Design and Evaluation of a Visualizing Tool for Logistics Analysis

Linda Klamer

Tutor at Linköping University: Magnus Bång
Tutors at Systecon: Christian Wigge and Maria Bånkestad
Examiner: Rita Kovordanyi
Upphovsrätt


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Abstract

Communicating complex relationships discovered with logistics analysis is a challenge within Life Cycle Management. The aim of this thesis is to propose a design for a visualization tool that simplifies such communication for improved expert-manager collaboration. Semi-structured interviews were conducted with expert users - the prospective primary user group of the tool - in order to gain knowledge about the requirements. Based on this, a HiFi prototype was developed using Axure and its usability was evaluated using scenario-based approach and SUS questionnaire. The results revealed that the experts found current methods both time consuming and challenging. A tool with the purpose of displaying results from logistics analysis – for both experts and managers - should offer flexibility, both in terms of functionality and appearance. In addition, it is essential to reduce the complexity to increase the understanding of novices. Future work should include customers in the design process.

Keywords: Visualization, usability, qualitative methods, complexity
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1 Introduction
To visualize a complex relationship that is comprehensible by both novice and expert users is difficult. Simultaneously, complex information must be conveyed from experts to novices in a comprehensive way while ensuring that the essential parts are not lost in the process. This difficulty is experienced by the employees at Systecon who are the primary users and developers of the Opus Suite Software. Systecon is a company that works across the entire product life cycle and has over 40 years of experience. Systecon helps their customers to find the optimal balance between their requirements on performance and availability as well as the resources to achieve this. To get an overview of what factors that affect the output and cost can easily be obtained by using the Opus Suite software. (Systecon AB, 2013)

In the current programs, the ability to transfer result in an easy and understandable way is low. Several workers have therefore created their own solution and procedure with the help of third-party programs. This difficulty has given rise to this study, which aims to find out if there is a need of a new program specifically produced for simplifying the process of presenting and transferring information to Opus Suite users.

1.1 Purpose
The purpose of this study is to investigate Opus Suite and find out if there is a need of a new program with the aim of showing results from Opus Suite analyses and if so, what requirements there are on such a program. An interactive prototype with the aim of displaying results from optimization analysis will be developed and evaluated by experts.

1.2 Research Questions
The following research questions will be investigated in this study:
1. What are the requirements of a user interface with the purpose of showing optimizing results to novices?
2. How can the result be visualized so that it is understandable by everyone included in the work process?
3. How can the user interface be developed so that it has high usability for both experts and novices?
1.3 Delimitations

Due to limited resources, a working technical interface will not be developed. The focus will be put on identifying the requirements and needs of a potential program for showing result from Opus Suite analysis. As this study is a first step in investigating if there is a need of a simpler way of visualizing result, merely expert users will participate as they are the primary users of the product.
2 Background

The following section addresses theories and central terms that are essential for making this thesis understandable for the reader. Images and a description of the domain structure are also presented.

2.1 Domain Background

The Opus Suite Software is developed and provided by Systecon and it offers control over all phases and aspects during the life cycle of a technical system. Opus Suite consists of three integrated products: OPUS10, SIMLOX and CATLOC that together make it possible to predict and evaluate the performance and costs of a technical system. It is advantageous to use all products jointly as they provide different services but it is not required since they work independently. The suite is a highly interactive system that contains many different parameters which the user can toggle as desired. OPUS10 is mainly used for cost-effective spare parts optimization with realistic modeling of technology and support solutions that can reduce the spare parts investment by at least 30% while increasing system availability (Figure 1). SIMLOX is a tool for scenario simulation that enables analysis of expected performance over time given a certain support solution and operational scenario (Figure 2). CATLOC is a tool for cost analysis which provides knowledge and complete control over costs and revenue (Figure 3). (Systecon AB, 2013) The result view for the suite contains, in general, diagrams and tables. Mutual for all products is that the result view in respective program has high interactive functionality. It is, for example, possible to zoom in at one pile and change what parameters that should be visible. However, to present or forward these results to another Opus Suite user or a customer the expert must either use a static report or manually transfer chosen information to an Excel document and/or PowerPoint.
Figure 1: A screenshot from the result view in OPUS10 that displays the Cost/Efficiency curve which is a key step in OPUS10 optimization. It shows a series of solution points that displays maximum achievable system efficiency at different budgets. The table is interactive where the user easily can select which solution points to study.

Figure 2: A screenshot from the result view in SIMLOX. The view offers several different graphs and perspectives that enables the user to observe results from the entire organization or look more closely at certain locations, systems or resources.
Figure 3: A screenshot of the result view in CATLOC. This is the most flexible tool that lets the user observe cost distributed over components, time, resources, departments or actions by using drag and drop.

2.2 Visualization

Visualization is according to Williams, Sochats & Morse (1995) a cognitive process that is performed by humans in creating a mental image of a domain space such as images and graphics. Computer-generated graphics of complex data is according to Sharp, Rogers, & Preecee (2011) called information visualization and is usually interactive or dynamic. The benefit of using interactive visualization is to gain knowledge about dynamically changing domain data or information in comparison with attaining it from text-based information (Sharp et al., 2011). The aim with interactive visualization is, according to Ware (2013), to help the user to perform cognitive tasks more effectively by optimizing applications. By using visualizations one can solve problems faster and better as well as shorten the learning time. However, to obtain good visualization, Ware believes that the user should be able to drill down and find more information about anything that seems interesting. It should also be possible to hide information if needed, and a computer system should accept user commands to support the thinking process.

Moreover, Tufte (1986) argues that in order to create a good visualization the designer has to use layering. Hence, the secondary elements in a picture must be toned down so that visual clutter is reduced, the primary elements of the figure are clarified, and undesirable visual interactions are eliminated. By replacing coded labels in a figure with
direct ones, one can reduce discontinuity in the exposition. In addition, by using the smallest possible effective distinctions one can produce emphasis. To reduce visual clutter one can remove parts of a figure that do not add to its content. (Tuft, 1986) Further, Benyon (2010) and Johnson (2014) emphasize the importance of designing for memory, thus, it is much easier to recognize something than to recall it. For example, novice users tend to, according to Benyon (2010), prefer menus with the reason that they can scroll through it until they find the appropriate alternative while experts instead might think it takes too much time and often prefers a keyboard shortcut. Johnson (2014) believes that using pictures or icons where it is possible to convey a function also stimulates the recall process of associated information. Additionally, Johnson emphasizes how making the system familiar to the intended user will decrease the users’ workload.

2.3 Distributed Cognition

Distributed cognition is according to Rogers (1997) an approach to study all aspects on cognition from a cognitive, social and organizational perspective. Cognitive systems are studied by distributed cognition and contain individuals and/or various artefacts (Rogers & Ellis, 1994). An example of this would be an individual’s interaction with various artefacts or a group of persons that interact with each other and several artefacts (Rogers, 1997). The aim is, however, to explain how the dynamic structures - the individuals and the artefacts - coordinate and interact with each other (Rogers & Ellis, 1994). Furthermore, Roger and Ellis (1994) describe cognitive activities as activities between individuals and artefacts as well as internal and external representations in terms of representational media such as manuals and displays. The internal representation is individual memories and the external representations are both paper-based and computer displays. This, in turn, refers to how information and knowledge resources are converted during work activities. For instance, when a computer system is being designed it should be considered how a new system might fit into or disrupt current working practices. At first, the problems and effectiveness of how the group works with the current system are identified. (Rogers & Ellis, 1994)

In addition, Norman (1998) emphasizes the importance of considering people’s mental models when developing and designing software systems. Mental models are often referred to as a set of beliefs about how a system works. Hence, a user tries to understand a system with his own mental model of the system and its interaction and not the designer’s mental model. Furthermore, Norman (1988) suggests that a system reaches good usability
when the designers and the user’s mental model of the system correspond and this, in turn, can be achieved by creating a system that is based on the intended user’s mental model.

2.4 Usability
Usability is by ISO 9241 (2010) defined as “The extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use”. In addition, Benyon (2010) believes that for a system to achieve a high degree of usability it has to contain appropriate functions and information content that is organized in a suitable way from the user’s perspective. Hence, people will be able to do things in the system with the appropriate amount of effort as well as it should be easy to learn how to do things and remember how to do them after a while. A common issue for usability is that technology often comes between people and the activities they want to perform. In addition, Benyon (2010) emphasizes the difference between novice and expert users, arguing that a novice user needs to be guided through an interaction while an expert is an experienced user and has learned all sorts of details.

Furthermore, Sharp, Rogers and Preece (2011) state that usability can be broken down into six goals: effectiveness, efficiency, safety, utility, learnability and memorability which corresponds with the ISO 9241 (2010) definition. The usability goals are in turn normally operationalized as questions with the purpose to alert the interaction designer early in the design process to potential problems and conflicts.

The first goal effectiveness is a general goal that refers to how good a product is at doing what it is supposed to do. Efficiency refers to how efficient the product is to use and how it supports the users in performing their tasks. Safety includes protecting the user from undesirable situations such as performing an unwanted action by mistake. It also includes a user’s fear of the consequences of making errors and in what way it affects their behavior. Utility refers to the products’ functionality and to what extent it lets the user do what he wants. How easy a system is to learn to use is what learnability refers to. People, in general, do not like to spend a lot of time learning how to use a system. The last goal memorability refers to how easy a product is to use when it has been learned once. This is particularly important for an interactive system where all functions are not being used continuously. Hence, the user should remember or at least easily be reminded how to perform the task without having to relearn it. (Sharp et al., 2011)
3 Method

The following chapter is divided into two parts. The first part describes the methods that were used in this study and the second part defines the method theory which is the basis of the first part.

3.1 Method Design

Below follows an overview of the methods used in this paper in order to gain an understanding of the requirements of both the current programs in Opus Suite and the future product, as illustrated in Figure 4. The choice of methods will be further discussed in section 3.2.

In a first step, the primary investigator received a brief introduction to Opus Suite by the supervisors at the company as well as from three separate unstructured interviews with the Head of Business Area Defense, the Director of Business Development and the Head of Product Development. In a second step, the interview questions were developed and semi-structured interviews were conducted according to Goodwin (2009) and Sharp et al. (2011) as described in Section 3.2.1.

In a third step, the analysis consisted of a basic version of an affinity diagram which formed the basis for the paper sketches. These, in turn, were discussed at a workshop held together with the supervisors at the company. The best suggestions were thereafter established in a Hi-Fi prototype as described in Section 3.2.2. As a final step, the prototype was evaluated with expert users.

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**Figure 4: A description of the workflow**

- **Prestudy**
  - Brief introduction to the Opus Suite Software
  - Three unstructured interviews
  - Intensive course in SIMLOX

- **Interview**
  - Semi structured interviews
  - Affinity diagram

- **Design**
  - Paper sketches
  - Work shop with the supervisors at the company
  - Prototype

- **Evaluation**
  - Think-aloud test
  - SUS survey
3.1.1 Equipment

“GoToMeeting” is a tool for online meetings and was used to conduct interviews with experts that were located outside Stockholm. The interviews were recorded directly in the GoToMeeting software or by the recording feature on an iPhone 7. The prototyping tool Axure was used to create and evaluate the HiFi prototype.

3.1.2 Participants

A total of 19 participants took part in the study. Eleven participants were involved in the interviews and eleven participants were involved in the evaluation process. Three participants took part in both processes. The participants were recruited internally at Systecon and did not receive any compensation for participating.

3.1.3 Interview

A total of eleven interviews were conducted. Four of the interviews took place at Systecon in Stockholm and seven interviews were conducted via “GoToMeeting”. All the interviewees were considered as Opus Suite experts with an average of twelve years of experience. The longest experience of a participant was 26 years and the shortest experience of a participant was two years. Before the interview began the interviewer introduced the reason for the interview, the structure of it and the expected result of the study. The interviewee was informed about confidentiality and was asked to give a verbal consent. The session was audio recorded for further analysis. The interview started with some basic questions about the interviewee to find out relevant background such as title and years of experience within Opus Suite. After that, open-ended questions were asked about the current programs and the potential future program. The questions can be found in Appendix A.

3.1.4 Design Process

After the interviews, the most common thoughts about the current program and the experts’ current approach to present results as well as opinions about a new potential program were compiled. Three divergent design suggestions were sketched and presented to the tutors, the Director of Business Development and the Head of Product Development at Systecon. Considering the complexity of the Opus Suite software, a workshop was held with the tutors with the purpose of deciding what design suggestions and functionality that is
possible to apply. Thereafter a new convergent design suggestion was sketched with the best suggestions from previous sketches and produced in the prototype tool “Axure”.

3.1.5 Evaluation

The evaluation process of the prototype began with a pilot test in which one expert would try out the instructions and the prototype. Some minor changes in the structure, as well as a function in the prototype that were working incorrectly, were fixed. The evaluation took place at Systecon in Stockholm, using a Think-Aloud test and an SUS-survey. Ten experts took part of the evaluation.

To begin with, the participant received a brief introduction to the idea of the program by the primary investigator as well as instructions to the structure of the evaluation. Thereafter, the participant was given a paper with some introductory information about the case, see Appendix C. Before the participant received instructions to the first task, questions were asked about their first impression and if they can describe what they see and what kind of functionality there is. The instructions to the tasks were given written on a paper to make sure it was presented equally to each participant, see Appendix D. After the assignments were accomplished, the participant began with completing the SUS-survey and then he got the opportunity to express his thoughts and opinions.

The results from the think-aloud tests and SUS-survey were compiled and suggestions of improvements were ranked after how critical the changes were considered to be.

3.2 Method Theory

3.2.1 Interview

Sharp et al. (2011) states that structured interviews are much alike to a questionnaire where the interviewer asks the same questions to each participant, with the questions being short and well formulated. An unstructured interview is in contrast to a structured interview more like a conversation around a specific topic and they often go into significant depth. In addition, a semi-structured interview combines features from both structured and unstructured interviews. A basic script with pre-planned questions is used by the interviewer so that the same topics are covered with each interviewee. The interviewer asks a question and then probes the interviewee until no new information is coming. (Sharp et al., 2011) Moreover, Goodwin (2009) emphasizes the importance of conducting the
individual interviews while the interviewee has access to the product or is located in the context where it normally is being used. It is often preferable to watch people in action since people tend to generalize their own behavior when self-reporting. Also, it prompts one’s memory to have artefacts. In addition, the interviewer should avoid asking leading questions where the preferred answer is implied. That can be avoided by using open-ended questions to the greatest extent possible and if it is essential to ask some leading questions it can be done at the end of the interview. (Goodwin, 2009)

### 3.2.2 Prototyping

A prototype is according to Arvola (2014) an early draft of how a future product can look like. Without a prototype, it can be hard to specify what requirements the future product will have. In addition, Arvola (2014) states that it is hard to anticipate how certain design choices will affect the user experience.

Furthermore, Arvola (2014) states that a prototype can be either vertical or horizontal. In vertical prototypes, the functionality is implemented as intended but only for a few functions. As a result, it is only possible to test the usability of the design concept. In horizontal prototypes, the functionality is not implemented in detail which results in that they can be used for demonstration but not for user testing. A T-prototype is the combination of vertical and horizontal prototypes. On the surface, a T-prototype appears to be functioning and completed as the horizontal prototype but it has the vertical depth of a few functions. (Arvola, 2014)

According to Benyon (2010), there are two main types of prototyping: low-fidelity (lo-fi) and high-fidelity (hi-fi). Lo-fi prototypes are often paper prototypes with low level of detail while hi-fi prototypes are interactive computer based prototypes with a high level of detail (Arvola, 2014; Benyon, 2010). Subsequently, when a design idea is implemented as a hi-fi prototype, it can evolve and its functionality can be added gradually (Arvola, 2014).

### 3.2.3 Think-Aloud Protocol

A method for usability testing of for instance software and websites is the Concurrent Think-Aloud (CTA) protocol (Ericsson & Simon, 1985). The essence of the method is that the intended users are asked to conduct a specific task with the artefact that is being tested while at the same time verbalizing their thoughts and actions (van den Haak, De Jong, & Jan Schellens, 2003). Sharp et al. (2011) believe that the method is a useful complement to
observing in the sense that the researcher gets a better understanding of what is going on in a person’s head. In addition, Ericsson and Simon (1985) believes that there are two types of verbal reports that should be considered, CTA and Retrospective Think-Aloud (RTA). In contrast to CTA the participant performs the task in silence, often while being video recorded, and afterward verbalizes his thoughts, often while watching the screen recording.

3.2.4 Standardized Questionnaires
Sauro & Lewis (2016) states that to obtain participants’ satisfaction with the perceived usability of systems, standardized questionnaires is a form that can be used directly after usability testing. The elements in a questionnaire are normally multiple choice questions or points on a rating scale. The advantages of using standardized questionnaires are that they increase objectivity, replicability, quantification, economy, communication and scientific generalization.

3.2.5 System Usability Scale
The System Usability Scale (SUS) is a standardized questionnaire that according to John Brooke (1986) is a simple usability scale with the purpose of giving usability a subjective assessment. SUS is a Likert scale consisting of ten statements that are rated from strongly disagree to strongly agree, see Appendix. Each statement is answered by selecting a number from one to five. Every other statement is positive or negative (Sauro & Lewis, 2016).

Bangor, Kortum, and Miller (2008) believe that the result from a SUS evaluation is easy to understand for people from most disciplines for the reason that the result gives a value between 0-100. A product with a result that is 85 or above can be considered as an excellent product. A score that is above 70 is a good product while a result below 70 indicates that the product has usability issues and should be reviewed. (Bangor, Kortum, & Miller, 2008b)

3.2.6 Task success
Task success is according to Tullis & Albert (2013) the most common usability metric and can be calculated for any study that includes a task. Usability metric or user experience metric aims to measure aspects of the interaction between the user and product (Tullis & Albert, 2013). Task success is normally collected as a binary measure where a completed
task is coded as 1 and failed task is coded as 0 (Sauro & Lewis, 2016). It measures effectiveness, i.e. if a user can complete a given set of tasks (Tullis & Albert, 2013).
4 Results

The result section is presented in two parts. The first part shows the prototype and the second part presents the result from the usability evaluation.

4.1 Prototype

4.1.1 Design Method and Rationale

Since the purpose of the program is to present results and increase the cooperation between all users in the work process, great emphasis was put on how the design can be implemented to include all parts. This, in turn, resulted in four separated but integrated states of the program with the purpose of displaying information with different kinds of functionality. The first state Data Manager is the most complex view and is intended for the expert user where the result from the Opus Suite analysis is imported and desired data is chosen to be transferred to the next state Editor. The state Editor is planned to be the analyst’s design tool where layout can be chosen as well as graphs and functionality. This, in turn, can either be transferred to the state Presenter or Viewer; in both states, the data is set which entails that it is not possible for a user to manipulate the data in any way. The state Viewer is intended to include novice users where they are offered guidance throughout the program and have the opportunity to navigate by themselves. The fourth state Presenter aims to work as a tool for presentations while keeping the level of interaction selected in the Editor state. This study will present a design suggestion for the Editor state.

Furthermore, design choices and functionality were carefully considered in cooperation with the tutors at the company given the importance, as described in Section 2.2, to stay within the intended users’ mental model. The color scheme was chosen to correspond with the company’s visual guidelines. To reduce visual clutter, it is possible to hide the menu and the user can then reveal the menu to insert desired graphs and tools. As described in Section 2.3, icons have been used at those places where they can convey a function.

4.1.2 Opus Suite Visualizer

Figure 5 illustrates the first view of the Editor state. The menu is precipitated to give the user an initial overview over the different choices that can be done. The menu can be hidden by clicking on the arrow located in the menu’s top left corner. The first title “Selector” that can be found on the top of the menu displays the different selectors that can be used. In this
context, a selector can be used to manage the graphs that are visualized. In this prototype, Opus Selector is the only selector that is functioning because it is very fundamental for the Opus Suite Software. The second title “Graphs” presents the various graphs that are available and are in this prototype divided according to the program where the analysis has been done. The third title “Filters” displays what general filters that are accessible and these can be used for all graphs. The last title “Insert” is intended to demonstrate what kind of functionality that will be available in the tool. These are, however, not active in the prototype.

Further, the user can work on several spreadsheets by opening multiple tabs, and the name of the tab can be changed. The user icon in the top right corner shows what state the user is in and makes it possible to change state by using the submenu that appears when the user clicks on it. The arrow next to the user icon is the share button which enables the user to share states with other users. The menu Properties located in the top right corner is a drop-down menu with interface related options such as font size and background color and is folded by default.
Figure 5: The initial view of the state Editor
Figure 6 illustrates the default appearance of each graph. The graph called *Opus Selector* works as a selector for all chosen graphs and the orange circled points are in this prototype possible to select. By using the selector, the user can decide what information that he wants to be viewed. For example, when the user chooses a point in the Opus curve, information for this particular point is revealed in all graphs, as seen in Figure 7. A selected point is, as seen in Figure 7, filled with red color. Connected to the Opus Selector is a clear button which resets all graphs to default settings and a tab menu for the two failure rates. *Failure rate 1* is the blue curve and *Failure rate 2* is the green curve.
Figure 8 demonstrates when *Failure rate 1* is selected. Consequently, it is marked with a blue color and the green curve (Failure Rate 2) is therefore not visible. In addition, the graphs *Cost* and *Completed Traffic Hours* show only result from all points in the Opus curve for *Failure rate 1* and not for both curves as seen in Figure 6 when no selection have been made. Since no point is selected in the curve no point specific data is revealed.

![Figure 8: Example of when Failure rate 1 is selected](image)

In Figure 9, a point on the Opus curve is selected, the point is therefore marked red and point specific data is presented in all graphs. By using the menu connected to the graph *System State*, the user can, as seen in Figure 9, change the time perspective.
Figure 9: Shows the menu connected to the graph System State unfolded

Figure 10 illustrates when two points on the Opus curve are selected and it gives the user the ability to compare respective result. In addition, the unit filter is now visible and placed in the middle of Figure 9. The unit filter is a tab menu that works as an additional optional filter which enables the user to filter the appearance of each graph to display result from all units by selecting the check box called All units or the selected unit, as in this case the unit Uptown.

Figure 10: Shows when two points and the unit Uptown is selected
4.2 Evaluation

4.2.1 Observations from Usability Tests
To begin with, most users expressed an uncertainty about the title “Opus Selector” that is located in the menu, since it is from before an unknown term. All users did however successively understand the meaning of it, when seeing the graph and when given the chance to try out its functionality. A few users had some initial issues with understanding the connection and difference between the filter for failure rate and the points on the Opus curve, for example, that they had to choose a point to view its information in all graphs. Once the connection was established they liked the idea.

Several users had issues with task four and mainly how to apply the operational profile as a layer on top of the system state graph. The ones that struggled did not see the checkbox located beneath the time/total menu and wanted to drag the cost effectiveness graph and somehow drop it on top of the system state graph.

Most users found it difficult to understand how to select to view only one unit. Some users thought it was by using the item stock graph and a few users needed guidance to find the filter. Once they found the filter it was obvious how to use it.

Most users wanted to click on an option in the menu to use it.

Further, comments from the users before and after the usability test can be found in Appendix.

4.2.2 Usability Metrics
The result from the SUS-survey gave an average of 81.25 with a standard deviation of 9.207 (Figure 11). The distribution of the task success result is displayed in Figure 12.
Figure 11: Shows the SUS-score from the expert users.

Figure 12: Shows the percentage distribution per task. The distribution for when the user directly completed the task was at lowest 40% and highest 100%. A maximum of 50% of the users completed the task after some clicking while 20% of the users at most needed help to complete the tasks.
5 Discussion
The following section includes a discussion that reflects the chosen method of the study and the result.

5.1 Results
The purpose of this study was to find out if there is a need to simplify the process to present result from optimizing analysis and how this, in turn, can be visualized to be understandable by both experts and novices. The requirements gathering revealed that the demand exists and the workers at Systecon put a lot of effort in preparing presentations to make it understandable for their customer. For example, the technical knowledge, as well as the interest in details, can vary among the customers. This, in turn, entails that the workers must prepare for various scenarios which require backup pictures in case the customer happens to be interested in more technical details than expected. The requirements gathering also revealed that the workers request more flexibility, in that sense that it should be possible to alternate the terminology, interface and what kind of information that is being presented.

Furthermore, as mentioned in Section 4.1.1 the prototype consists of four states with the purpose of adapting its complexity, as well as functionality depending on the user’s level of comprehension. This, in turn, enables the experts to include a customer in the work process in an easier way and adapt the level of complexity to the user’s knowledge level. In addition, a great benefit is that the customer can access and interpret the information in the state Viewer by themselves. Since the data is set, hence cannot be manipulated, the expert can relax and does not have to worry that the customer by accident manipulates the data in some way. It is also the expert’s choice to decide what information that should be visible in order to reduce visual clutter as Tufte (1986) emphasizes the importance of. Another advantage is that it enables a way for the experts to present in a more dynamic way. For example, in the prototype, one can by using the Opus Selector control all graphs and what information that is visible. In addition, since the primary users of the program are the experts, the functionality and appearance of the Opus Suite Software were carefully considered in order to stay within their mental model (Norman, 1998; Sharp et al., 2011). Since only one state was evaluated with one type users, experts, the advantages of all four states is mainly speculations that origin from the requirements gathering as well as Section 2.
The evaluation of the prototype gave a SUS mean of 81.25 (SD = 9.207), which shows usability above the Bangor et al. (2008) score for good usability (at 70, as presented in Section 3.2.4). The think-aloud test showed a various result for the understanding of the navigation of the prototype. All users did, however, like the concept of the prototype and the fact that it is was much more modern than the current programs which might have affected the high result. In addition, it implies that the program has a good chance of achieving the six usability goals stated in section 2.4. Effectiveness is represented by task completion and the qualitative result, the users could perform expected tasks. The qualitative result display that the prototype reach good efficiency and safety. The users thought that it was easy to navigate in the prototype and were not afraid to make mistakes. Utility could not be measured in the prototype due to the limitations of the prototype tool. All participants thought that the prototype was easy to learn and did not believe they needed much assistance to use it which indicates that the system has high learnability. Memorability is difficult to measure since the prototype only is tested once by each participant but considering the high learnability rate one can assume that it is easy to use once it is learned.

What needs to be improved in further development of the program is how the filters are displayed. The current solution does not present which filter that is general or connected to a specific graph in an understandable way. One solution might be to keep all general filters beneath the header so that it is always visual to the user. Graph-specific menus that can be accessed by either a secondary click or a symbol on the graph is a solution that would make the distribution clearer. In addition, as Benyon (2010) emphasizes, the user should be able to use keyboard shortcuts.

5.2 Method
The case study involved interviews with expert users to gather requirements, learn about the current work procedure to present results as well as find out if there is a need for a new tool. It was in total eleven expert users that were interviewed which in turn might question the study’s reliability since it is a small sample. It is however only a limited group of people that qualifies and the researcher put the focus on collecting a heterogeneous sample with internal workers, representatives in other countries and external users of the Opus Suite software.

In addition, the interviewees did not have access to their computer during the interviews as they were mainly performed at distance, hence they did not have the
opportunity to illustrate said process which is something Goodwin (2009) strongly recommends. The reliability of this study is maintained by attaching the interview script and describing the methods that were used which in turn make it possible for others to verify and redo the study.

To evaluate the prototype, CTA and SUS-survey was used. One might argue that by using CTA, the participant is likely to perform better than usual due to the fact of a more structured working process (van den Haak et al., 2003). Although, considering the increased workload, they might perform worse. RTA, on the other hand, lets the participant perform the tasks at his own pace and in retrospect explain his actions. This, in turn, takes longer time, since the participant both has to execute the assignments and then watch the video. This is the main reason why CTA was chosen for this study. In addition, there is also a risk that the participant forgets why a certain option was made which is why RTA is preferably used for shorter evaluations (van den Haak et al., 2003).

Both before the evaluation and the interview began, the participants were informed about the purpose of the evaluation or interview as well as the purpose of the study and the structure of it. To maintain the validity, the participants were informed about their anonymity in the study and asked not to discuss the subject with colleagues to decrease the risk of being influenced or influence a coworker. This does not exclude whether they discussed it prior to the study which might influence the reliability of the study.

6 Conclusion
Visualizing and conveying complex optimization information is difficult and is what have been investigated in this study. The primary users of the Opus Suite software believe it is both time consuming and challenging to communicate the result from optimization analysis to novices such as their customers in a comprehensive way. To simplify this process a prototype has been developed as a suggestion how the optimization result it can be visualized so it is understandable for broad users. The following questions are the research questions that were outlined in the introduction.

First, what are the requirements of a user interface with the purpose of showing optimizing results to novices? From the requirements gathering it was found that the expert users were positive to the concept of developing a new program mainly for presenting result. They also had several ideas and suggestions of functions that would support them in their daily work. As stated in Section 2, it is beneficial to reduce the complexity and visual clutter to make it comprehensive by a novice user, which conforms with the expert
users’ opinions. In addition, flexibility is required - the terminology and appearance should match the novice mental model.

Second, how can the result be visualized so that it is understandable by everyone included in the work process? To visualize complex information is problematic, in particular when it involves all kind of users with different level of knowledge. For it to be understandable by novices, it is important to simplify and only include what is necessary to reduce the user’s workload. It is also advantageous to consider both the novice and expert’s mental model and how the design can be created so that it is familiar, as presented in Section 2. In addition, it is good to use images or pictures where they can convey a function.

Third, how can the program be developed so that it has high usability for both experts and novices? It is difficult to develop a program that successfully can be used by both novices and experts. For the expert user, it must offer the possibility to drill down to details as well as exclude unnecessary data. The suggestion that arises from this study is to use multiple states where the level of complexity and interaction vary. Hence, the expert user can simplify and only include information that is understandable and essential. Subsequently, it provides the opportunity for not only the expert user to benefit from the program.

Future work should involve further investigating of all states of the user interface and include novices.
References


Systecon AB. (2013). This is Systecon. Retrieved February 16, 2017, from https://www.systecon.se/sv/om-systecon?gclid=CJb-ucn8o9ICFRfGsgodcwAGtA


Appendix
Appendix A - Open-ended Questions

Introduktion


Etik

- Du får när som helst ta paus eller avbryta intervjun utan några som helst konsekvenser. Har du några frågor innan vi börjar? Jag startar inspelningen nu om det går bra?

Om deltagaren

- Namn?
- Roll och yrkestitel?
- Vad har du för utbildning?
- Hur länge har du jobbat inom branschen?

Nuvarande Situation
**Situation 1**

- Hur länge har du jobbat med Opus Suite?
- Använder du alla program?
- Varför använder du Opus Suite? Vad är syftet med att använda programmen?
- Hur tycker du att det är att använda programmen?
- Är det lätt/svårt, för mycket/för lite funktionalitet?

**Situation 2**

- Hur går du tillväga för att ta fram resultat som du sedan ska presentera?
- Hur går du tillväga för att presentera resultat för andra experter/noviser?
- Känner du att du ofta behöver gå tillbaka/göra om/ta fram nya resultat på nytt?
- Finns det något irritationsmoment eller problem i dagsläget med resultatvyn och/eller med att visa resultat för andra?
  - Exempel?
- Om du ska skicka resultat till t.ex. en chef – hur gör du?
- Hur skulle du vilja att det fungerande?
- Upplever du att till exempel managers/potentiella kunder/medarbetare har svårt att ta till sig resultat?
- Är det något specifikt som du upplevt att de är intresserade av eller inte intresserad av?

**Framtida lösning**

- Om du får tänka helt fritt hur skulle du vilja att det fungerande när det kommer till att visa resultat?
- Ser du några orosmoment med ett potentiell nytt presentationsverktyg med syfte att visa resultat?
- Vad har du för krav på ett sådant program för att du skulle använda det?
- Vad för sorts funktionalitet skulle du vilja ha i ett sådant presentationsverktyg
- Välja parametrar/kunna analysera?
**Specifika frågor**

- Finns det någon funktion i resultatvyn som du tycker är extra bra? – Varför?
- Finns det någon funktion i resultatvyn som du tycker är mindre bra? – Varför?
- Tror du att managers skulle använda programmen mer om resultatet presenterades på ett annat sätt?
- Presenterar du någon gång live i verktygen?
- Varför/varför inte?
- Är det några resultat som du ofta vill få fram men inte går att få fram i resultaten?

**Avslutning**

- Är det något som du tänkt på som vi inte pratat om under intervjun?
- Finns det någon som du känner som du tänker att jag skulle kunna testa den här prototypen på?

Stort tack för att du har deltagit!
Appendix B - The Result from the Interviews

The result from the interviews showed that 10 out of 11 participants thought that the current way of presenting result from Opus Suite analyses is hard and expressed a need for a simpler solution. It was found that the current programs are initially hard to understand and entails trial and error. In addition, the participants emphasized that once you learned the functionality of the programs they are easy and logical to use. Moreover, when the participants present results from Opus Suite analyses the common approach is to extract the needed result to an excel document and create customer-specific charts. The most common changes are new names on the various parameters and a change of colors with the aim to simplify and make it understandable for a novice user. When presenting to a customer most of the participants avoid presenting live in the programs due to the fear of getting lost in the program or that something does not go as expected. Furthermore, Table 1 shows reactions and desires about a potential new program with the purpose of showing results from Opus Suite analysis.

<table>
<thead>
<tr>
<th>Wanted effect goal</th>
<th>Unwanted effect goal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flexible/simple/interactive</td>
<td>Too complex for a novice</td>
</tr>
<tr>
<td>Create, save and share templates</td>
<td>That a novice user misinterpret</td>
</tr>
<tr>
<td>Ability to customize the appearance</td>
<td>Loss of control over the process</td>
</tr>
<tr>
<td>Drag and drop on bars</td>
<td></td>
</tr>
<tr>
<td>Easy enough for a manager – complex enough for an expert</td>
<td></td>
</tr>
</tbody>
</table>
Appendix C - Introduction to the Case

Introduktion

Vi har förvärvat nya tåg och ska på samma gång köpa in ett reservdelslager till dessa tågen. Vår supportorganisation består av 3 huvuddepåer, UPTOWN DOWNTOWN och MIDTOWN, och ett centrallager, CENTRAL:

![Supportorganisation Diagram]

I vår analys har vi 46 tåg som kör ungefär 15 miljoner km i veckan

![Driftprofil]


Ett annat orosmoment är att fordonstillverkaren har underskattat felintensiteten på reservdelarna så nästa steg i analysen är att fördubbla alla felintensitetera och se hur tillgängligheten ändras. I Data Manager har vi för de två olika felintensiteterna gjort
kostnads/tillgänglighets- optimeringar av reservdelslagret samt beräknat tillgängligheten på förslaget från leverantören.

Den datan finns nu tillgänglig då vi kommer in i Edit-läget.
Appendix D - Usability Test


2. Du vill få en överblick över systemets kostnad och prestanda, använd dig av ”Opus Selector” för att välja de case/alternativ som du vill studera och dra ut de grafer du är intresserad av.

3. Sedan vill du titta närmare på kurvan för ”Failure Rate 1” och den valbara punkten på Opuskurvan.

4. Du vill titta närmare på systemets tillgänglighet per vecka och samtidigt se driftprofilens som ett lager ovanpå.

5. Sedan blir du intresserad av att se vad leverantören föreslår och specifikt för enheten ”Uptown”.

6. Nu vill du rensa dina val och istället jämföra de valbara punkterna på kurvorna för Failure rate 1 respektive Failure rate 2.
Appendix E - SUS Survey

Vänligen ringa in det värde mellan 1 (instämmer inte alls) och 5 (instämmer helt) som överensstämmer med din uppfattning för varje påstående. Svara spontant och lägg inte för mycket tid vid varje påstående.

1. Jag tror att jag skulle vilja använda det här systemet regelbundet.
   Instämmer inte alls 1 2 3 4 5 Instämmer helt

2. Jag tyckte att systemet var onödigt komplicerat.
   Instämmer inte alls 1 2 3 4 5 Instämmer helt

3. Jag tyckte att systemet var lätt att använda.
   Instämmer inte alls 1 2 3 4 5 Instämmer helt

   Instämmer inte alls 1 2 3 4 5 Instämmer helt

5. Jag tyckte att systemets olika funktioner var väl integrerade.
   Instämmer inte alls 1 2 3 4 5 Instämmer helt

6. Jag tyckte att det var för mycket inkonsekvens i det här systemet.
   Instämmer inte alls 1 2 3 4 5 Instämmer helt

7. Jag kan tänka mig att de flesta skulle lära sig använda det här systemet väldigt fort.
   Instämmer inte alls 1 2 3 4 5 Instämmer helt

8. Jag tyckte att systemet var väldigt besvärligt att använda.
   Instämmer inte alls 1 2 3 4 5 Instämmer helt

   Instämmer inte alls 1 2 3 4 5 Instämmer helt

10. Jag behövde lära mig mycket innan jag kunde börja använda systemet.
    Instämmer inte alls 1 2 3 4 5 Instämmer helt
## Appendix F – Comments from the Users’

<table>
<thead>
<tr>
<th>Before test - first impression</th>
<th>After completed test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clear – You understand what you can do</td>
<td>Easy to use</td>
</tr>
<tr>
<td>Relatively intuitive</td>
<td>One learns quickly</td>
</tr>
<tr>
<td>Nice and clean</td>
<td>Good with drag and drop</td>
</tr>
<tr>
<td></td>
<td>Nice to use the Opus curve for filtering</td>
</tr>
<tr>
<td></td>
<td>Enabling more people to interact, not only experts</td>
</tr>
<tr>
<td></td>
<td>The connection between “Opus Selector” and graphs was a bit unclear to begin with</td>
</tr>
<tr>
<td></td>
<td>Filter – which one is global vs local?</td>
</tr>
<tr>
<td></td>
<td>Possible to see more details</td>
</tr>
<tr>
<td></td>
<td>Be able to see what options/filters that are applied on each graph</td>
</tr>
</tbody>
</table>

*Table 1: Displays comments from the users' during the evaluation*