E-MAIL VISUALISATION
A Comparative Usability Evaluation

Saad Alharbi and Dimitrios Rigas
Department of Computing, University of Bradford, BD7 1DP , Bradford, U.K.

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Abstract: As the number of e-mail accounts and messages grow rapidly, traditional e-mail clients that are used nowadays have become difficult to use. Therefore, this paper shows how the usability of e-mail clients can be improved using information visualisation. An experimental e-mail visualisation tool was developed in order to organise e-mail messages in the inbox. It visualises messages based on the date of receiving messages with senders' e-mail addresses. An experiment was carried out to test whether information visualisation could significantly enhance the usability of e-mail clients. The performance of 30 users was observed in a standard e-mail client and the proposed prototype. The results showed that information visualisation could significantly improve the effectiveness and the efficiency of e-mail clients.

1 INTRODUCTION

E-mail is the most widely used application nowadays and it can be the reason for buying a personal computer (Whittaker, Bellotti, & Moody, 2005). It is used everyday in our lives and has become the application that users spend much of their time using. Therefore, the number of e-mail messages increases rapidly. University of California stated that about 31 billion e-mail messages have been sent in 2002 and this number might be doubled in 2006 (Frau, Roberts, & Boukhelifa). In another study, it has been shown that the average user gets around 49 e-mail messages a day while high volume users can get more than hundred (S. Rohall, Gruen, Moody, & Kellerman, 2001). Gwizdka stated that there were 89.1 billion e-mail accounts worldwide in 2002 which is 67% more than 1999 (Gwizdka, 2002). Users usually leave their e-mail messages in the inbox for different purposes such as managing appointments and to-do list. Therefore, e-mail inboxes have become cluttered and difficult to use.

The usability of e-mail clients has not been considered significantly at present. Therefore, this paper describes how the usability of e-mail can be enhanced using information visualisation. It shows an e-mail visualisation tool which visualises e-mail messages based on the date of receiving messages and groups them according to senders' e-mail addresses. An experiment was carried out in order to test whether the information visualisation can improve the usability of e-mail clients. It compares users' performance in a well-known traditional e-mail client (Microsoft Outlook) with the proposed graphical e-mail prototype. The usability was measured in this paper by considering the efficiency and the effectiveness of each e-mail version. Efficiency was measured by calculating the time taken for accomplishing the experimental tasks where the effectiveness was measured by calculating the percentage of tasks completed successfully.

2 RELATED WORK

As the number of e-mail accounts and messages grow rapidly, traditional e-mail clients that are used nowadays have become difficult to use. Therefore, more usable email clients that help users browsing email messages easily are needed. Many studies have been performed in the last few years in order to enhance the usability of e-mail clients. Using folders has been proposed to be the way of organising messages in the inbox (Duchenaut & Bellotti, 2001). It has shown that folders have many problems such as long nesting and they might not be used over time (Rigas, Yu, Klearhou, & Mistry, 2001; Whittaker & Sidner, 1996). Folders are inadequate especially when the high volume e-mail users use them as well as some users having difficulties generating

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appropriate folders label (S. L. Rohall, 2002). Filtering and sorting features in e-mail clients were found difficult to use for organising messages (Duchenaut & Bellotti, 2001). Auto classification has been proposed also to organise messages but it was proven as error prone (S. Rohall, Gruen, Moody, & Kellerman, 2001).

Many studies used information visualisation for enhancing the usability of e-mail clients based on many factors. The date of receiving e-mail messages was used in many studies as the main visualisation factor. Yiu and colleagues visualised e-mail messages based on the time of receiving messages (Yiu, Baecker, Silver, & Long, 1997). E-mail messages were displayed as dots and organised on X, Y axes where time was presented along the X-axis and the senders on Y-axis. The properties of messages (e.g. status and subject) in this visualisation were hidden as well as it has not been evaluated in term of usability. "MailView" is an e-mail tool which visualises e-mail messages depending on the time of receiving messages and presents them as glyphs chronologically (Frau, Roberts, & Boukhelifa). One of the most important advantages of this tool is that it presents the details of the e-mail messages in separate layer. But there was also no usability evaluation results given.

Sudarsky and Hjelsvold developed a tool that visualised the e-mail inbox depending on a hierarchal nature of domain names in e-mail addresses such as COM and EDU (Sudarsky & Hjelsvold, 2002). This approach contains two basic views hierarchal view, which is a tree generated from the domain names, and temporal view which presents the e-mail messages. The result of the tool evaluation showed a significant improved performance as well as improved overall preferences (Sudarsky & Hjelsvold, 2002). Therefore, in our point of view the hierarchal e-mail visualisation is an effective way but users will face difficulties remembering the domain names.

The relationships between e-mail messages (message threads) were also used for visualising e-mail archives. Venolia and Neustaedter pointed out that e-mail clients will be more useful if conversation threads were used as the main display of e-mail clients (Venolia & Neustaedter, 2003). They presented a mixed-model visualisation that presents sequence of e-mail messages and reply relationships among the messages of conversation. The users' understanding of message threads was tested and the result showed they were able to understand them. Even though this technique has shown understanding by users the usability of this technique has not yet been tested. Rohall and colleagues visualised e-mail archives using the relationships between the senders of e-mail messages (S. Rohall, Gruen, Moody, & Kellerman, 2001; S. L. Rohall, 2002). Messages were displayed as connected tree in different colours to show the relationships between them. For example, an e-mail message that coloured purple is from someone outside the recipient's work.

As shown above most of the visualisation techniques used in e-mail enhancement depend on thread conversation, social network and temporal views. Viegas and colleagues developed a tool called "TheMail" for visulising e-mail archive but, it used different visualisation techniques which relied on the content of e-mail messages (Viegas, Golder, & Donath, 2006). This tool presents a series of keywords in columns arranged along a timeline each keyword was shown in different colour. The size of keywords depends on their frequency and distinctiveness. Keywords are displayed in this tool textually which could lead to difficulties in understanding the e-mail inbox. The content of e-mail messages was also used for visualising e-mail archives by using self-organising maps. Here similar e-mails are located close to each other (Nürnberger & Detyniecki, 2006).

As it is shown most of the above studies have not tested whether the information visualisation improved the usability of e-mail clients. In addition, it was inferred that message threads is a useful feature for presenting the messages history. But it might lead to usability problems when it is used as the main factor of visualising e-mail inboxes especially with high volume of e-mail messages. Also, hierarchal visualisation was shown a very effective way for organising e-mail archives. Therefore, this paper presents an e-mail tool which visualises messages based on the date of receiving messages with a hierarchal view of e-mail addresses and evaluates its usability.

3 E-MAIL VISUALISATION

An e-mail visualisation tool was developed in order to test whether information visualisation can improve the usability of e-mail clients. Therefore, apart from displaying messages it does not offer any of the e-mail functions such as sending e-mail messages. E-mail messages are visualised in this tool based on the date of receiving messages and senders' e-mail addresses. Figure 1 shows the inbox in this tool is divided into 3 parts

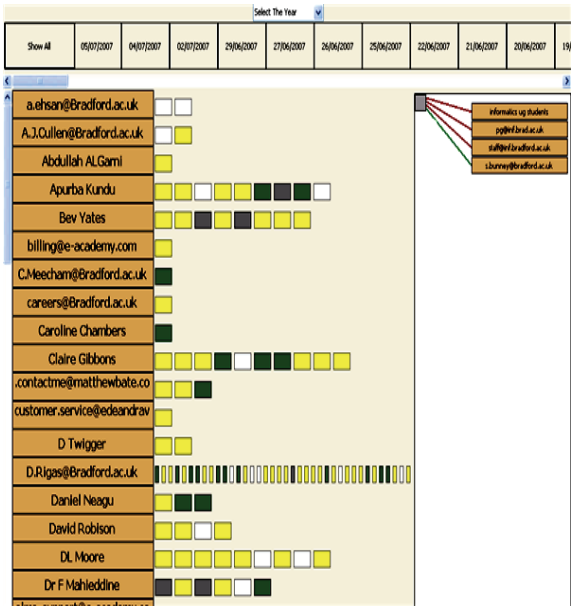

Figure 1: Screenshot of the mail inbox.

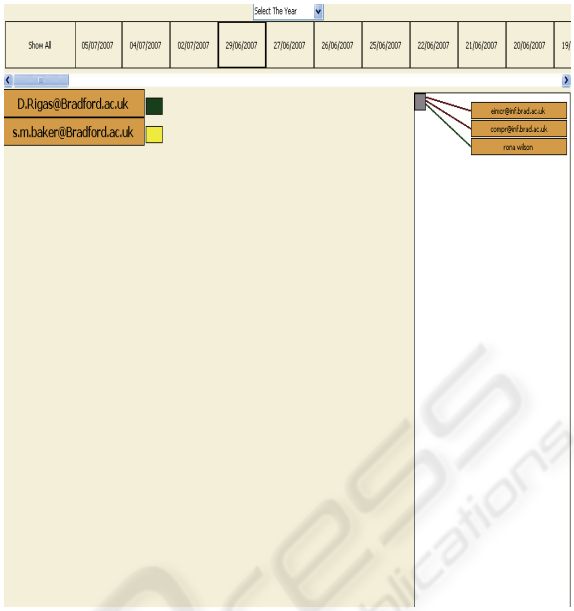

Figure 2: Screenshot of the inbox after selecting a date.

dateline, main view and temporal view. The top part of the inbox is the dateline which presents all the dates that contain e-mail messages in chronological order. A drop down menu that contains the previous years was added in order to minimise the number of presented dates and to reduce the scrolling operations. All messages in the inbox are presented as squares in the main view. Where they are classified based on the alphabetically ordered list of e-mail senders in the left side of the inbox. The size of presented squares depends on the number of e-mail messages sent by the e-mail sender. Moreover, as the number of e-mail messages sent by a sender increases the size of presented square will be smaller. Rather than displaying the status (New, Read, Replied, Forwarded) of e-mail messages textually it is displayed here by colours. The unread (New) e-mail messages are displayed in yellow whereas the read (Opened) messages are displayed in white. The e-mail messages that sent as reply are displayed in green and those that sent as forward are displayed in grey. Subject, attachment and priority were hidden in order to reduce the graphical complexity in the main view. However, they can be displayed with the content of the e-mail message by clicking on the e-mail message in the main view. The number of the displayed messages and addresses in the main view can be reduced by selecting the required date from the dateline (see Figure2).

The recipients of an e-mail message can be shown in the temporal view by moving the mouse cursor over its icon in the main view. Rather than using the traditional textual way of displaying the recipients (TO, CC) of an e-mail message they are presented using colours. Where all e-mail addresses connected by green lines represent received the e-mail message as carbon copy (CC) and those who received it as normal messages (TO) their e-mail addresses are connected by red lines.

4 EXPERIMENTAL DESIGN

An experiment was designed to test if the information visualisation can enhance the usability of e-mail clients. This was conducted by performing a comparative usability study between one of the well-known e-mail clients, Outlook Express, and our visualisation prototype. Thirty postgraduate students from the Department of Computing at the University of Bradford were asked to participate in the experiment. The experiment was two-condition within-subjects design therefore each user was asked to perform the experimental tasks in the standard e-mail and the visualisation tool. Users were free to use any of the functions that offered by Outlook Express such as sorting e-mail messages and searching for an e-mail message whereas they were not able to use these functions in our prototype. In order to avoid transfer of learning affects, the order of the conditions was varied between users (counter-balanced) (Dix, 2004). Meaning that, 15 users

started the experiment using the standard e-mail clients and the other started by using our prototype. A Five minuets demonstration was given to all users before performing each condition.

Two usability metrics were selected to measure the usability of both experimental conditions efficiency and effectiveness. Efficiency was measured by calculating the time taken to accomplish each task. The effectiveness of computer software can be measured by knowing whether the required tasks could be accomplished successfully (Jordan, 1998). Therefore, the percentage of users who complete all tasks and the percentage of tasks completed by all users were selected to measure the effectiveness of each experimental condition. The main hypothesis of this experiment is that visualising e-mail messages should enhance the usability of e-mail clients. Therefore, e-mail visualisation tool should result in an overall reduction in time taken to complete the tasks. Also, it should result in an overall increase in both the percentage of completed tasks and the percentage of users who completed all tasks.

5 EXPERIMENTAL TASKS

Users were asked to perform 10 tasks in each experimental condition in each task they had to locate an e-mail message with the provided relevant information such as the date of receiving, the sender's e-mail address and subject. In order to test the experimental email tool in various conditions, the experimental tasks were in three different complexity levels easy tasks (3 tasks), medium tasks (4 tasks) and difficult tasks (3 tasks). The location of e-mail messages in the inbox were considered when designing the easy tasks so users do not need to perform scrolling and searching operations to find an e-mail message. The number of given email message information was considered when designing the medium tasks as well as whether it can be seen directly in the inbox. Therefore, users occasionally needed to open e-mail messages in the medium task in order to know whether it is the required one or not. For example, in one of the medium tasks users were asked to find an e-mail message by the attachment name with the date of receiving. In the difficult tasks, users were mainly asked to find e-mail messages by asking them about the recipients (TO, CC) of the e-mail message beside other information such as the sender's e-mail address.

6 RESULTS

The performance of users in each condition was observed and filled in an evaluation form. This form contains the time taken for completing each task and whether each task was completed successfully. The effectiveness and efficiency were analysed independently as shown below.

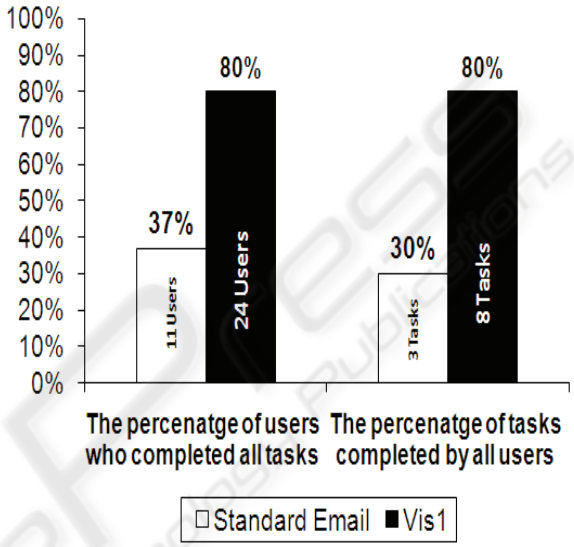

Figure 3: Users (%) who successfully completed all task and tasks (%) completed by all users.

6.1 Effectiveness Results

The number of users who successfully completed all tasks was calculated to produce an overall percentage of users who successfully completed all tasks. Also, the number of completed tasks successfully by all users was calculated to produce an overall percentage of completed tasks in each experimental condition. Figure 3 shows the percentage of users who successfully completed all tasks and the percentage of tasks completed by all users. It shows that the percentage of users who completed all tasks successfully in the visualised e-mail is greater than in the standard e-mail. Also, it shows higher percentage of completed tasks in the visualised e-mail. Chi-Square was used to test the significance in the effectiveness data. The results indicated that the percentage of users who completed all tasks in the experimental condition is significantly higher than in the standard email (X^2 = 15.8, df= 1, cv=3.84, $p<0.05$). In addition, It showed a significant difference in the

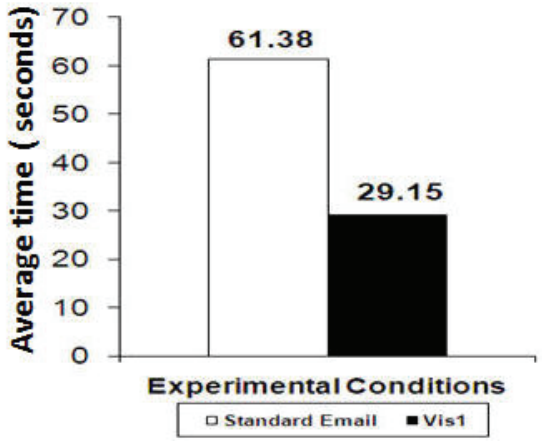

Figure 4: The overall time taken to complete the tasks.

number of completed tasks by all users in the experimental condtion (X^2 = 5.05, df= 1, cv=3.84, p<0.05) when compared to the standard email. Thus, visualising email messages such as in the proposed email tool could improve the effectiveness of email clients in terms of number of tasks completed successfully and number of users who completed all tasks.

6.2 Efficiency Results

As mentioned earlier, time taken for completing each task was selected to measure the efficiency of each experimental condition. Therefore, it was added together to produce a total time in each experimental condition. The average time for completing all tasks was calculated in each condition in order to compare the difference between them. Figure 4 shows the overall time taken to complete experimental tasks in the e-mail visualisation prototype, which is denoted in the graph by Vis1, is lower than in the standard e-mail. Because the experiment has two-conditions and the obtained data is quantitative, t-test was used to test the difference in time between the experimental conditions (Sanders & Smidt, 2000). It showed an extreme significant reduction in the time taken for completing tasks in the visualised e-mail (t_{58} =8.4, p< 0.000).

A detailed analysis was performed based on the complexity level of the tasks. Figure 5 shows that the time taken for completing each task in both conditions. It shows reduced time for completing the easy tasks in the visualization prototype. The average time taken to complete easy tasks in the proposed email is 9.64 (standard deviation 7.19)

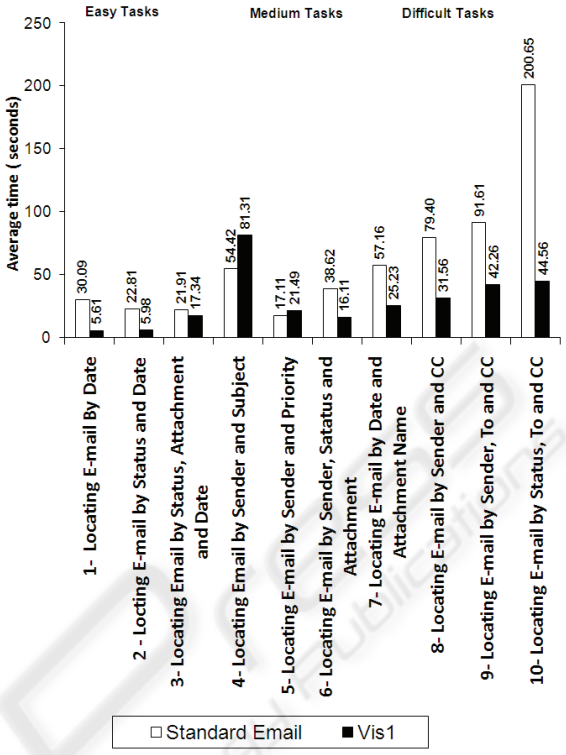

Figure 5: Time taken to complete each experimental task.

seconds where it is 24.94 (standard deviation 15.25) seconds in the standard email. In the first two medium tasks, users were asked to find e-mail messages by the subject and priority respectively. As these are hidden in our prototype, users took longer time to perform these tasks than in the standard e-mail. The average time taken to complete medium tasks in the standard email is 41.83 (standard deviation 69.65) seconds where it is slightly lower in the proposed email 36.06 (standard deviation 27.39) seconds. The average time for completing difficult tasks in the standard email was 123.89 (standard deviation 79.93) seconds where it was reduced to 39.64 seconds (standard deviation 12.77) in the proposed email visualisation. This is because of the recipients (TO, CC) of the e-mail messages are directly displayed to the users in the temporal view.

7 DISCUSSION

The results showed time taken to complete tasks was dramatically reduced in the e-mail visualisation prototype. Also, the percentage of users who successfully completed all tasks and the percentage of tasks completed by all users were significantly increased in the e-mail visualisation prototype.

Therefore, it confirmed the hypothesis that information visualisation significantly improves the usability of e-mail clients. The detailed analysis showed that the main reasons of e-mail visualisation tool being more efficient than the standard e-mail is dividing the mail inbox into sections as well as using colours for presenting information. The dateline in the visualized e-mail was found very useful for grouping e-mail messages because it significantly reduced the time taken to complete easy tasks.

The results showed that the temporal view is a very useful feature because it significantly reduced the time taken for completing difficult tasks. Therefore, rather than displaying the recipients (TO, CC) on the temporal view only other information can also be displayed on it such as the subject and attachment.

Using colours for presenting the status of e-mail messages significantly reduced the time taken for completing most tasks. Therefore, colours can also be used for presenting more information such as the priority of e-mail messages.

The results showed that information hiding could negatively affect the usability of e-mail clients. It affected the performance of users when performing medium tasks.

8 CONCLUSIONS

As e-mail is used daily in our lives and the number of e-mail messages grows rapidly, traditional e-mail clients have become difficult to use. Therefore, this paper proposed an e-mail visualisation tool in order to organise e-mail messages in the inbox. This tool visualises messages based on the date of receiving messages with a hierarchical view of e-mail addresses. An experiment was designed in order to test whether information visualisation could enhance the usability of e-mail clients. The performance of users was compared in a standard e-mail client with our prototype. The results showed that the e-mail visualisation tool could significantly improve the usability of e-mail clients. Information hiding was shown negatively affecting the usability of e-mail clients. Therefore, further experiments will be carried out to evaluate the effect of integrating the auditory feedback (e.g., speech and non-speech sounds) in the email visualisation. In these experiments, some of the email data will be communicated aurally.

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