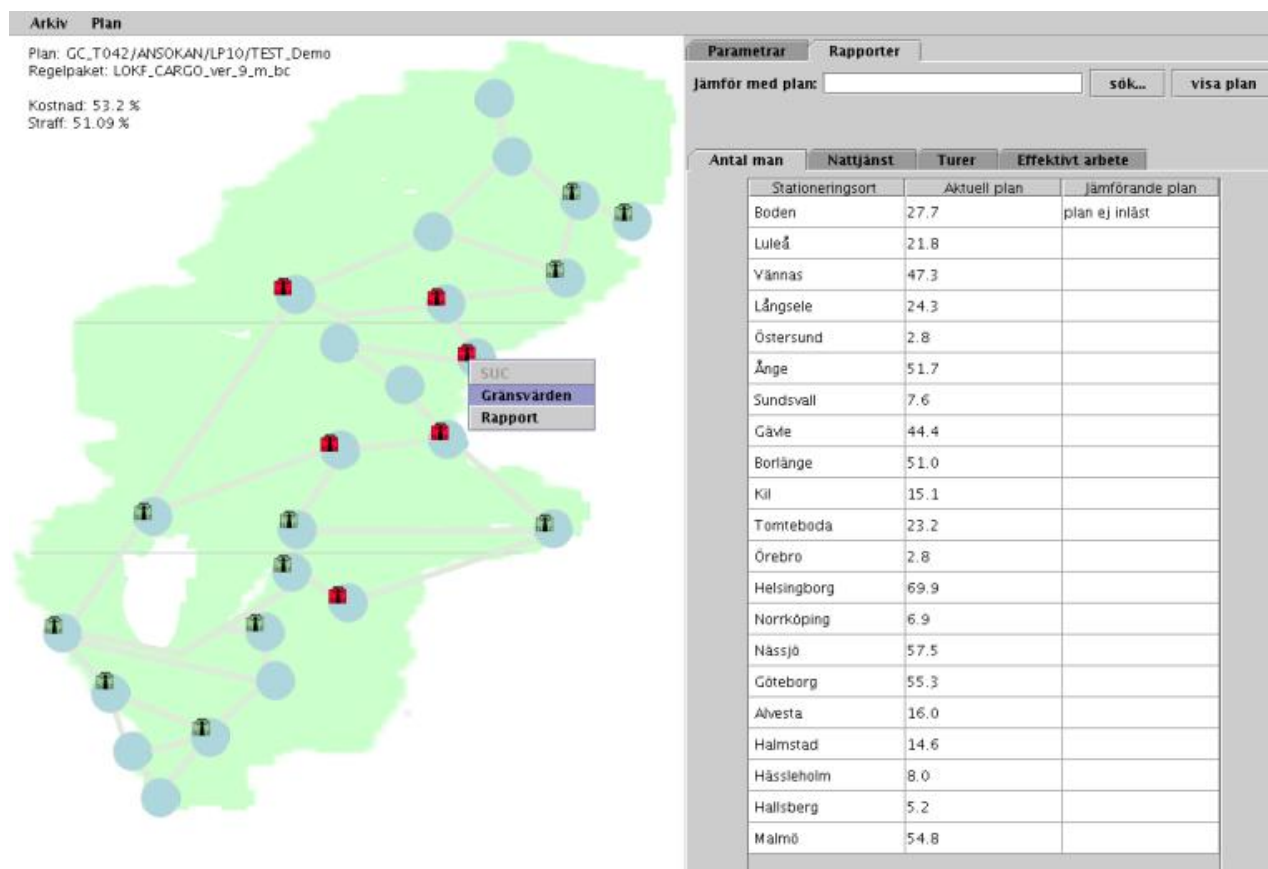


Figure 26. The third prototype, the report tabbed pane is visualized.

6 EVALUATION

Evaluations have been carried out throughout the whole process. In the final evaluation we wanted to know if the requirements that were set up in the analysis and design guidelines were met. This was done both during a co-operative evaluation with the users and by ourselves as designers. We also performed a cognitive walkthrough using the same tasks as the users were given and pretended to be in a real user situation.

The final evaluation took place at the users' workplace in Gävle for a couple of hours. The users involved were the same users that have been involved since the start. This means that they weren't strangers of the tool and much of the graphical user interface and the functions were proposals from themselves. The evaluation started out with a short presentation of the tool and then the tests took place. Since there will be no one-time user we felt that it would give better result if they had seen the tool before the tests started.

6.1 Results of the evaluation

We first present the co-operative evaluation and then how the requirements and heuristics are met from the evaluation methods.

6.1.1 Co-operative evaluation

The technique that was used for the test with the users was co-operative evaluation. This technique was chosen because it focuses on identifying usability problems in the prototype as well as on collaboration between the users and the evaluators. This felt fulfilling since we already had a good relation with the users and wanted their opinions. The users did the test one by one and the other test persons waited outside until it was their time to do the test. The users were given a sheet with a number of tasks (see appendix C) for them to perform and they were asked to talk aloud during the test. The tasks were of the kind that tested features of the tool that they use in their everyday work. The comments were written down by us and later analyzed. Sometimes we asked questions if there was something that was unclear to us or something that needed to be explained. The test took about 30 minutes for each test person. Since the users were very satisfied overall, we tried to see how the requirements were met during the test. There were no major comments or feedback for us to consider, so basically this was just a chance for them to use the tool.

6.1.2 Functional requirements

There were four major functional requirements.

1. The geographic view should present all the crew bases with the results of the values from the plan in an overview with their status. That was solved with the map and the crew bases represented geographically. The users were satisfied with seeing the crew bases geographically instead of a list.
2. The analytical tool should present all the crew bases so that the users can choose to see the values for a closer analysis; *detail on demand*. By choosing *reports* in the view the user

can choose which values to look at. If the users want to see all the values for a certain crew base they basically choose *report* in the right click menu for the crew base. Since the design rely on trust for the users' threshold values and the fact that the user can analyze and base decisions due to knowing if the value is *OK*, *not OK* or *good*; the use for the reports should only occur when comparing results in the later phase of the planning procedure.

3. The geographic view should show all information in an alternative way to numbers. The values are presented with symbols showing the status of the values with colours. The design was based on the knowledge that the users want to see what's *not OK* in a plan, to know where to work further. If the user wants to see the differences between the values that are *OK* and *good*, the user chooses *all values* in the combo box. The values that are *good* in the plan are not shown at all because they don't need to focus on these. If *all values* are chosen it means that the users can draw conclusions that what is not green or red is *good*.
4. Showing the numeric values for the plan and the ability to choose another plan to compare it with solved the comparison problem. The numbers are shown next to each other in geographic order, which makes it easy to find and compare them.

6.1.3 User requirements

The flexibility requirement was that the user should be able to choose whether to look at the geographic view to view the results or to see them as numbers, as before. In the geographic view there is a choice to see the results divided in the attribute categories or per crew base and see the values listed, as in the report, but with relevant values only. The users were satisfied with analyzing the geographic view and using numbers when comparing the results from earlier plans.

The usage of the analytical tool reduced the steps that the users have to perform to open and read the information with more than 85 percent.

After half an hour of testing they were as familiar with the tool as a mature user. Since the tool is very easy to learn according to the evaluation, there will not be any problem to be able to use the tool after a long period of non-usage. This means that even if they don't remember the navigation and so on, they will be able to learn it again within a couple of minutes' usage. In this test we were not able to try this since no any longer breaks occurred.

All users were very satisfied with the results and felt as if it would improve their daily work. The time and effort it took earlier to work with the plan has decreased more than we could hope for. They were happy with both the way they could get an overview of the status of the plan and how easy it became to compare different plans.

6.1.4 Heuristic evaluation

In the heuristic evaluation Ben Shneiderman's Eight Golden Rules (Shneiderman, 1992) were used to evaluate the design. These principles can be used as guidance when designing or as validation to see if the design follows the principles. Us as designers did the evaluation.

1. Strive for consistency

The terminology is consistent throughout the tool and is the same as from the reports.

2. Enable frequent users to use shortcuts

The user can find the menu for the certain crew base either by clicking directly on the crew base at the map or use the main menu and choose which the crew base of interest.

3. Offer informative feedbacks

The users receive feedback when making a choice anywhere in the tool.

4. Design dialog to yield closure.

All dialogs have a beginning, middle and end. When the user takes an action, he/she starts something, works with that until satisfied and then closes the action.

5. Offer simple error handling.

There shouldn't be any way the user can make mistakes or errors. If the users end up at the wrong crew base or choose wrong value, there's always a way to change the value or crew base.

6. Permit easy reversal of actions

Since there are not any actions than can be made in the tool that changes data, there is not really anything that can go wrong. To change the threshold values is the only action that can be made wrong and the user can save the threshold values put in to make sure that they are saved.

7. Support internal focus of control

The tool won't do anything that the users don't ask for. The users choose what information to analyze and at what threshold level.

8. Reduce short-term memory load

The interface is kept simple and not too much information is being displayed. The reports are kept in a single tab for a good overview.

7 DISCUSSION

In this chapter the results from the whole work process will be discussed, as well as the methods used. Each phase of the process will be discussed, the factors that have affected the results, what could have been done differently, what could have been made better and what have been learnt from it.

7.1 Work process

The development process can be done in many different ways; it was chosen to work according to a user centred development process since the user and the user context are important in this design. If a traditional approach had been used, the tool would probably look very different than it does now. Without the input from the users too many assumptions would have been made. Another reason was that a tool like this doesn't exist at Carmen, so to reduce the users' cognitive workload when trying to imagine the tool; it felt best to design prototypes and use them in discussions.

It took quite a while to get an understanding of the planning process and how the users work. But since we had a good relation and communication with the users a lot of phone calls and e-mailing could go on when there were things we didn't understand. From the beginning we tried to learn everything about Carmen's systems as well, but realized soon that it would have taken too much time and effort without being important for our thesis.

7.2 The analysis phase

To perform a user analysis gave a good understanding for the users and their context. The initial contacts with the users were through e-mail and telephone. A lot of information was gathered and handled. The large and most important information gathering took place during visits to the customers at their workplace, both in Stockholm and in Gävle. It seemed that we lost a bit of information when only communicating through phone as well as it is easier to get an understanding of how the users work and use the systems by seeing it ourselves instead of having them telling us about it. At the first visit in Stockholm we sat next to the users and observed them while they worked and also interviewed them. Performing the interviews in their natural context gave the users the ability to illustrate their answers with the help of the system. The observation was also important because a lot of actions were performed without the users' knowledge. The requirements changed a lot during the analysis phase the deeper we got into the problem. The requirements helped us once again to stay focused and understand what had to be accomplished. Since most of Carmen's customers are based in other countries and cultures it would have been excellent to try the design for them as well.

7.3 The design phase

The design phase took a lot of time and effort and the tool grew bigger than our intention was in the beginning. The initial purpose was to do design proposals for visualizing large amounts of information. But in the end a prototype was built with lots of functionality and with a connection to the plan. The first prototypes made were basically for the reason of communicating concepts and ideas within the design group and with our supervisors.

When the design solution became steadier a dynamic prototype was programmed in Java. The first thought was to do an interactive prototype on paper but that was changed when we realized that it would take a lot of time and effort. The interactivity could also be shown better with a dynamic prototype. This would lead to less work later, since an implemented prototype was going to be conducted anyway.

The users took place in the design phase and that felt both satisfying and important. What might have been done differently if done again is that these users were considered the only users, which means that the tool might not be as general as we preferred. Our intention with this thesis was to design a tool for GC, which made it specific for their needs and wants. Our hope is though that other customers of Carmen should see the design as useful as GC does. All that has to change is the map and the values.

The workshop gave us a bigger understanding for the work process and the users' needs and wants. It seemed as when the users were all gathered their came to a common understanding on how a plan is analyzed. It required a lot of planning to make the workshop run so well. A lot of plans were made for drawing and designing but we ended up discussing most of the things. The workshop gave us lots of feedback for the third prototype. An extra day was put away in Gävle for us to gather the material and ask questions for the things that weren't completely understood.

The scenarios made it easier to understand the tasks and to focus on the users and the actual planning problem from the beginning to the end. By writing it, we stepped into areas that we hadn't given any thought in advance and it gave us an understanding of the tasks the users performed. It was an easy way to communicate with the users as well as with each other. In the initial parts of the design process paper prototypes were made.

7.4 The evaluation phase

Evaluation was done both with and without the users throughout the design process. The final evaluation took place at GC in Gävle together with the users. Since the users, the strategic planners and the managers, have been well aware of what we been up to, the final evaluation and presentation didn't give any outstanding news or feedback. Although, they were very happy with being able to test the final prototype by themselves and with real data the usage felt trustworthy. We wanted to know if the requirements that were set up in the analysis were met and so a cognitive walk-through was used to test the sequences of action that could be performed. The Eight golden rules (Shneiderman, 1992) were also analyzed to

how good they were met, both from our own and the users input. That was done because even if the users are satisfied, it doesn't mean that the user interface is user friendly.

The time schedule that was set up in the beginning of the project was followed without any delays.

7.5 The research questions

How to design an analytical tool for strategic railway planning that filters and visualize information from physical reports?

The main answer to this question is first and foremost to do a thoroughly analysis of the users and the tasks they perform. It is essential to know what data is relevant to be able to filter the unnecessary data. It is also important to know in what order the information is needed since it might be that not all information should be visualized at the same time. A number of users need to be analyzed since their usage can differ from each other. The users should also be involved in the design process to make sure that the tool agrees with their wishes.

How to filter the data so the relevant information can be separated and visualized?

To distinguish and group information to facilitate the visualization is important. The users should determine the grouping because they and usually not the designer have the domain knowledge.

How to show the filtered information in an overview?

It is vital to present related information with the same appearance, to facilitate the users' cognitive workload and give the users a chance to get an overview of the information.

How to give the user an idea of the status of the information?

With symbols representing different kinds of information and colours representing its status, it is possible to visualize the necessary information and understand its status with an overview.

7.6 The final prototype and future work

The third and final prototype is the result of two iterations from earlier prototypes. Both the users and Carmen Systems are satisfied with the final prototype but some work is still left to do. For example it is hard to see the exact numbers for the threshold values and to see which result is the better one in the *Report* view of the tool. We also want to design a way for the users to have different templates for special periods of time, such as holidays and so on.

7.6.1 The geographic view

The use of colour and symbols in other cultures than Swedish/Western were not taken into consideration in this thesis. Since there are many values that will be shown together at the same time, we needed a way to separate them from each other as well as they needed to be representative for the value. Some of them might feel a bit childish but we are of the opinion

that it is more important to understand what the symbols represent, than to have diagrams that the users have to give meaning to. The symbols representing the values were designed together with the users as we felt that the users must feel satisfied and totally understand the meaning of the symbols. Some of them were later changed due to their inconvenience as symbols and some values were put together into one symbol. The symbols keep all the information since no text is added in the geographic view. If numbers or text had been used, the whole purpose with making quick conclusions due to an overview would have been lost.

7.7 Adaptability to other areas

The interest for this thesis has been overwhelming both from Carmen and GC's side. GC even wants to use the analytic tool in real production.

The analytical tool is a good start since Carmen is getting more customers from the railway market and the solution with the static reports isn't as pleasing as it should be. DB is currently complaining over the long time spent waiting while printing reports, due to large amount of both necessary and unnecessary information. All information isn't even needed for making decisions and conclusions of the plan. Also other reports used in the system could be visualized in the same way. With the use of the map it is possible to visualize the traffic flow, which was a wish from the users, and to visualize resources that the crew bases keep. The tool could also be adapted and used for the flight industry with some changes in the geographic view.

We hope and forecast that this tool will be used for other customer of Carmen's.

8 CONCLUSIONS

The main question for this master thesis has been:

How to design an analytical tool for strategic railway planning that filters and visualize information from physical reports?

And to be able to answer this question we first needed to answer these questions:

- How to filter the data so the relevant information can be separated and visualized?
- How to show the filtered information in an overview?
- How to give the user an idea of the status of the information?

The answer from these questions was used as a base for developing design proposals for an analytical tool. A thoroughly analysis is important to know exactly what tasks the users perform and in what order. From analyzing the users and their work tasks we realized that the usage of the reports took too much time and effort. Our main goal was therefore to design a prototype that should decrease the time for analyzing and facilitate the act of drawing conclusions from the reports *Costs and Penalties* and *Base Constraint*.

The design proposal became later a dynamic prototype and was evaluated with users and these results led to further development of the prototype.

Working with iterations and a user centred design approach during the development process gave us the opportunity to design an analytical tool that fulfilled the users' needs, wishes and requirements. The output from each iteration gave us useful feedback e.g. about the users' work process which had a great impact on the next iteration.

A design with a geographic view made it possible for the planners to quickly draw conclusions from the overview. It decreased the time for opening and reading the report with 85 %. It also made it easier to see problem areas and to give a better mental model over the result for the users.

Showing the result of two different plans next to each other facilitates the comparison. The comparison is made for each value and is ordered geographically which agrees with the geographic view.

Filtering information was crucial for our design. When dealing with large amount of information it is important to choose only the relevant information to work with, otherwise it is impossible to make a good overview. This was done by careful analysis and a close collaboration with the users. It wasn't necessary for the planners to see all information at the same time since they work with problems to enhance the solutions, i.e. with values that are not good enough. The good values don't need any additional work, there are already satisfying.

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10 APPENDIX

This chapter contains interview questions and evaluation tasks in Swedish.

Appendix A

Intervju på Green Cargo – Stockholm

Användare

1. Vilken databakgrund har en planerare? Attityd till teknik?
2. Vilken domänkunskap har en planerare?
3. Vilka krav ställs på planerare?
4. Ålder på planerare?
5. Är planerarna begränsade på något sätt, tex av handikapp, kulturellt, språkligt?
6. Vilken arbetsmiljö har en planerare? - ljudförhållanden, störningsmoment mm
7. Är det tidspress och stress under en planering?
8. Är planerarna motiverade att göra förändringar?
9. Hur lång tid tar det för en ny planerare att lära sig arbetuppgifterna?
10. Hur ofta kommer det nya användare?
11. Utför planeraren någon annan uppgift samtidigt/innan eller efteråt?
12. Hur ofta används systemet?
13. Hur långa tidsperioder används systemet åt gången?

Planering

1. Hur går en turplanering till?
2. Vad vill en turplanerare se?
3. Vilka egenskaper är viktigast för spår, stationer och tåg att kunna se?
4. Hur matas indata in?
5. Hur ser man att informationen är sparad?
6. Hur modifieras indata
7. Hur ofta modifieras stationers, spårens och tågens egenskaper?
8. Överenskommelse som har bestämts (ej egentligt lagliga) får de bokföras i systemet?

System

1. Hur används pairing idag?
2. Vad är bra med ÅngPS?s
3. Vad är dåligt med ÅngPS?
4. Svagheter med Carmens system?
5. Styrkan med Carmens system?
6. Andra verktyg för planering?
7. Vad användes tidigare?

Appendix B

Green Cargo- Intervju med Strategiska Planerare

Allmänna

1. Vad är er huvudsakliga uppgift?
2. Vilken information tittar ni på? Rapporter?
3. Vilken information används mest frekvent?
4. Hur hittar du information i rapporterna när de är 150 sidor långa? Skrivs ut?
5. Innan Carmen, hur löste ni rapporterna då?
6. Hur ofta tittar du på exempelvis rapporten "Kostnader och straff"?
7. Varför så sällan/så ofta?
8. Hur långa tidsperioder sitter ni med rapporterna?
9. Vad är viktigt i den rapporten och hur nyttjas informationen? Nämn den viktigaste informationen.
10. Vad är irrelevant eller används sällan?
11. I vilken situation används rapporterna "Kostnader och straff"?
12. Tittar ni på andra rapporter tillsammans med/jämförelse med "Kostnader och Straff". Vilka?
13. Är det för att något saknas i "Kostnader och Straff" rapporten?
14. Hur gör ni för att ta fram rapporten?
15. Är det mycket tidspress/stress vid planeringen?
16. Vilket anser du är det största problemet med rapporterna?
17. Att visa på flöden i trafiken. Är det intressant att se flöden?
18. I vilken situation är det intressant att se flöden?
19. Hur skulle ni vilja se det?
20. Hur ser ni stationeringsorterna framför er. Karta? Ortsnamn? Sträckor?
21. Ser ni flöden i trafiken i dag? Hur?
22. Om flöden visades grafiskt, vad skulle vara intressant att göra med den?

Användare

1. Hur många strategiska planerare finns?
2. Var finns dessa personer placerade?
3. Har ni olika användarroller?
4. Vilken databakgrund har användaren?
5. Vilken domänkunskap har användaren? Skiljer det sig mellan användare?
6. Hur ofta kommer det nya användare?
7. Vilka krav ställs på en ny användare?
8. Hur lång tid tar det för en ny användare att lära sig arbetsuppgifterna?
9. Genomsnittsålder på användare?
10. Hur sitter ni? (Ljutförhållanden, störningsmoment mm) Sitter ni mycket i telefon?
11. Är användaren motiverade att göra förändringar?
12. Vilka andra arbetsuppgifter har ni?
13. Vilka problem anser ni behöver lösas?

Appendix C

Green Cargo - Uppgifter för utvärdering

Uppgifter

1. Luleå och Boden visar ej godkänt resultat på antal man. Gör några enkla ändringar i planen för att försöka lösa detta.
2. Gå tillbaka till den geografiska vyn och se vad resultatet blev.
3. Gränsvärdet för antal man i LE är lite väl högt, ändra till 10-20. Förändring?
4. Titta på alla resultat för BDN.
5. Vad ligger procenttalet på effektivt arbete i HM?

Frågor

Hur känns det att använda systemet?

Underlättar det överblick över resultat av plan?

På vilket sätt?

Litar du på satta gränsvärden?

Känns det OK/Lätt att ändra gränsvärden?

Hur uppfattar du att överblicken på planens kvalitet har förändrats?

Går det fortare att läsa resultatet i den grafiska vyn än i rapporterna?

Är det något som saknas?

Kommentarer och frågor?

