Designing a Risk Manager Dashboard

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Abstract

This thesis explores the design of a dashboard interface viewing financial data, specifically clearinghouse data relevant for getting an overview of the current risk situation. The target user is a risk manager at a clearinghouse. The design is based on available research and guidelines on graphical perception, information visualization and dashboard design. The design process is described from the initial problem analysis to prototyping and testing. The resulting design concept is presented with sketches and motivations of the choices made. The thesis was conducted in cooperation with Cinnober Financial Technology, a provider of software and services for trading and clearing.
# Contents

1 Introduction 3  
  1.1 Problem Statement 3  
  1.2 Related Work 4  
  1.3 Report Outline 4  

2 Information visualization 7  
  2.1 Graphical perception 7  
  2.2 Graph types 9  
    2.2.1 Bar charts and stacked bar charts 9  
    2.2.2 Pie charts and doughnut charts 9  
    2.2.3 Line charts and area charts 10  
    2.2.4 Heat maps 11  
    2.2.5 Tree maps 11  
    2.2.6 Bullet graphs 11  
    2.2.7 Sparklines 14  
    2.2.8 Small multiples 14  
  2.3 Color 14  
  2.4 Layout 16  
  2.5 Interactivity 16  

3 Trading and Clearing 19  
  3.1 Exchanges 19  
  3.2 Clearinghouses 19  
    3.2.1 Risk management 20  

4 Method 21  
  4.1 Design Process 21  
  4.2 Guidelines 21  
  4.3 Usability Testing 24
## 5 Result

5.1 Predesign stage ......................................................... 25  
5.1.1 Know the user ...................................................... 25  
5.1.2 Functional analysis ................................................ 25  
5.1.3 Competitive analysis .............................................. 26  
5.1.4 Usability goals ...................................................... 26  
5.2 Design stage .......................................................... 26  
5.2.1 Coordinated design ................................................ 28  
5.2.2 Prototyping .......................................................... 28  
5.3 Usability testing ....................................................... 32  

## 6 Conclusions ......................................................... 35  
6.1 Future work ............................................................ 35  

## 7 Acknowledgements .................................................. 37  

References ............................................................... 39
## List of Figures

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1</td>
<td>The elementary perceptual tasks described by Cleveland and McGill (adapted from [CM84, Figure 1]).</td>
<td>8</td>
</tr>
<tr>
<td>2.2</td>
<td>Grouped and stacked bar charts showing the protein, fat, carbohydrate and fibre content per 100g of</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>different foods. Based on data from the Swedish National Food Agency’s food database [Age14].</td>
<td></td>
</tr>
<tr>
<td>2.3</td>
<td>A pie chart and a doughnut chart.</td>
<td>10</td>
</tr>
<tr>
<td>2.4</td>
<td>A line chart and an area chart showing the electricity usage in Sweden June 2013–June 2014. Based</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>on data from Statistics Sweden’s statistical database [Swe14].</td>
<td></td>
</tr>
<tr>
<td>2.5</td>
<td>A geographical heat map showing the population density of the Nordic countries 2011. Design by</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Johanna Roto, Nordregio [Rot11].</td>
<td></td>
</tr>
<tr>
<td>2.6</td>
<td>The GNOME Disk Usage Analyzer can show the disk usage using a tree map (author’s screenshot).</td>
<td>13</td>
</tr>
<tr>
<td>2.7</td>
<td>A bullet chart.</td>
<td>13</td>
</tr>
<tr>
<td>2.8</td>
<td>Yield, kg per hectare, by crop and year in Sweden 1965-2013 displayed using small multiples. Based</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>on data from the Swedish Board of Agriculture [Agr14].</td>
<td></td>
</tr>
<tr>
<td>2.9</td>
<td>The online tool Colorbrewer [Bre14] can be used to generate color schemes. Here a diverging color</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>scheme with seven data classes is shown (author’s screenshot).</td>
<td></td>
</tr>
<tr>
<td>2.10</td>
<td>A scatter plot matrix showing Anderson and Fisher’s classic Iris flower data set [Fis36]. A subset</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>of the data has been selected by “brushing” one of the scatter plots, and the selected points have</td>
<td></td>
</tr>
<tr>
<td></td>
<td>been “linked” together with corresponding points in the other scatter plots by highlighting.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Visualization by Michael Bostock [Bos12].</td>
<td></td>
</tr>
<tr>
<td>3.1</td>
<td>Trading without a central clearinghouse (to the left) and with a central clearinghouse (to the</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>right).</td>
<td></td>
</tr>
<tr>
<td>4.1</td>
<td>The steps of Nielsen’s usability engineering model [Nie92]</td>
<td>22</td>
</tr>
</tbody>
</table>
5.1 Some of the applications used for inspiration, from top to bottom: Bloomberg Industry Leaderboard [Blo14], Microsoft Office Outlook 2007, Spotify web app [Spo14] (author’s screenshots) ........................................ 27
5.2 Some early sketches ........................................ 28
5.3 A mockup of the final risk manager dashboard concept. Note that the colors used to represent different instruments are not consistent between lists, this should be fixed before doing user tests ........................................ 29
5.4 A mockup of the final risk manager dashboard concept, drawn to match the common style for Cinnober’s clearing dashboards. Illustration by Kajsa Olofsson, Cinnober ........................................ 30
5.5 Coordinated highlighting is used to link related list items ........................................ 31
5.6 The interactive prototype in its current unfinished state ........................................ 33
Chapter 1

Introduction

A risk manager at a clearinghouse needs to be aware of the current risk situation, and a vital part of that is to be able to analyze information about clearinghouse members and their trades. Data about members, instruments and trades exists in abundance in Cinnober’s clearing platform, but how should this data be presented so that the risk manager doesn’t get overwhelmed, and instead quickly get an overview over the most important information?

One way to cope with the information overload is by using a dashboard. Exactly what is meant by dashboard differs depending on who you ask, but a good attempt at defining what a dashboard is is made by Few: “A dashboard is a visual display of the most important information needed to achieve one or more objectives, consolidated and arranged on a single screen so the information can be monitored at a glance” [Few13, p. 26].

An alternative definition is given by Yigitbasioglu and Velcu: “[A dashboard is] a visual and interactive performance management tool that displays on a single screen the most important information to achieve one or several individual and/or organizational objectives, allowing the user to identify, explore, and communicate problem areas that need corrective action.” [YV12]

Dashboards can be useful tools to aid decision making, but in order to be really effective, they have to be designed and customized to the tasks they are meant to support.

Many dashboards today fail to support the tasks at hand in a good way and many of them do not take into account how the human perception works [Few13, Chapter 2].

1.1 Problem Statement

The goal of this work is to design a dashboard concept for clearinghouse risk managers. The purpose of the dashboard is to help risk managers get a quick overview of the current risk situation. Existing usability guidelines and best practices for information visualization and dashboard design should be followed when designing the concept.

The thesis starts with a review of information visualization techniques and guidelines. The review is made to get a good foundation for the design of the dashboard but it can also be used as a reference for future projects at Cinnober, when designing dashboards for other purposes.

Feedback has been sought continuously during the design process to make sure that the dashboard displays information that risk managers actually find useful and that helps them achieve their goals. To ensure that the usability and dashboard guidelines are followed, the final concept is heuristically evaluated.
The work is done as part of Cinnober’s UX-team’s effort to design clearinghouse dashboards for several user groups. A specific clearinghouse was used for this pilot project. Other clearinghouses will probably have slightly different needs and the design would have to be adapted.

The dashboard concept presented is made with tablet computers in mind, but all the information about dashboard design and information visualization in this report applies to dashboards in general.

The risk manager dashboard is supposed to complement an existing web user interface for interacting with the clearing system. The dashboard will be kept simple, focusing on only the most important use cases, while the existing interface has a lot of functionality and supports many different user types, but can be a bit overwhelming and is not optimized for specific user needs.

1.2 Related Work

Shah, Freedman, and Vekiri have written a thorough review of graph comprehension research. They note that there are two major types of graph interpretation models, the ones about the extraction of facts from graphs, which focus on perceptual tasks, and the broader models that look at the relationship between the graph design, the viewer’s prior knowledge and the current task. They go through findings about the strengths and weaknesses of tables, bar charts, line charts, pie charts and stacked bar charts. They also discuss, among other things, 3d-graphs, animation, color and the effect of size and aspect ratio. Finally, they deal with the effects on comprehension of data complexity, the task, the user’s graphical literacy, prior knowledge about the content and the user’s visual ability and working memory [SFV05].

Edward Tufte has written four books about the visual display of information. In his books, Tufte gives many examples of good and bad design. Among other things he warns of chartjunk – unnecessary decoration that draws attention away from the data and sometimes actively deceives by distorting how the data is perceived. Instead he argues for visually clean graphics with a high “data-ink ratio” [Tuf01][Tuf95][Tuf97][Tuf06].

Yigitbasioglu and Velcu have done a literature review, identifying the main issues to consider when designing dashboards. They try to answer three main questions: What design features should be used for designing effective dashboards? How much of users previous experiences and knowledge should be taken into account when designing dashboards? Do dashboards need to be designed differently for different cognitive styles and personality types? [YV12]

Stephen Few’s book Information Dashboard Design draws from his experiences from 30 years in the business intelligence and information design industry. The book covers the whole process from choosing what data to display, through choice of display media, to layout. Few also shows examples of what he thinks is bad and good dashboard design, and describes design guidelines and common mistakes to avoid [Few13].

1.3 Report Outline

The report starts with an overview of graphical perception, showing how knowledge about our perception can be used to design charts and graphs that conveys information in a clear way. An overview is also given over the use of color, layout and how interactivity can be used to aid the understanding and exploration of the data (chapter 2). Then trading and
clearing is briefly explained to give some background to terminology used later in the report (chapter 3).

After the background, the design process is described (chapter 4) and then applied, resulting in a dashboard prototype (chapter 5). The report ends with conclusions and suggestions for further research (chapter 6).
Chapter 2

Information visualization

The goal of information visualization is to present abstract data to the user in a clear way by taking advantage of the human’s great visual perception system.

Often information can be perceived faster and easier when presented in a graphical way, but it is not always the case. To find the best visualization to use we must know both what the visualized data should be used for, and what kind of visualization best supports that use case. Vessey argues that there are spatial and symbolic tasks, and that graphs supports solving spatial problems best, while numeric tables are best for symbolic tasks [Ves91]. However, that doesn’t tell the whole story, as different kinds of graphs emphasize different spatial features of the data. For example, Washburne’s experiments show that tables facilitate recall of specific amounts, bar charts are better for more complex comparisons and line charts are better for trends [Was27].

2.1 Graphical perception

The purpose of a graph is to convey information. In order to do that the viewer must be able to extract the information from the graph easily and at least fairly accurately.

Cleveland and McGill describe a set of elementary perceptual tasks used when extracting quantitative information from graphs, see figure 2.1. Based on a series of experiments they found an ordering of the tasks from most to least accurate:

1. Position along a common scale
2. Positions along nonaligned scales
3. Length, direction, angle
4. Area
5. Volume, curvature
6. Shading, color saturation

This list is good to keep in mind when choosing graph type, however the accuracy of reading values is not the only thing that matters, and in some cases other things are more important, for example getting a rough idea of the “shape” of the data, spotting outliers or fitting all data on one page.

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1E.g. increases and decreases over time and repeating patterns.
Figure 2.1: The elementary perceptual tasks described by Cleveland and McGill (adapted from [CM84, Figure 1]).
2.2 Graph types

As noted earlier different types of graphs are are good at showing different things. Here’s a short review of a few common graph types, and when and why they are suitable to use.

2.2.1 Bar charts and stacked bar charts

A bar chart encodes quantities as the length of bars. Since the bars are aligned, the perceptual task used for extracting information from a bar chart is “position along a common scale”. A bar chart can have either vertical or horizontal bars. An advantage with horizontal bar charts is that it’s easier to fit labels directly at the bars with horizontal text.

In a stacked bar chart the bars are divided into sub-bars (see figure 2.2). With stacked bar charts you can accurately see differences between the totals and compare the category at the bottom of the stacks. Comparing between other categories is less accurate, and comparing categories in the same stack even less so [CM84].

Since reading the sub categories is not very accurate, stacked bar charts must be used with care. Few suggests that stacked bar charts can be suitable “[...] when we must display multiple instances of a whole and its parts, with emphasis on the whole” [Few13, pp. 126-127]

Cleveland and McGill recommends replacing stacked bar charts with a grouped bar chart (see figure 2.2) or dot chart\^2 since they are more accurate [CM84], but while it is true that they show the same information more accurately, they also take up more space, so they can be hard to use when you want to display many instances in a small area.

2.2.2 Pie charts and doughnut charts

The use of pie charts is widespread even though it is discouraged by many ([CM84][Tuf01, chapter 9][Few13, chapter 8]) and for the most part the discouragement is well deserved. When reading single values pie charts are far less accurate than bar charts [CM84]. They are

\^2A dot chart is an alternative to bar charts suggested by Cleveland [Cle84] using the position of dots instead of the length of bars.
Figure 2.3: A pie chart and a doughnut chart.

about as accurate as comparing subcategories of a stacked bar chart, with the disadvantage that they take up more space.

But pie charts do have an advantage: A pie chart clearly signals that the pieces are parts of a whole – that they always sum up to 100%. There are also studies showing that pie charts can be more accurate than bar charts when comparing the size of combinations of pieces instead of doing individual comparisons [SL91].

A doughnut chart is a pie chart with a hole in the middle (see Figure 2.3). The empty space in the middle is sometimes used to display a caption. Some argue that doughnut charts are even less accurate than pie charts because they remove the angles in the middle of the pie that are used when comparing slices.

2.2.3 Line charts and area charts

Figure 2.4: A line chart and an area chart showing the electricity usage in Sweden June 2013–June 2014. Based on data from Statistics Sweden’s statistical database [Swe14].

While bar charts displays individual values and are useful for comparing distinct items in nominal or ordinal categories, line charts are suited for displaying items along an interval
2.2. Graph types

scale, for example measurements over time. Line charts highlight the shape of the data series instead of the individual values and give better support when trying to answer questions about relative changes, such as increases or decreases, in the data [Was27] [Few13, Chapter 8].

Area charts are a stacked version of the line chart. They display how a total quantity made up of several parts changes over an interval. There are several problems with area charts. Similarly to the stacked bar chart, comparing the heights of the areas is less accurate than comparing a line along a common scale. Another problem is that since the areas are stacked, change in one category affects all categories above it, this makes it harder to see trend changes in isolated categories. Change in one category can be obfuscated if other categories change at the same time and it makes it harder to compare the shape of different categories (cf. for example the line and area charts in figure 2.4).

2.2.4 Heat maps

Heat maps use differences in shading or color saturation to encode quantities, which means they are not suited for giving accurate readings, but they allow a lot of data points to be displayed side by side and can be good for spotting patterns and for giving an overview of the data.

Heat maps can simply be colored rectangles or circles in a row or on a grid, but heat mapping can also be combined with other chart types, giving them an extra quantitative axis. A common use case is heat mapping on geographical maps (figure 2.5).

See section 2.3 for more information on choosing good heat map color schemes.

2.2.5 Tree maps

Tree maps were originally invented for visualizing the structure and hard disk usage of a file system hierarchy, but they can be used for displaying all sorts of hierarchical data where there is a need to visualize both the hierarchy and the quantity of different categories and subcategories [Shn92].

In a tree map the available space is divided into as many rectangles as there are top level categories. The sizes of the rectangles encode a chosen quantity of the category. Each category is then recursively divided into smaller rectangles representing sub categories (see figure 2.6). The color of the rectangles can be used to encode additional categorical data or, using heat mapping, another quantity.

Tree maps use area to encode quantities which is low on the order of perceptual tasks and thus only give an approximate idea of their sizes. The strength of tree maps is that they can give an overview over large, hierarchical data sets in a limited space.

2.2.6 Bullet graphs

A bullet graph is a bar chart with a single bar, on a background with differently shaded zones, usually one zone for bad, one for acceptable and one for good. A comparative value is marked with a short line across the bar (see figure 2.7). The bullet graph was designed by Few as a better alternative to the circular, space wasting, gauges commonly used on dashboards [Few13].
Figure 2.5: A geographical heat map showing the population density of the Nordic countries 2011. Design by Johanna Roto, Nordregio [Rot11].
2.2. Graph types

Figure 2.6: The GNOME Disk Usage Analyzer can show the disk usage using a tree map (author’s screenshot).

Figure 2.7: A bullet chart.
2.2.7 Sparklines

A sparkline is a small chart, used to give context to a value. Sparklines lack visible scale markings and are not meant to be used for reading out specific values, they are used to convey the shape of the data. They can be used in table cells or embedded in text like this $22.3^\circ$C. Sparklines are usually line charts but other types of charts, e.g. bar charts can also be used [Tuf06, Chapter 2].

2.2.8 Small multiples

Small multiples is an alternative to trying to fit all data into one chart, instead multiple smaller charts with the same size and scales are put side by side for easy comparison (see figure 2.8) [Tuf01, Chapter 8].

![Small multiples example](image)

Figure 2.8: Yield, kg per hectare, by crop and year in Sweden 1965-2013 displayed using small multiples. Based on data from the Swedish Board of Agriculture [Agr14].

2.3 Color

Colors should be used consistently throughout a design, the same colors should not be used to represent different things. When using color to represent categories it’s good to think about what people associate with different colors. Using a color the viewer naturally links with the category can reduce their cognitive load (see for example the colors used in figure 2.3). Also keep in mind that some colors are difficult to distinguish for colorblind persons, red and green being the most common.

The number of colors should be kept limited, and the colors used should mainly be soft and muted. Stronger more saturated colors can be used sparingly to highlighting important information. Too many and bright colors makes it hard to focus on the information and bright colors can also affect how the size of areas are perceived [CHM83] [SSM11].

When using colors to represent ordinal or quantitative data such as in a heat map a “perceptually ordered” color scheme should be used. The strongest cue for perceived order
2.3. Color

is a color’s lightness, so a good choice of scale is using a single color hue and gradually altering the lightness, going from light to dark. It’s also possible to use a scale with changing hue, as long as the lightness also changes, see for example figure 2.5. If the data has a natural midpoint, such as a mean or zero value, a diverging color scheme, with two colors meeting in the middle, can be used.

Using light colors for smaller values and dark colors for larger values is a common cartographic convention [HB03]. This convention is perhaps confusing when using the common yellow-red color scale for people familiar with black-body radiation and color temperature, since a color gets darker and redder as the temperature decreases.

A helpful resource for choosing color schemes is Colorbrewer\(^3\), an online tool designed at the GeoVISTA Center at Penn State University to help select good color schemes for geographical maps. Colorbrewer can generate single and multi-hue sequential, diverging and categorical color schemes with different numbers of data classes (see figure 2.9) [HB03]. Colorbrewer also informs about whether the chosen color scheme is suitable for colorblind users and if there may be problems reproducing it on a screen or in print.

![Color Brewer Screenshot](http://colorbrewer2.org/)

Figure 2.9: The online tool Colorbrewer [Bre14] can be used to generate color schemes. Here a diverging color scheme with seven data classes is shown (author’s screenshot).

\(^3\)http://colorbrewer2.org/
2.4 Layout

How things are shaped and laid out affects how we perceive them. The gestalt laws of organization, formulated by Gestalt psychologists in the first half of the 20th century describes some principles for how we organize our perceptions and perceive form and patterns [BGG03, Chapter 6].

Some of the most commonly discussed laws are:

**Proximity** Objects that are near each other are perceived as grouped.

**Similarity** Objects that look similar are perceived as grouped.

**Common fate** Objects that move together are grouped together.

**Good continuation** We perceive smooth and continuous shapes over sudden changes.

**Closure** If several perceptual organizations is possible, we will prefer “closed” figures over “open” ones. For example these four dots \( \cdot \cdot \cdot \) will be interpreted as a square \( \Box \) rather than as a cross \( \times \).

**Enclosure** Objects enclosed with a common border or background color are perceived as a group.

The Gestalt laws most useful to keep in mind when doing layout are probably proximity, similarity and enclosure. More detailed descriptions of the Gestalt Laws can be found in [BGG03, Chapter 6] and [Few13, Chapter 5].

2.5 Interactivity

A dashboard should let the user get an overview over the most important information without having to interact, but that doesn’t mean that the dashboard should not be interactive at all. If the user sees something interesting on the dashboard, they may want to see more details or they may want to focus on a subset of the data by filtering or zooming in.

Filtering can be done with free text input or by using predefined filters that can quickly be activated and deactivated with the press of a button. Filtering can also done by “brushing”: interactively selecting a subset of the data in a graph by click and drag (or, on touchscreens, by dragging a finger), see figure 2.5 [BC87][BCW87].

The user may also want to see how different measures are related. An important way to show relations is to group items on the display by using the gestalt principles discussed in section 2.4. Additional relations can be shown interactively by visually “linking” an item the user selects to related items on the dashboard, e.g. by highlighting them (see figure 2.5) [BCW87]. Relations in data displayed in tables can be explored by sorting on different columns to see which items have similar values.

Additional information about an item can be displayed on demand, when the user clicks, hovers or touches the item. An alternative to toggling filters or extra information by clicking, is to only have the action happen while the finger is held on the button or item and as soon as it is released the display is restored to the original state. This "click-hold-release" is suggested by [Few13, p. 190] as a way to show supplementary information without risking that the user confuse what they see with something else, for example by accidentally leaving a filter active and mistaking the filtered data for all data (cf. Larry Tesler’s criticism of modes [Tes12]).
Shneiderman’s *Visual Information Seeking Mantra* “Overview first, zoom and filter, then details-on-demand” is a useful principle to keep in mind when designing information visualizations [Shn96].
Figure 2.10: A scatter plot matrix showing Anderson and Fisher’s classic Iris flower data set [Fis36]. A subset of the data has been selected by “brushing” one of the scatter plots, and the selected points have been “linked” together with corresponding points in the other scatter plots by highlighting. Visualization by Michael Bostock [Bos12].
Chapter 3

Trading and Clearing

3.1 Exchanges

An exchange is a central place for trading various financial instruments such as stocks, bonds, futures and options.

Bonds are "tradable debt". Buying a bond is basically giving a loan to the bond issuer, which the issuer promises to pay back with (usually fixed) interest [Har03, p. 40]. A future or futures contract is an agreement saying that the buyer has to buy, and the seller has to sell, an asset on a predetermined date at a predetermined price [DG98]. An option is similar to a future, but more flexible. It gives you, for an upfront fee called premium, the option, but not the obligation, to buy or sell an asset at a specified price and time in the future. A call option gives the right to buy and a put option gives the right to sell. [DG98] [Har03, p. 42].

The exchange makes it easier to trade by matching buy orders with sell orders, so that the buyers and sellers doesn’t have to find a suitable counterparty on their own. Since the exchanges have large volumes of trades going through them they can analyze the supply and demand and set appropriate prices.

The exchange also offers a guarantee so that even if the buyer fails to pay or if the seller doesn’t deliver the shares the counterparty will still get what was agreed upon. This guarantee is given with the help of a clearinghouse.

3.2 Clearinghouses

The clearinghouse guarantees a trade by stepping in as a middleman: instead of the buyer and seller trading directly with each other, the clearinghouse splits the contract in two so that the clearinghouse acts as a buyer for every seller and a seller for every buyer (see figure 3.1). This process of replacing the original contract with a contract with someone else (the clearinghouse) is called novation [DG98, p. 403].

The clearinghouse and the exchange are sometimes owned by the same company, but they can also be separate organizations, and one clearinghouse can serve more than one exchange.
3.2.1 Risk management

Only clearing members are allowed to trade directly at the exchange and clearinghouse. To decrease the risk that a member doesn’t fulfill their obligations, the demands for becoming a clearing member are high. But there is still a risk that something happens, so all members are required to deposit collateral to the clearinghouse to make sure that the clearinghouse can step in if a party does not fulfill their obligations.

Instead of becoming a clearing member yourself, it is possible to make an agreement with an existing clearing member and trade through them. To keep track of the various trading activity the clearing members have different kinds of accounts on the clearinghouse, for example house accounts for the members’ own trading, individual segregated accounts (ISA) for individual larger clients and omnibus accounts for several smaller clients.

The amount of collateral needed for being allowed to trade is called margin. The margin can be calculated with the help of different risk models for example Value at Risk (VaR) or Standard Portfolio Analysis of Risk (SPAN).

The quality of the collateral is important. If a member deposits collateral in the form of shares in the member, the collateral will be worthless in case the member defaults, so the collateral wouldn’t provide any security. The collateral also needs high liquidity, so that the clearinghouse can convert them into cash quickly when needed. Liquidity is the degree to which an asset can be sold or bought without affecting the price. Something that can be sold or bought in large quantities without affecting the price much has high liquidity [DG98].

Because of the quality needs the clearinghouse usually have rules for what is allowed to be used as collateral, for example cash in certain currencies, gold and government guaranteed bonds.
Chapter 4

Method

4.1 Design Process

The design process used was inspired by Nielsen’s usability engineering model (Figure 4.1) [Nie92] but while Nielsen’s model describes the process all the way to finished product, this project ends at the prototype stage. The model has also been slimmed down somewhat to fit the constraints of the project:

– Predesign stage
   1. Know the user
   2. Functional analysis
   3. Competitive analysis
   4. Usability goals

– Design stage
   1. Coordinated design
   2. Guidelines
   3. Prototyping
   4. Testing

In the predesign stage, the problem at hand is analyzed, trying to make clear who the user is, what their goals are, what the requirements are, if someone else has tried to solve the problem, etc.

In the design stage you try to create a good solution to the problem, based on the the information acquired in the predesign stage. Usability guidelines are used to help guide the design, together with iterative prototyping and testing.

4.2 Guidelines

Nielsen recommends that several types of guidelines should be used: general usability guidelines, category-specific guidelines and product-specific guidelines [Nie92].

Nielsen’s 10 basic usability heuristics were used as general usability guidelines. The heuristics were originally developed by Nielsen and Molich [MN90][NM90] and have been
0. Consider the larger context
1. Know the user
   - Individual user characteristics
   - The user’s current task
   - Functional analysis
   - Evolution of the user
2. Competitive analysis
3. Setting usability goals
4. Participatory design
5. Coordinated design of the total interface
   - Standards
   - Product identity
6. Guidelines and heuristic analysis
7. Prototyping
8. Empirical testing
9. Iterative design
   - Capture the design rationale
10. Collect feedback from field use

Figure 4.1: The steps of Nielsen’s usability engineering model [Nie92]

revised after an analysis of 249 usability problems to find the heuristics that best explains real usability problems [Nie94a]. The latest version can also be found on Nielsen Norman Group’s web page [Nie95a]:

Visibility of system status The system should always keep users informed about what is going on, through appropriate feedback within reasonable time.

Match between system and the real world The system should speak the users’ language, with words, phrases and concepts familiar to the user, rather than system-oriented terms. Follow real-world conventions, making information appear in a natural and logical order.

User control and freedom Users often choose system functions by mistake and will need a clearly marked ”emergency exit” to leave the unwanted state without having to go through an extended dialogue. Support undo and redo.

Consistency and standards Users should not have to wonder whether different words, situations, or actions mean the same thing. Follow platform conventions.

Error prevention Even better than good error messages is a careful design which prevents a problem from occurring in the first place. Either eliminate error-prone conditions or check for them and present users with a confirmation option before they commit to the action.

Recognition rather than recall Minimize the user’s memory load by making objects, actions, and options visible. The user should not have to remember information from one part of the dialogue to another. Instructions for use of the
system should be visible or easily retrievable whenever appropriate. (Read full article on recognition vs. recall in UX.)

**Flexibility and efficiency of use** Accelerators – unseen by the novice user – may often speed up the interaction for the expert user such that the system can cater to both inexperienced and experienced users. Allow users to tailor frequent actions.

**Aesthetic and minimalist design** Dialogues should not contain information which is irrelevant or rarely needed. Every extra unit of information in a dialogue competes with the relevant units of information and diminishes their relative visibility.

**Help users recognize, diagnose, and recover from errors** Error messages should be expressed in plain language (no codes), precisely indicate the problem, and constructively suggest a solution.

**Help and documentation** Even though it is better if the system can be used without documentation, it may be necessary to provide help and documentation. Any such information should be easy to search, focused on the user’s task, list concrete steps to be carried out, and not be too large.

The “critical design practices” listed by Few were used as category specific guidelines, to help evaluating how well the design works as an information dashboard [Few13, Chapter 12]:

- Organize information to support its meaning and use.
- Maintain consistency to enable quick and accurate interpretation.
- Put supplementary information within reach.
- Make the experience aesthetically pleasing.
- Expose lower-level conditions.
- Prevent excessive alerts.
- Keep viewers in the loop.
- Accommodate real-time monitoring.

Additionally his list of thirteen common design mistakes was used to help identify possible problems [Few13, Chapter 2]:

- Exceeding the boundaries of a single screen
- Supplying inadequate context for the data
- Displaying excessive detail or precision
- Expressing measures indirectly
- Choosing inappropriate display media
- Introducing meaningless variety
- Using poorly designed display media
– Encoding quantitative data inaccurately
– Arranging information poorly
– Highlighting important information ineffectively or not at all
– Cluttering the display with visual effects
– Misusing or overusing color
– Designing an unattractive visual display

Product specific guidelines, must be developed for each project based on prototyping and testing [Nie92].

4.3 Usability Testing

The size of the project has not allowed large scale usability testing, instead simpler and faster techniques have been used. Most evaluation and testing has been done quite informally, by asking clearinghouse experts and members of the Cinnober UX-team for feedback. This kind of “opportunistic evaluations” are often done early in the design process to get quick feedback on ideas [SRP07, Chapter 12].

Semi-structured interviewing was used for evaluating later mockups, and heuristic evaluation, which is recommended by Nielsen as a good “Discount Usability Engineering” technique [Nie94b] was conducted on the final design concept to find remaining usability problems.

The guidelines in section 4.2 that were used as a help during development, were also used for the heuristic evaluation. A heuristic evaluation is done by going through the interface, inspecting its elements, comparing them against the guidelines and compiling a list of usability problems found during the evaluation. The list should contain motivations as to why the problems are problems, relating back to the guidelines [Nie95b].
Chapter 5

Result

5.1 Predesign stage

5.1.1 Know the user

The target user group for the dashboard is risk managers at clearinghouses. Among other things, risk managers monitor the members’ trading to see patterns that may indicate a risk.

Unfortunately it has not been possible to talk directly with risk managers during this project since it is still a pilot project with no clearinghouse involved that could provide users. Cinnober does however have employees that through their work with existing customers and clearing systems have expertise about the clearing trade, so in the absence of risk managers these clearing experts have been asked for advice.

5.1.2 Functional analysis

A dashboard should quickly show the information the user needs to accomplish their goal. To identify what the most important pieces of information are for a risk manager for keeping track of the risk situation, the experts were asked what key measures that they would be interested to see as a risk manager on a clearinghouse. Their answers were compiled into a list of eight key pieces of information:

Member activity How big part of the trade activity, counting both sales and purchases, that is generated by the different members and their accounts (in cash value, not volume).

Member exposure How big part of the trades, netting sales and purchases, each member has.

Instrument activity How the trade activity, both sales and purchases, is distributed between different instrument types.

Instrument exposure How the trades, netting sales and purchases, are distributed between different instrument types.

Upcoming instrument expiries are interesting to keep track of since the trading activity will usually increase near expiries.
Margin/Collateral ratio  How big part of the members deposited collateral that is required to cover the margin requirement. A margin call will be sent when this is nearing 100%.

Outstanding margin calls  When a member needs to deposit more collateral in order to continue trading a request for more collateral is made, this is called a margin call. Margin calls are no problem for the clearinghouse if the member quickly answers by depositing more collateral, but a margin call that is not settled quickly may indicate that the member has problems.

Collateral breakdown  What the deposited collateral consists of, this could be for example cash in different currencies, gold or bonds.

We specifically didn’t ask how the experts wanted the dashboard to look, just what goal they had and what information they thought could help reach that goal. As Few notes, talking about appearance at this stage can easily detract the focus from trying to clarify what the user is trying to accomplish [Few13, Chapter 3].

During requirement discussions we also identified the users’ need to easily share what they have seen in the interface with other colleagues. The importance of easy sharing of interesting finds in information visualization systems is also noted by Shneiderman [SP05, p. 581]

5.1.3 Competitive analysis

The main ”competitor” for the dashboard is the current clearinghouse user interface, even if, as explained in the introduction, the dashboard is not meant to replace it but to complement it. The current interface has been looked on for inspiration and has been a good tool for exploring what kind of data is available in the clearing system. A few finance and stock market apps and websites, and some popular non-finance apps have also been examined. Some examples can be seen in figure 5.1. Another source of inspiration have been the examples of dashboards given by [Few13].

5.1.4 Usability goals

The user should be able to take in the presented information “at a glance”, getting a quick overview of the current situation with minimal interaction needed. More detailed information should be accessible on demand by interacting with the dashboard, but this information should be displayed without leaving the dashboard screen completely.

5.2 Design stage

When the functionality and goals of the dashboard has been decided on, the next important thing is to decide how the information identified in the functional analysis should be displayed.

The recommendations about information visualization outlined in chapter 2 and the general and dashboard specific usability guidelines described in section 4.2 were used as starting point for the design work.
5.2. Design stage

Figure 5.1: Some of the applications used for inspiration, from top to bottom: Bloomberg Industry Leaderboard [Blo14], Microsoft Office Outlook 2007, Spotify web app [Spo14] (author’s screenshots).
5.2.1 Coordinated design

A consistent design has benefits both for the users of a system, by reducing the learning curve, and for the designers and developers, as a common basis increases the possibility for component reuse [Nie89].

The risk manager dashboard should be consistent not only with itself, but also with other dashboards developed at Cinnober. Therefore the design of the clearinghouse dashboards for different user groups was discussed together with the UX-team to try to make the dashboards consistent in layout, visual design and interaction, while still being customized for their specific use case. Finally the dashboards should also try to be consistent with the users expectations stemming from use of other applications.

5.2.2 Prototyping

Layout and choice of diagrams

Several sketches were made to test out different design ideas (see figure 5.2). The design that was chosen took the eight identified key measures and divided the interface, into one area per measure. The member measures (exposure, activity and margin) were grouped together in a row at the top and instrument measures (exposure, activity and collateral breakdown) in a row at the bottom. Event notifications (margin calls and expiries) were put in a column to the right (see figure 5.3).

![Figure 5.2: Some early sketches.](image)
5.2. Design stage

Figure 5.3: A mockup of the final risk manager dashboard concept. Note that the colors used to represent different instruments are not consistent between lists, this should be fixed before doing user tests.

For the member exposure and activity measures the member total was determined to be the most important, but to be able to see a breakdown on account types would also be desirable. Similarly, for the instruments the total is the most important, but a breakdown on types (commodity types or contract types depending on the measure) would also be interesting according to the experts.

Stacked bar charts were chosen for the exposure and activity measures because of the need to show many items side by side. Even if they are less good for making comparisons between subcategories, the stacked bar chart gives a rough picture and accurately shows the total amount in a very compact way. Grouped bar charts would have been a good choice if the space had allowed it.

The margin/collateral ratio is illustrated with a sparkline and a bar chart with a red zone near and over 100%, creating a kind of simplified bullet graph. One initial idea for displaying margin was to have one bar for deposited collateral and one for required margin displayed side by side, this idea was scrapped since it is an indirect measure; what the user really is interested in is the difference between the two.

Collateral breakdown was displayed with a tree map in some mockups, since the initial understanding was that this data could have several layers of subcategories. This doesn’t seem to be the case, so other chart types like bar charts or maybe even a pie chart would have been better suited.

Upcoming expiries and margin call notifications are displayed in a side bar in a calendar and list. This is similar to the to-do bar in Microsoft Outlook, an email, calendar and task manager application which we think many of the users in the target group will be familiar with. The dashboards for other user groups have similar side bars that show notifications and events that are important for their users’ needs. The notifications are time-stamped so that it is easy to see how old they are even when the user doesn’t see when they are added.
Figure 5.4: A mockup of the final risk manager dashboard concept, drawn to match the common style for Cinnober’s clearing dashboards. Illustration by Kajsa Olofsson, Cinnober.
5.2. Design stage

If the interface is extended in the future with other views than the dashboard, e.g. detailed pages for member information and instrument information, the side bar will be visible on those views as well.

Context

_To be truthful and revealing, data graphics must bear on the question at the heart of quantitative thinking: “Compared to what?”_  
— Edward Tufte, *The Visual Display of Quantitative Information* [Tuf01, p. 74]

All measures except the collateral have a historical comparison. The margin/collateral ratio uses sparklines, since it’s important to know the trend when judging how troubling a certain ratio is. A high ratio with a very stable trend might be less worrying than a lower ratio that is quickly increasing. The member measures uses a stacked bar for easy comparison with the previous time period’s total partitioned between account types. The trend was considered more important for the instrument measures, so there the historical context is shown using line and area charts above the top lists. This allows for fewer list items, but makes it easier to compare the instruments than when using sparklines.

Attention

Red color is used to highlight important information, either as dots next to an item or by directly coloring the bar in need of attention in a bar chart. Other colors are kept a bit muted so that they don’t compete for attention with the red.

Things needing attention are for example if the activity or exposure has dropped quickly for a member, if an account’s margin/collateral ratio has increased sharply or if a margin call have gone a long time without being answered.

Interactivity

Coordinated highlighting is used throughout the interface to “link” related items. For example tapping on an item in the member exposure list also highlights that member in the member activity and margin/collateral lists and tapping on an item in the instrument activity list will also highlight the corresponding item in instrument exposure (see figure 5.5). Tapping on a member item in the top row will also filter the three lists in the bottom row to show instrument and collateral information only about the highlighted member. Both the filtering and the highlighting can easily be undone by tapping on the item again.

![Figure 5.5: Coordinated highlighting is used to link related list items.](image-url)
An alternative way of interaction would be to use the *click/tap-hold-release* pattern described in section 2.5: only having the highlighting and filtering happen while the finger is held on the item and as soon as it is released restoring the display to its original state. The two alternatives should be tested with an interactive prototype to get a feel for what works best.

Member exposure, activity and margin can be filtered by account type. Instrument exposure can be filtered on contract type and instrument activity can be filtered on currency type. Feedback about which filters are active is given by graying out the filter buttons of filtered out categories.

Search functionality letting the user search simultaneously through members, instruments, types of accounts, commodity types, currencies etc. has been discussed and will be included in future interactive prototypes, but is not visible in the current mockups. The search could either filter out or highlight relevant items in the interface.

Sharing information from the dashboard with others will be supported with a screen shot button, that lets the user take a screen shot, annotate it by drawing and writing and then sending it to a person in their contact list. Making it easy to share what is seen in the interface directly instead of forcing the user to explain with only text or voice will hopefully reduce the risk for misunderstandings.

**Aesthetics**

The design has been kept flat and simple, following the recent "Flat UI"-trend. Flat design is a good fit for dense data displays, with few decorations or 3d effects that clutter the display and draw attention away from the data. Keeping the display simple also follows Tufte and Few’s recommendations, saying you should avoid so called "chartjunk" and keep the “data-ink ratio” high [Tuf01][Few13, Chapter 6].

**Interactive prototype**

Development of an interactive prototype based on the final mockup sketches was started but only partially finished. The prototype can display mock data with working graphs, coordinated highlighting, filtering and sorting, but due to lack of time the side-bar is not yet implemented, and user testing on the prototype has not been done. The current version of the interactive prototype can be seen in figure 5.6.

### 5.3 Usability testing

A semi-structured interview was done with one of the experts most familiar with risk management. The interview started by showing a mockup to the expert and letting him comment on it freely, then asking what he thought about the chosen measures, comparisons and categorization of data, if they were relevant and if other measures, comparisons or categories would be more helpful. Some alternative designs and diagram types were also viewed to get feedback.

Several changes were made based on the information gained during the interview. The margin/collateral list was changed to show the ratio for each member’s house, omnibus and ISA accounts separately. The instruments were grouped based on expiry date into three groups: near, mid and long. The instrument activity filter was changed to filter on currency.
5.3. Usability testing

A heuristic evaluation was done using the guidelines described in section 4.2 resulting in a list of usability problems:

- In the mockup sketches an area chart is used for showing instrument exposure to emphasize that they are part of a whole and add up to 100%, but a line chart would arguably be better, because they are easier to read accurately and would make it easier to see how exposure and activity vary together. Using a different chart here introduces “meaningless variety” and is perhaps an “inappropriate display media”.

- The information in the side bar may be interpreted as less important and not looked on as often since it doesn’t visually look like it belongs to the main area.

- The colors used for different instrument and collateral categories should be consistent in all graphs and lists, this is not the case in the mockup sketches. The colors should be fixed in future prototypes, before doing user tests. If possible the colors should also be chosen to have some connection to the category, or at least not actively confuse the viewer, for example it would be better to use orange to represent copper than aluminium.

- The different hues of blue and gray can sometimes be difficult to tell apart, for example if one bar is completely of one hue, which one is it?

- A possible problem is the filtering of instrument data when selecting a member. If this per member data is used often, or if it needs to be compared between members, the display will have to be redesigned so that instrument data divided per member is
somehow displayed per default in order to stick to the recommendations of showing all important data on one main screen. To know if this data is needed, or if it would be excessive and clutter the display for no gain, user tests would need to be conducted.

– The member displays uses bars to show a comparison with historical data, the historical instrument data is shown in line charts, and the collateral breakdown lacks historical comparison completely. This was motivated by an assumption that the users would be more interested in the details of historical change of the instrument measures, and not so interested in historical collateral data, but these assumptions would need to be tested to see if these inconsistencies are warranted.

– Feedback about when the data was last updated is missing. This information would be useful both for the user and for colleagues when sharing screenshots.
Chapter 6

Conclusions

The goal of this project was to create a concept for a clearinghouse dashboard aimed at risk managers. A concept was developed, based on an analysis of the user groups needs, with a design based on research and best practices regarding information visualization.

The concept can be used to continue the development of the dashboard for risk managers, but it can also be used, together with the overview of information visualization and dashboard design in the first part of the report, as a reference when designing other dashboards.

6.1 Future work

This work could be continued in several ways. The main thing needed to take the project forward would be to do more testing, on real users. Since there are several differences between clearinghouses, the best would probably be to focus on one clearinghouse and their risk managers first. Testing would be needed both to see if the chosen measures and the layout needs revising. Interaction with the interface should also be tested, for example by finishing and using the interactive prototype.

Even if the dashboards will have to be customized for different clearinghouses and different user groups, several components will probably be very similar and possible to reuse, so a future project could be to make a modular system that makes it easy to switch out components and try out different layouts, which can speed up future development of dashboards.

Existing dashboard creation tools should also be examined to see if they are flexible enough to support the wanted design and to be a viable alternative to using a general purpose programming language.
Chapter 7

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References


