Aiding financial operators when completing daily tasks

LOUISE WIKSTÉN
Abstract
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Sammanfattning
Aiding financial operators when completing daily tasks
Louise Wikstén
KTH Royal Institute of Technology
Stockholm, Sweden
lwiksten@kth.se

ABSTRACT
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Keywords
Reminders; to-dos; task management; visual attention; user evaluation

1. INTRODUCTION
It is common for many people to engage in multiple activities simultaneously, especially in workplaces. This leads to many daily work tasks, for several projects, that a person should remember to complete before the workday is over. A great challenge for knowledge workers in today’s work environment is to manage multiple ongoing tasks [7]. González and Mark [9] maintained that interruptions are common in information work, both internal and external. Recovery from interruptions often has a significant overhead cost since workers may have to remember exactly where they were in a chain of logic, or why they decided to take their most recent action on a task [7].

An additional challenge within the management of multiple tasks is that all tasks need to be remembered. Therefore, the use of reminders to aid task management is one solution. The design of a reminder is no simple task, as it needs to be sufficiently specified to be a retrieval cue [21], distinguishable [1][19], and suited to context [6].

For financial operators working at a hedge fund, the management of daily tasks is critical. A hedge fund is typically a “private investment company that manages the funds of a limited number of wealthy individuals and institutional investors” [14]. Since traditional hedge funds operate through their prime brokerages, a hedge fund’s trades need to be cleared by the prime brokerages [14]. Thus, all trades need to be reported to the prime brokerages for clearing at the trade date. A hedge fund often operates through multiple prime brokerages, and different prime brokerages have different processes for reporting trades. Thus, the financial operators need to keep track of which prime brokerage to report their trades to, how to report them, and make sure that all reports are completed before they leave the office for the day.

The existing task management and reminder systems often require manual work to create tasks or reminders. For an hedge fund’s operations team, it is not clear how many tasks that need to be handled during a day, that is, the number of trades that day.

This thesis describes a study of how to design a graphical user interface (GUI) that aids operations staff working at a hedge fund in the financial sector to manage their daily tasks. The research was conducted at a large financial company, who develops a product for employees in the financial sector, and mainly focused on aiding the workflow for an operations team at one of the company’s clients. The client was in the process of migrating to the company’s product, which lacked a good overview of daily trades and each trade’s status. By conducting contextual inquiries and running a design workshop, a design was proposed and evaluated with usability experts, a business expert, and users.

2. BACKGROUND
This section introduces related work and different tools that have been developed to aid users in different areas. This includes research and previous work on task management applications, how emails have been used to manage tasks, research on reminders, and the use of colors to guide visual attention in an interface.

2.1 Task Management
When it comes to task management, González and Mark [9] found that information workers, such as analysts, software developers, and managers, constantly moved between different topics and managed multiple information streams during a workday. Switching between tasks was not without effort, and task complexity, task duration, the number of interruptions, and the task type influenced the difficulty of switching back to a previous task [5].

To manage daily tasks and interruptions, people have different strategies. Bellotti et al. [2] found in their study from 2004 that their participants liked to use comprehensive lists for planning and making sure that things were not forgotten. These lists presented all to-dos on a single page. Other ways of managing tasks amongst the participants were informal priority lists, state tracking resources, and time management resources (e.g., booking time for working on a task in the future, or adding to-do events in the calendar). Bellotti et al. [2] suggested that task management tools should be designed to support an overview of all tasks and allow for different types of planning, such as prioritizing and categorizing.

2.1.1 Applications for Task Management
Dragunov et al. [7] developed TaskTracer, an application to support multiple concurrent activities for information workers. By monitoring different applications, the aim was to help
multitasking workers rapidly locate, discover, and reuse past processes to successfully complete tasks. This approach would be one step towards solving the problem of task switching identified by Czerwinski et al. [5], as mentioned above.

Bellotti et al. [2] designed a personal task list manager called TaskVista. The researchers sought to collect and list to-dos as well as to create tasks from the to-dos. Each to-do could be associated with a deadline, a priority, file storage for related files, and a list of people, for sharing tasks. The TaskVista hid all completed tasks in the list, but did not delete them.

2.1.2 Task Management with Emails

According to Whitaker and Sidner [25], in 1996 email was one of the most successful computer applications ever devised, and millions of email users spent significant proportions of their work time dealing with their emails. They found that email was not only used for asynchronous communication, and coined the term email overload for the use of email for functions that it was not designed for. In 2014, Grevet et al. [10] replicated their study by Whitaker and Sidner [25] and found that email overload still was a problem.

The conflict of email for task management has engaged many researchers. After studying how people managed tasks in email, Bellotti et al. [3] designed a tool called Taskmaster to manage tasks found in emails. The tool grouped emails to make it easier to identify emails that belonged to a thread, making it possible to add meta-information, such as deadlines of a message, and designed mechanisms to make it possible to give the users an at-a-glance sense of deadlines and obligations. The tool was found to be compelling by test participants.

Even though it is common, email overload and the use of email for task management have drawbacks. People who receive a lot of email communication experience higher stress levels [13]. Checking emails less frequently has been shown to decrease stress and email communication experience higher stress levels for task management have drawbacks. People who receive a lot of email, research has identified advantages of using computer-based systems for issuing reminders. Reminders could not only be triggered by date, but also by events in the system, which could be used by information workers to organize their work in a systematic way. Common ways to record reminders include media such as emails, formal paper to-dos, print outs, and e-calendar entries [2].

The design of computer-based reminders is a great challenge, and there are two primary aspects that need to be considered: how to present the reminder to the user, and what information a reminder should present. Miyata and Norman [19] define the two aspects as reminder as signal and reminder as description. These aspects of a reminder are independent of each other, as a reminder can be an effective signal but a poor description.

2.2 Reminders

A reminder is “a signal that indicates that a suspended or backgrounded task still exists or that it is ready for further processing” [19]. In 1983, Malone [16] identified advantages of using computer-based systems for issuing reminders. Reminders could not only be triggered by date, but also by events in the system, which could be used by information workers to organize their work in a systematic way. Common ways to record reminders include media such as emails, formal paper to-dos, print outs, and e-calendar entries [2].

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2.2.1 Reminder as Signal

Reminders as signals are used to indicate that something is to be remembered without specifying what it is. For a reminder to be a good signal, it should be unusual and unexpected, as well as suited to the appropriate context [19]. An example of a good signal is the use of flashing lights for a person that is engaged in an auditory task, who might not be able to distinguish sounds. For reminder apps, one suggestion is to allow the user to set a custom ringtone for reminders to make it easier to distinguish them from phone calls [1]. McGee-Lennon [18] found that reminders are most effective when they are delivered at the right time and location.

One challenge of determining when to deliver a reminder is that one task’s reminder is another task’s interruption [19]. The use of context may be one way of finding a natural breaking point. Indeed, the use of rich context for determining when to deliver reminders was one important feature in the design of a context-aware reminder system by Dey and Abowd [6]. Rich context included, in addition to time and location, weather forecast, a person’s current activity status, daily schedule, and events that occurred. When designing reminders that account for context, it is important to consider the social context, or a reminder may become annoying or embarrassing [18].

A common way to design reminder systems is to keep the activity to be remembered constantly visible [19]. An advantage of continual presence is continual reminding, but disadvantages include clutter, distraction, and potential loss of working space. This is similar to how people organized their desks in the study by Malone [16], where one participant expressed that he or she would forget to do something if it was placed it out of sight. In a multimodal home reminder system, a reminder screen was favored to keep at the hub of the home to remind about general tasks and schedules [18].

2.2.2 Reminder as Description

Reminders as descriptions aid in retrieving what is to be remembered, and for a reminder to be a good description, it should be a memory retrieval cue [19]. The specification level of the cue can vary, and a loose specification can be adequate if it contains sufficient information for a certain purpose, even if inadequate for other purposes [21].

The message style of a reminder may benefit from being suited to the event that the reminder should represent. In a study of multimodal reminders in the home, users commented that they might prefer urgent reminders in a short message while less urgent reminders should be in a longer and politer message [18].

2.3 Guiding Visual Attention

When presenting information on a computer display, it usually contains information both relevant and irrelevant to the user [17]. Therefore, it is important to guide the user’s focus to the information that is desired. Visual attention is a term used to describe a set of mechanisms that modulate visual information, and these processes allow for rapid and accurate processing of relevant stimuli [8].

Visual cues, such as flashing, moving, and zooming frames, can guide visual attention [17]. Attention can further be guided by local display changes, which evoked the strongest responses when occurring against an otherwise static display [20]. Another way of guiding visual attention is by coloration [12].

2.3.1 Coloration

Coloration is one way of guiding attention in information to be scanned [12]. Supak et al. [22] used color in their GUI to help users attend to certain elements in their interface, so that the user was quickly oriented upon first entering the application. They also made the decision to limit their color palette to a few colors to keep their design simple and to not distract the users.

Bellotti et al. [3] developed a task management application for reminding users of tasks received in emails. They used a bar with red and green colors, and the ratio between the colors was used to
indicate the urgency of completing a task. This was perceived as a simple and quick indication that a task was due soon.

Different colors have been shown to attract more or less attention. Warm colors, such as red, yellow, and orange, have been shown to draw attention and are suitable to highlight elements in a GUI [23]. Cool colors, such as green and blue, are often associated with positive feelings, and attract less attention [23]. Green, yellow, and red can further be associated with the colors of traffic lights, where green means go, yellow means caution, and red means stop. Heath and Etheridge [11] used the traffic light color scheme to indicate status of processes on a display.

The use of color is not without problems, and an informed color selection process is needed. Users with color perception deficiencies may not be able to take full advantage of the colors used for guiding attention [22].

3. RESEARCH PURPOSE AND CONTEXT

A person working in an operations team at a company in the financial sector has tasks that need to be completed before leaving the office. Often, the team has additional tasks and responsibilities, which makes it difficult to remember all mandatory tasks. Previously developed task management applications may not suit all use cases as they often depend on user input, and in the case of a financial operator the number of tasks varies, as there is not a set amount of trades to manage each day. Thus, there is a need for a dynamic task management system that will use system status instead of relying on the user to enter all tasks and reminders.

This thesis has investigated how to design a GUI for aiding and reminding operations staff to manage their daily tasks. The GUI should make it easy for an operator to verify that all work is completed, as well as reminding the user when there is work left to complete.

3.1 Research Question

The research question examined in this thesis is:

\[
\text{How can a GUI be designed to remind and aid users to verify that trade information has been managed correctly?}
\]

3.2 Hypotheses

Previous research has shown that several task management systems that aid the user to keep track of their daily tasks exist [2][7]. When designing reminders, it is important to make sure that they are suited to context [6] and not annoying [18]. In addition, users have been found to appreciate the use of coloration with the aim of guiding visual attention [3][22]. Based on these findings, the following three hypotheses were developed for examination in this master thesis:

(H1) It is possible to design an intuitive GUI to remind and aid the user in verifying that trade information has been reported correctly.

(H2) Reminders should be presented to the users if they have not handled all daily tasks at a certain time during the day.

(H3) Highlighting colors should be used to indicate critical information that needs to be addressed in a GUI.

3.3 Context

The principal, for whom the research was carried out, develops a product which aims at helping employees in the financial sector, such as traders, brokers, and asset managers, to trade and manage positions in global capital markets. Customers are generally central or commercial banks, corporates, securities, and lending and financing organizations. The principal’s product consists of several applications and integrations to different capital markets. The product is customizable as customers can use the application’s API to develop their own extensions.

The principal has clients that are hedge funds. Hedge funds often use prime brokerages to facilitate and coordinate extensive, complex trading in a variety of instruments. Prime brokerage is a name for the global clearing services that large complex financial institutions offer to hedge funds. Services include the handling of a hedge fund’s collateral, financing, and securities clearing facilities. Through these services, the prime brokerages may have knowledge about the hedge fund’s positions [14]. Therefore, large hedge funds often operate through the accounts of several prime brokerage firms to not allow a single prime broker to know all their positions [14]. Stated in contracts between a hedge fund and a brokerage is that the hedge fund need to clear all trades to the prime brokerage at the end of the day.

The principal’s product does not provide a good overview of trades with different statuses, and it can be difficult to verify that trades and trade reports have been successful. As the work tasks for an operator at a hedge fund include the reporting of trades to their prime brokerages on time, the principal’s product would need to support a simple overview. Thus, this thesis was carried out in close collaboration with one of the principal’s clients, a hedge fund company, and its operations staff.

3.4 Delimitations

This thesis has been limited to only study the design of a GUI for reminders and verification in the financial sector. Further, the GUI was especially designed to suit one of the principal’s clients, a hedge fund, and therefore it is not a representative sample for all potential users of a similar system.

Due to the users available for study, this thesis has been limited to only study male participants.

4. METHOD

4.1 Contextual Inquiry

Two contextual inquiry sessions were conducted at the workplace of one of the principal’s clients. Both subjects (P1, P2) were male and worked in an operations team at the client. The sessions were conducted in Swedish, and the interviewer in both sessions was the master thesis student. The first session lasted one hour and 15 minutes, and the second session lasted one hour.

The purpose of the contextual inquiry sessions was to get deep insight in how the user works, the challenges that they face and understand all daily tasks that the user had to complete. The use of contextual inquiries gives a thorough view of the user’s work, since details that people do not normally pay attention to are available for study [4]. As the aim was to develop a tool specific to the principal’s client, contextual inquiries were considered a suitable method for user research in this thesis.

Since the sessions took place at the client’s office, there was a risk that confidential data could be caught on tape. Therefore, notes were taken as documentation by the interviewer during the sessions. The participants signed a consent form informing about the aim of the study and data collection before participating in the study. During the sessions, the participants showed and explained tasks that they complete every day. The interviewer occasionally interrupted to ask questions about the process. At the end of the sessions, the interviewer quickly summarized the findings and
verified with the participants that there were no misunderstandings.

At the time of the contextual inquiry, the client was in the process of migrating from their old system to the principal’s product. Therefore, they had limited experience with the principal’s product, and showed the workflow in their current system and explained how they imagined a similar workflow in the new system.

4.2 Design Workshop

The findings from the contextual inquiry sessions were used as inspiration to create design solutions in a design workshop. Five participants (WP1-WP5) attended the workshop and they were all male. They were hired as financial software developers at the principal’s workplace (see Table 1 for detailed participant information). The workshop was conducted in a conference room at the principal’s Stockholm office and was held in English. The goal for the workshop and a workshop agenda were distributed prior to the workshop.

<table>
<thead>
<tr>
<th>Participant ID</th>
<th>Age (years)</th>
<th>Years of experience</th>
</tr>
</thead>
<tbody>
<tr>
<td>WP1</td>
<td>29</td>
<td>2.5</td>
</tr>
<tr>
<td>WP2</td>
<td>35</td>
<td>5</td>
</tr>
<tr>
<td>WP3</td>
<td>24</td>
<td>3</td>
</tr>
<tr>
<td>WP4</td>
<td>27</td>
<td>2.5</td>
</tr>
<tr>
<td>WP5</td>
<td>38</td>
<td>10</td>
</tr>
</tbody>
</table>

Table 1. The workshop participants.

The workshop started with a brief introduction of the goal of the workshop and a short summary of the results from the contextual inquiry sessions to give the participants an understanding of the end-users’ needs. To make the participants feel comfortable in the setting and introduce them to visual thinking, the workshop began with a simple design exercise. After the warm-up exercise, participants were asked to write down their ideas during a five minute-brainstorming session. The participants then took turns to present their post-it notes with design suggestions.

A collaborative design phase followed the brainstorming session. The participants were split in two groups and given the task to create designs for the GUI. Each group discussed and sketched designs for ten minutes, before presenting their design to the other group. To refine each design, the groups handed their sketches to the other group. The groups had ten minutes to discuss and refine each concept.

After a short break, the designs were put on a whiteboard, and the participants were asked to individually write down at least one advantage and one disadvantage of each design on post-it notes. The participants presented their post-it notes and placed them below the designs on the whiteboard. When each participant had presented his post-it notes, a short discussion about which concept to continue with was held. Each participant was encouraged to give their opinion on which design they preferred.

The entire session lasted one hour and 30 minutes and was facilitated by the master thesis student. The design workshop was documented with images, and all post-it notes, sketches, and designs were collected and saved.

4.3 Prototyping and User Evaluation

Based on findings from the contextual inquiry sessions and the design workshop, a GUI for reminding users about trade information reporting tasks was prototyped. The prototype consisted of two different user interfaces, one with a dashboard design, while the other was an interactive application to be integrated in the principal’s product. The dashboard prototype was created as a real webpage using JavaScript and HTML, but with mock-up data. The interactive prototype was developed in JavaFX and used mock-up data. Both JavaScript/HTML and JavaFX were selected since it is easy to create prototypes while maintaining a feeling of an authentic application. The initial design of the prototypes was influenced by the principal’s existing product and discussions with co-workers.

The evaluation of the GUI was divided in three different types of sessions, due to a limited number of end-users. Therefore, the evaluation consisted of two cognitive walkthroughs, one business expert review, and two think-aloud evaluations. The master thesis student facilitated all sessions and they were held in Swedish. Between the two cognitive walkthrough sessions, before the business expert review, and before the first think-aloud evaluation, the design was iterated to eliminate previously identified usability issues.

For the cognitive walkthroughs, two evaluators (E1, E2) were recruited. Both evaluators were male interaction design students conducting their master’s theses. They were both previously familiar with the interviewer, but had no experience with the principal’s product. The cognitive walkthroughs took place in a quiet café, and the evaluator was asked to examine six tasks, divided into subtasks, for usability. The tasks and subtasks are presented in Appendix I. When assessing each subtask, the evaluator was instructed to ask four different questions, which have been developed by Wharton et al. [23]. The questions were: “Will the user try to achieve the right effect?”, “Will the user notice that the correct action is available?”, “Will the user associate the correct action with the effect they are trying to achieve?”, and “If the correct action is performed, will the user see that progress is being made toward solution of the task?”.

Before assessing the tasks, the evaluator was given a brief introduction to the problem and a description of the end users. Based on the four questions, the evaluators were asked to assess the design, and any information that the evaluator found useful for each task was written down in a form. After completing all tasks, a semi-structured interview with questions about the design was carried out. Notes and the form filled in by the evaluators were saved as documentation.

The business expert review was carried out with a business expert (BE), who was a male software developer with ten years of experience working with the principal’s product. The business expert had worked in close contact with the client whom the project was carried out with, and had valuable insights regarding their system. The review was an informal session in the principal’s office, in which BE was presented with the tool and asked about his perception. Notes were taken as documentation during the review.

The think-aloud user evaluation was conducted with the same two participants (P1, P2) that participated in the contextual inquiry sessions. The evaluations were conducted in the participants’ workplace. During the evaluation, the participants were given four tasks to complete in the interactive prototype, and the tasks were handed to the participants one by one. The dashboard interface was only presented with an explanation of what it was to the participants, since it did not support any interaction. After interacting with the prototype and seeing the dashboard, the participants were asked to fill out a form with six statements and to indicate if they agreed with the statements. The form can be
found in Appendix II. At the end of the session, a semi-structured interview with eight questions, about the user’s opinions, was held. The interview questions can be found in Appendix III.

5. RESULTS

5.1 Contextual Inquiry

The purpose of the contextual inquiry sessions was to understand the users’ workflow, including tasks to complete and challenges faced. During a regular workday, the operations team was responsible of managing tasks in different areas. One of the team’s tasks was reconciliation between systems. The operator needed to reconcile to verify that the numbers in different systems matched. Some reconciliation tasks were automatically completed and generated a report for the operators to inspect. Other reconciliation needed to be performed manually by matching numbers. The operator needed to keep track of the systems being reconciled, because the market prices could differ slightly between market places, and therefore the reconciliation could appear to have failed even if that was not the case.

Other tasks for the operations team was to manage daily trades. These trades needed to be reported to the prime brokerages, and different prime brokerages wanted the reports in different formats. A few prime brokerages wanted the reports as PDF files, while others accepted Excel-sheets. The operator needed to keep track of which receiver who wanted the report in a certain format as well as what information was necessary. Some of the trades did not need to be reported at all, since the trade market managed those reports.

Both participants needed to use, and keep open, several application windows on their computer screen during the day. Thus, the operators needed to switch between different windows to complete tasks. A few of the tasks were time critical, and at certain times during the day the operator needed to handle events in the system within a few minutes. Due to changes to their organization when adapting to the principal’s product, additional tasks would be added to the operations team’s area of responsibility. This included monitoring of another system, which presented the status of reports to remote systems. Whenever problems occurred and a report failed, the operator would need to take action.

In the operations team, the operators worked in collaboration. They frequently asked each other questions and discussed their tasks, such as who should take care of the reconciliation or report the trades. Even though the reporting of trades was a mutual responsibility, the operators worked mainly on their own screens.

During a workday, interruptions were common. Interruptions could be from co-workers with questions that needed to be handled immediately, or emails informing about processes that failed and needed immediate response. The amount of work to complete each day varied, and it was not possible to predict how much work there would be. Generally, the number of trades to manage was higher in mornings compared to afternoons.

P1 expressed that it was critical in their daily work that all tasks were completed in time. Daily tasks included the management of trade reports, reconciliation between different systems, and making sure that no technical errors occurred.

“Never leave the office without making sure everything is completed” – P1 (author’s translation)

In their, at the time of the inquiry, current system, they had three different tabs that presented trades of different types. When the three tabs were empty, the operations staff knew that they had completed their daily tasks. A similar workflow in the principal’s system was not yet envisioned, and the participants did not know how to accomplish the same simple overview. P1 stated that a simple tool for keeping track of what had been accomplished and what was remaining during the day was missing in the new system. At the time of the contextual inquiry sessions, it was clear that the participants were not yet familiar with the principal’s product. The workflow for completing simple tasks, such as finding items, was slow and they were not yet acquainted with how to do it optimally.

P1 had suggestions on the design of a tool for making sure that daily tasks were completed in the system. The first suggestion was that the system should issue a warning at a certain time each day if there were any trades that had not yet been handled. P1 further suggested the use of an informative window to display the status of all daily trades and the statuses that they were in. P2 described that a system running in the background, which could be inspected whenever there was a chance, would serve as a good way of monitoring remaining work. Additionally, P2 expressed a need for being informed whenever a process failed, but was not sure how.

“Both an email and a popup-window as a warning [for remaining trades] would be irritating” – P2 (author’s translation)

Both participants handled a great deal of daily tasks through email. P1 explained that email was used as a primary tool for informing the user about the status of different processes. Whenever a process failed, or any event occurred in a system, an email was sent to inform the user. Both contextual inquiry participants expressed that it was difficult to handle all emails received, but that they still would like to receive emails about events in the system since they have the emails on their phones as well and can always find out when systems fail.

“Monitoring is important since we want to solve issues as soon as possible to make sure it does not lead to greater problems” – P2 (author’s translation)

Findings from the contextual inquiry session show that it was important for the participants to make sure that all tasks were completed before leaving the office. One of these tasks was the reporting of trades to their prime brokerages, and the participants wanted a system that would make it easy for them to see if there were any trades left to report. The participants wanted to be informed about system events, which, at the time of the sessions, mainly were communicated through email. Therefore, the participants received large amounts of emails, and it was considered difficult to manage.

5.2 Design Workshop

All participants expressed an understanding of the goal of the workshop during the introduction.

The warm-up exercise was well received and everyone took the exercise seriously. When presenting their drawings, it was clear that everyone had the ability to draw clear sketches and diagrams of how the interaction with a product works.
During the brainstorming session, the participants came up with several ideas. The ideas could be categorized in two main categories: ideas that should extend and make use of existing functionality in the product, and ideas that had a dashboard design to present the status of the trades.

Two participants (WP2, WP3) suggested that color served as a good indication of the status of a report, since it would make it easy to identify statuses. The use of alerts for reminding the user of daily tasks was a suggestion from two participants (WP2, WP3). WP2 suggested that alerts should be presented to the user at the end of the workday but was concerned that users would not notice the alert if they were not looking at the screen when the alert was shown. WP3 suggested that alerts should be presented to the user whenever something appeared in the system that needed to be handled manually.

The second design (D2) had a dashboard design, with the aim of providing the user with an overview of report status at a glance and is presented in Figure 2. The design displayed information about the number of trades remaining to report, the number of trade reports that were had an error status, and the number of trades that were successfully reported. A pie chart displayed the ratio between reported trades, failed trades, and trades not yet managed. In the lower right corner of the dashboard, one list with ten of the trades with error status and ten of the trades remaining should be presented. When clicking on one of the panels presenting the number of trades with a certain status, a window with a spreadsheet of trades with that status should be opened. The pop-up window should allow for managing those trades.

In the second iteration of the designs, no group drew a new sketch of the design, even though they were instructed to. However, both groups discussed and criticized the other group’s design thoroughly. All participants managed to write down strengths and weaknesses within each design, and presented them to the group. The strengths of D1 were that: a summary of trades and their statuses would be a good feature (WP1), it was based on the principal’s current product which would make it easy to implement (WP3), it aims at making it easy to find all information needed in one place (WP4, WP5), and it would be preferable to a technical user (WP2). The weaknesses of D1 were that: it was not considered an elegant visual design (WP3, WP5), it would be cumbersome to present all information in one page (WP1), and it may be confusing with too many windows (WP2, WP4).

The strengths of D2 were that: it was a good dashboard overview (WP3, WP4, WP5), it had a good and interactive design (WP1, WP5), and it provided an at a glance view of statuses (WP2, WP4). Weaknesses of D2 were that: clicking on a panel and opening a new window would be annoying (WP4), the view would be difficult to implement in the principal’s current product (WP1, WP3), it would hide complex logic (WP5), and it would require further tools for drilling down to errors (WP2, WP3).

No workshop participant expressed any strong preference for any of the designs. The participants expressed that they would prefer D2 for the nice, visual GUI, but feared that it would be difficult to implement within the principal’s product. One participant (WP3) suggested that the designs were complementary and that a combination of the designs could be used.

5.3 Prototyping and User Evaluation

5.3.1 Initial Prototype Designs

The first designs of the prototypes are presented in Figure 3 and Figure 4. The proposed design was divided in two separate graphical user interfaces, which should be complementary. One interface was an interactive application for personal use, and the other a dashboard view for the team to inspect on a shared screen.
5.3.2 Cognitive Walkthrough

Figure 3 and Figure 4 present the visual design of the two prototypes, which were inspected in the first cognitive walkthrough, with evaluator E1.

E1 thought that, for a user, it would be easy to identify if there was work left to complete during that day, since the panels at the top of the window would be the first thing a user sees in the application. However, E1 recommended the use of a larger sized or broader font for the explanatory text to improve readability. The major drawback with design of the interactive prototype was that the panels were not perceived as clickable. The scaling effect on mouse hover was an indication that it would be possible to interact with the panels, according to E1, but it would be better to make the panels look visually clickable as well. Further, E1 claimed that users are generally scared of clicking things in an application, why the redesign of the panels would be greatly encouraged. The use of a border to visually indicate that a status panel was selected was considered clear. However, E1 expressed that the ability to select multiple panels, e.g. for viewing both not handed trades and trades with error status at the same time, could be a preferred feature.

When shown the dashboard interface, E1 expressed that a legend for the pie chart would be necessary to inform about what was presented and to make the colors perceivable for users with color perception deficiencies. However, E1 did not understand the purpose of the pie chart, as it did not present any additional information.

E1 had several comments on the color selection in the prototypes, and was concerned that the applications would not suit users with color perception deficiencies. However, when using a descriptive label, the color selection would be adequate. Furthermore, E1 had comments on inconsistencies in both coloration and wording, including that it was not possible to read the column headings in white text against a light blue background, that the panels had white text while the tables used black text in the status column, and that both error and failed could be used as a description of a status.

Before the second cognitive walkthrough, a few changes were made to the designs. These changes were based on the results from the first cognitive walkthrough. An attempt at making the panels look more clickable was made by adding the effect of a different mouse cursor on mouse hover. Further changes included that the font size on the panels were increased and the column headings had a black font instead of white. The dashboard was updated with a legend to explain the pie chart and the table design for reports was updated.

As in the evaluation with E1, E2 perceived it as straightforward to identify how much work there was left to do during a day by looking at the status panels. However, E2 did not like the order of the different colors to indicate statuses, and suggested to use the order red, yellow, and green, instead of yellow, red, and green. The status panels were still not perceived as clickable, even though E2 imagined that the user would understand the mouse hover effects, i.e. the scaling effect and change of mouse cursor. E2 still suggested that it was important to make the panels look more clickable, without mouse hover. Further, E2 believed that the border of a status panel made it clear that it was selected, but that thicker borders could make it more evident. Sorting columns was perceived as easy, but one usability issue was found: that when filtering the table with the panels, the sort order was not kept.
When inspecting the dashboard, E2 commented that it was clear, that the color selection was good, and that it was good for the team to share the screen. By using statistical analysis, it might be possible to calculate how long it usually takes to complete remaining tasks, and thus present the estimation on the dashboard. The pie chart was, also by E2, considered unnecessary since it did not provide any extra information, and suggested an extension of the table to see status reports to additional markets. The dashboard would also benefit from making the table more visually appealing.

During the walkthroughs, both E1 and E2 were thoroughly considering all potential actions to complete task six (find the link to manage a trade), and finally assumed that they should double-click a trade row in the table. Neither E1 nor E2 found a double-click action intuitive, but could not think of any other interaction that should be suitable. E2 suggested that a mouse hover effect, such as a mouse hover effect on the status panels, could be used to indicate that a double-click action was supported.

E1 and E2 conveyed thoughts that it was difficult to assess the reminder aspect of the dashboard. E1 mentioned that when presenting the dashboard on a large screen, it would be difficult to not look at it. E2 imagined that the user would get used to look at the dashboard, and thus learn to use it as a reminder.

5.3.3 Business Expert Review

The evaluation with the business expert generated different results compared to the cognitive walkthroughs. BE commented that the columns used in the table in the prototype were not relevant in a real use case. BE liked the feature with clicking on a panel to filter the table to only display trades of a certain kind, and commented that the dashboard presented relevant information. Further, BE wanted to be able to double-click on a trade row in the table to manage the trade, and was happily surprised when realizing that a double-click interaction was already supported.

BE considered the prototypes to be a good addition to the principal’s product, especially when it came to monitoring the different statuses. Both the dashboard and the interactive prototype were perceived as providing a straightforward way for the users to view important information that existed, but was hard to retrieve. BE articulated, about the integration with the client’s system, that:

“We have not yet focused on easy monitoring in the system.” – BE (author’s translation)

5.3.4 Think-Aloud Evaluation

Before the think-aloud evaluation with the end-users, further changes were made to the prototypes. The column selection was changed to match the suggestion by BE, the prototype data was updated to resemble a real use case, and the panels were redesigned to appear more clickable. No further changes were made to the dashboard view. The final versions of the prototypes, which were evaluated with the end-users, can be seen in Figure 5 and Figure 6.

When presented with the interface during the evaluation, P1 explained that he was colorblind. However, he had no problem perceiving the colors used in the prototypes, and liked the colors used. P2 appreciated the color selection in the prototypes, and related them to the traffic light color scheme.

Both P1 and P2 used the table to identify if there were any remaining trades for the day in task 1. Both participants easily identified the trades in the table by the status column that presented the statuses in different colors.

“Knowing that all work was completed was one thing that worked well in the old system we used, but is missing in [the principal’s product]” – P1 (author’s translation)

For the second task, P1 expressed that he wanted to sort the columns, clicked on a column header, and scrolled down to see the trades with error status. He later managed to identify that it was possible to click on one of the status panels to filter the table. P2 indicated, during the second task, that he wanted to click the status panels, and while hovering over the panel he identified the “View Trades” label that had been added and clicked. In the follow-up interview, P2 further explained that he strongly enjoyed...
the scaling effect and of the status panels and the mouse cursor change on mouse hover as an indication that they were clickable.

The third task did not pose a challenge to any of the participants; they both appreciated the border that was added to a status panel to indicate that it was selected. They immediately clicked on a selected panel to deselect it, which was the desired action. P1 tried to select multiple panels as well, and explained that he would like the multi-select feature supported. Further, as there were three different types of trades that the operations staff managed, P1 suggested to extend the table view with three additional table tabs. P1 explained that one person in the operations staff could be assigned to only manage trades of a certain type. Thus, it would be advisable to have separate tabs for the different types of trades, in addition to a table with all trades.

For the fourth and final task, to manage a trade that had not yet been handled, both participants scrolled the table to find a trade with the correct status, selected the row and double-clicked.

“The that's how it works in [the principal’s product], so I imagined the same thing would be possible to do from here.” – P2 (author’s translation)

P2 did not only find the double-click action intuitive in the prototype, but mentioned in the follow-up interview that being able to link to different parts of the product from the application would make it very useful. Further, P2 stated that he would like to have the application as the main view in the principal’s product, and from it have links to relevant parts in the system to access when needed.

Both participants liked the dashboard, and they expressed that it was easy to be informed about system status. P1 uttered a concern that the dashboard view would never be used, even though he liked the idea. P2 was very enthusiastic about the dashboard, especially when understanding that the dashboard should be presented on a remote screen, and not his own computer.

“I would definitely want it on a large screen, and not just opened in a browser tab – then I would not use it” – P2 (author’s translation)

P1 and P2 wanted to be able to add additional information to the dashboard. P1 was interested in reports to different markets, and wanted to remove the pie chart to instead display the status of additional reports. P2 wanted the dashboard to display a small pop-up whenever a file arrived in their system from a remote source, which happened several times every day. However, P2 expressed concerns about presenting too much information on the dashboard:

“Do not clutter the dashboard, then it won’t be useful” – P2 (author’s translation)

By having a dashboard separate from the principal’s product, the participants expressed need for the possibility to access status of the system remotely, without the use of email.

“Maybe the dashboard could be a webpage suited to mobile phones – then it would be possible to get information when outside of the workplace in case anything urgent happens.” – P2 (author’s translation)

P2 expressed that the proposed design could be used in his daily work to make sure to not miss anything, and it would make the principal’s product easier to navigate. P1 stated that the proposed design would help to verify that everything was completed before leaving for the day, and by keeping track of the latest report statuses it would be possible to assure that no technical errors had occurred.

When filling out the statement form, to indicate how well the prototype and dashboard views served its purpose, both P1 and P2 ticked the boxes to indicate that they strongly agreed with all statements. Thus, they found it easy to identify if there was work left, they found the interactive prototype easy to navigate, and they found it easy to identify the trades that needed to be managed. Additionally, P1 and P2 indicated that the dashboard could serve well as a reminder that not all work was completed yet, that the dashboard presented relevant information, and that they could have use of the proposed GUI design in their daily work.

Besides aiding the operators at the principal’s client, P1 informed that the interactive prototype would not only be of use to the operations team, but also the traders at the company.

6. DISCUSSION

Results from the contextual inquiry sessions showed that it was important for the financial operators to not leave their office with work left to complete. The operations team was collaboratively responsible for managing the trades, but often worked individually on their own screens. Further, the operations team kept several windows open, and often reconciled between different systems that the numbers added up. The operators received system reports through emails frequently, and mentioned that it was impossible to manage, even though they still wanted updates through email.

The design workshop resulted in two different designs, one with a more functional interface that presented a summary of the report status as well as a table with all daily trades. The second design had a dashboard interface with large panels displaying the number of trades with different statuses. The workshop participants did not favor either one of the designs, but suggested that a combination of the two designs would be suitable.

During the cognitive walkthroughs, the evaluators identified the main issue as that the status panels not being clickable, that the double-click interaction to open a window for managing a trade was not intuitive, and that the dashboard’s pie-chart was difficult to understand as the major usability issues. However, both evaluators expressed that a user would be able to easily identify if there was work left, e.g. trades to manage, as well as identifying the trades that needed to be managed. The business expert liked the prototypes, and imagined them as a good addition to the principal’s product.

The final evaluation showed that the participants were satisfied with the design, and that it was something they found as a suitable solution for aiding their workflow. The participants were used to looking in tables and spreadsheets to identify trades not yet managed, and did thus not use the panels in the interactive prototype. The status panels were understood as clickable by one participant, while the other participant instead sorted the columns to find trades of a certain type. However, once they understood
the click interaction, it was appreciated and the deselect function was not a challenge. The double-click interaction in the table view was an intuitive feature, and because of it P2 wanted to keep the interface as his main view in the principal’s product. The dashboard was well received, even though P1 was concerned that it would never be used. P2, on the other hand, was very enthusiastic about the design and wanted to be able to access it from mobile devices as well. Both P1 and P2 had different suggestions on features they would like to add to the dashboard.

The evaluation results support hypothesis H1, which stated that it would be possible to design an intuitive GUI to remind and aid the user to verify that trade information has been reported correctly.

The users, P1 and P2, both received large amounts of email every day. Since they expressed that the email was not only used for communication, they can be seen as suffering from email overload [25]. Even though they did like the use of email for task management, they found it difficult to manage in large amounts. As a response to this fact, a decision was made to avoid the use of email as a reminder or task management system for verifying reports of trade information. This could potentially aid the users to reduce stress levels, as they would not need to check their emails as frequently [13][15].

The interactive prototype can be viewed to resemble the prototype for TaskVista that was developed by Bellotti et al. [2]. The interactive prototype designed in this study presents the trades that are remaining to manage in a table view, while the TaskVista presented all tasks in a list. In the evaluation, participants expressed that they wanted to be able to see only trades with error status and trades not yet handled, which is similar to hiding completed tasks in the TaskVista. The approach taken by Dragunov et al. [7] for the TaskTracer was more for keeping track of applications and managing interruptions, which was not perceived as a major issue for the participants in the contextual inquiries.

P2 wanted to keep the dashboard constantly visible on a large screen in the office, and continual presence is one way of reminding [16][19]. Keeping the dashboard constantly visible would minimize the need for context-awareness. P2 was however concerned that the dashboard would become cluttered with information, and thus too distracting. This is one of the drawbacks mentioned by Miyata and Norman [19] when using continual presence as a signal for the reminder. Keeping the dashboard constantly visible as a reminder conflicts slightly with hypotheses H2: that reminders should be presented to users if they have not handled all daily tasks at a certain time during the day. H2 states that the reminders should only appear whenever there are daily tasks not yet handled, while keeping the dashboard constantly visible means that the system status is always visible. P1 and P2 wanted to keep the proposed design for continuous monitoring of the system. Therefore, the dashboard would serve as more than a reminder and verification system.

Monitoring the system was important for P1 and P2 who appreciated the use of email since they would be informed about issues in the system, even when off work. During the evaluation, one participant expressed the need of being able to view the system’s status on his mobile phone by making the dashboard mobile friendly. This indicates that the end-user has a great desire of being constantly updated on the system’s status. For this purpose, a dashboard would be a suitable solution.

Since the end users, P1 and P2, did mark that they strongly agreed with each statement in the follow-up form, it indicates that they were overall satisfied with the proposed system design. Conflictingly, P1 and P2 marked that they strongly agreed with the statement that the dashboard presented information relevant to their work, but later expressed that they wanted to add additional information. This indicates that the participants were satisfied with the information presented, but realized that the dashboard had even greater potential during the interviews. As different users may be interested in different information, a suitable feature would be to make it possible to add custom modules to the dashboard, and allow the customers to add their own data to the screen.

The use of colors in the prototypes was well received by all participants in the evaluation, even though E1 was concerned about color perception for impaired users. However, the use of an additional descriptive label was an attempt at making the status panes clearer, and all participants liked having both color and label to indicate status. The colors selected for the design was aimed at guiding attention, and the use of yellow and red coloration for the trades that needed to be addressed is supported by previous research [23]. P2 commented in the evaluation that he did like the colors, especially because the colors did resemble traffic lights and made it easy to connect color and status. Both participants easily differentiated between trades with different statuses because of coloration, which is supported by findings that coloration is a way of guiding attention [12]. This supports H3, the hypothesis that color was a suitable selection for indicating information that needed to be addressed.

Concerning the usability aspect, one major challenge was to make the status panels look clickable, and the first attempts were not successful, as can be seen in the results from the cognitive walkthroughs. Additionally, in the think-aloud evaluation, after visual design changes, it was still not clear that the panels were clickable by looking at them, since P1 did not use the filtering functionality in the second task. However, when he finally did realize that the panels were clickable, P1 expressed that he liked the filtering feature. To identify the panels as clickable would be a major challenge for first-time users of the design, since they would not understand how to use them. When having identified the click functionality for the first time, the user would however be acquainted with the feature and know how to use it. Thus, this may not be a major drawback of the design, since the most users of the principal’s product use it daily.

Furthermore, being unfamiliar with the product could also be related to the challenges of the double-click interaction in the table view, to manage a trade, in the prototype. The evaluators E1 and E2 did not perceive it as intuitive in the cognitive walkthroughs. They managed to identify how to complete the task, mainly since they were given the task and the double-click option was the only alternative left. However, the business expert wanted to have a double-click action to manage a trade and tried it without knowing that it was possible. Further, both end-users immediately double-clicked on a row in the table to open the trade when handed the task. This indicates that a double-click action might not be intuitive for new users, but if the user is previously acquainted with the action, double-click actions are a suitable design choice.

6.1 Limitations

One drawback of this study was the limited access to end-users, but from the principal’s point of view, the GUIs were designed mainly for the specific client. To try to evaluate the GUIs designed thoroughly, an attempt was made with usability and business experts, but this did not generate any statistically valid results.
To use software developers in a design workshop might have been a conflicting choice of participants as they had good insight in the principal’s product, including possibilities and limitations. This limited their design ideas partly as they had a hard time imagining the design not fitting the principal’s product. On the other hand, they had insight in possibilities within the product and would not design any solution impossible to implement. A few of the developers were also familiar with the client, for whom this thesis was carried out. This may have been an advantage in case they had additional insights in the client’s workflow, but a disadvantage if they were using their own ideas to base their designs on. In this study, the participants managed to come up with several design suggestions, and not only ideas that were limited to the principal’s product. However, when conducting design workshops, it could be recommended to include participants without experience of the system and user as well.

The evaluation method for this thesis was chosen due to a limited number of end users available for study. The end users were very enthusiastic about the idea, and they needed a new system for aiding their workflow. Thus, the users may have had a system to compare with, but they may have been bias since the system was designed especially for them. Therefore, the use of other evaluation methods, in addition to end user evaluation, was a good decision, since the evaluators were more critical.

In this study, it is only the user interfaces that have been evaluated with prototypes. Thus, all participants had to imagine the fully working system in use at the user’s workplace. This may have affected the results, as the design was intended to be in place at the office and used continuously throughout the day to aid the workflow. For the interactive prototype, this is not a major drawback as the interaction flow, which was in place, was evaluated. However, this made it difficult to evaluate the reminder aspect, and the users had to imagine if it would aid them. Therefore, the use of a dashboard as a reminder system needs to be further investigated and the results from this thesis should be viewed only as a suggestion.

6.2 Future Work
The design studied in this thesis was aimed for only one of the principal’s clients. Therefore, there is a need for testing the design created in this thesis with other participants in addition to the end-customer.

The use of color was an attempt at guiding visual attention in the application, and even if the participants in this study expressed that they liked the use of color, there is no validation that it did guide their visual attention. Thus, one thing to investigate further would be to use an eye-tracking device to measure the effect of coloration in the prototypes. This could further support the usage of coloration in reminder GUIs, and color could perhaps be perceived as a good description or signal in a reminder aspect.

To identify the actual usage of the designs, evaluation of a functional system would be suitable. This was not possible within the scope and time limit of this thesis, but would be interesting for further research. The research should involve an implementation of the designs to evaluate both the reminder aspect of the dashboard and examine how well the proposed design suited the users.

7. CONCLUSION
This study examined the research question: How can a GUI be designed to remind and aid users to verify that trade information has been managed correctly?

One suggestion is the design developed for this thesis, which consisted of two complementary graphical user interfaces: one interactive user interface that a user should keep locally on his or her screen, and one dashboard interface to keep on a shared screen with the number of trades with each status. In both user interfaces, the statuses of different trades were color-coded, e.g. red indicated error, green indicated success, and yellow indicated that it needed to be reported. In the local user interface, beside panels with the number of trades with different statuses, the user could view all daily trades in a table view. The dashboard view was designed to present the same panels for number of trades with each status, as well as the status of the latest report to a certain market or report receiver.

It was perceived as easy and intuitive to identify trades that needed to be managed in the system. The participants in the study expressed that they thought the proposed designs would remind them of work left to complete, but the reminder aspect needs further research.

The method used in this thesis, contextual inquiries, a design workshop, and evaluation sessions, led to a design that was well received by the target users. Thus, this can be viewed as an effective way of designing when having a specified target group.

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9. REFERENCES


10. APPENDIX

10.1 Appendix I: Cognitive Walkthrough Tasks
The following tasks were used in the cognitive walkthrough with a detailed description of how to complete the task. The original tasks were presented to the evaluators in Swedish, but have been translated to English.

1. Identify if there are remaining tasks to be completed during the day.
   a. Open the application.
   b. Look at the different panels at the top of the application. See the number of trades with each status, and if there are any trades with an error status or not yet handled status, you are not finished.
2. View the trades that are not yet handled.
   a. Identify the panel that displays the trades that are not yet handled.
   b. Click on the panel, which will filter the table and thus only display the trades that are not yet handled.
3. View the trades that have an error status.
   a. Identify the panel that displays the trades with error status.
   b. Click on the panel, which will filter the table and thus only display the trades with an error status.
4. Display all trades when the table is filtered to only display one type of trade.
   a. Identify the panel that is selected.
   b. Click on the panel to remove the filter.
5. Identify if all trades by “Trader1” are completed.
   a. Sort the table by clicking on the Trader-column.
   b. Identify the statuses of Trader1’s different trades.
6. Find the link for managing a trade with status not yet handled.
   a. Find trade that is not yet handled in the table.
   b. Double-click on the trade’s row in the table to open a window from which it is supposed to be possible to manage the trade (window not yet implemented).

10.2 Appendix II: Form for Assessing Usability of Prototype
The following form was used in the think-aloud evaluation of the prototypes. The form was originally in Swedish, but has been translated to English.

Tick the box to indicate to which degree you agree with following statements:

1. It is easy to identify if there is work left to complete.
   - Strongly disagree
   - Disagree
   - Undecided
   - Agree
   - Strongly agree

2. It is easy to navigate in the prototype.
   - Strongly disagree
   - Disagree
   - Undecided
   - Agree
   - Strongly agree

3. It is easy to identify the trades that need to be managed.
   - Strongly disagree
   - Disagree
   - Undecided
   - Agree
   - Strongly agree

4. A dashboard presenting the status of today’s trades would remind me that I have not yet completed today’s work.
   - Strongly disagree
   - Disagree
   - Undecided
   - Agree
   - Strongly agree

5. The dashboard presents information that is relevant for my work.
   - Strongly disagree
   - Disagree
   - Undecided
   - Agree
   - Strongly agree

6. I would have use for a system like this in my daily work.
   - Strongly disagree
   - Disagree
   - Undecided
   - Agree
   - Strongly agree
10.3 Appendix III: User Evaluation Interview
The eight questions presented below are those asked after the think-aloud evaluation of the prototypes. (Translated from the original Swedish version to English).

1. How well do you understand the purpose of the application?
2. What do you think about the use of coloration to indicate statuses?
3. Was it difficult to understand what it was possible to do in the prototype?
4. How would a dashboard serve to remind about trades that have not yet been handled?
5. How much of the information on the dashboard was relevant to you?
6. How could this system aid in your daily work?
7. Do you think something is missing in the prototype or dashboard?
8. Is there anything else you would like to add?