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Visual Discussions: a visual representation of threaded discussion groups.

by

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Submitted to the Department of Electrical Engineering and Computer Science

in Partial Fulfillment of the Requirements for the Degrees of

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Abstract

This is an M.Eng thesis, based on software development work done in collaboration with Lotus Development Corp. In this project we are creating a visual overview of ongoing threads of a discussion database. This will allow users to quickly focus their attention to relevant areas of areas in a large information space.

Thesis Supervisors:

Dr. Judith Donath, Director of the Sociable Media Group at the MIT Media Lab.

Dr. Charles Hill, Interface Engineer, Lotus Development Corporation.

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Table Of Contents

List Of Figures

Chapter 1

Introduction

Threaded discussion system have become a useful tool for online team activities. However, as discussions grow to many threads, users can become overwhelmed . Currently, discussion databases do not provide much support for understanding what recent user interactions might be important to the reader. Current systems, such as Lotus Notes, Lotus Instant! Teamroom and Oracle Discussion Databases, notify users of new postings mainly by e-mail notification or by highlighting new postings. These systems, Lotus Instant! Teamroom and Oracle Discussion Databases, allow users to send other members of their group an e-mail reminder when changes are made, or new documents are added to a database (or Teamroom). Lotus Notes highlights by means of color, i.e. new postings are red. These approaches are not scaleable and do not quickly bring to the user's attention postings that may be relevant to his interest and responsibilities. The more e-mail is used for notification, the more the reader is flooded by e-mail and the onus is upon the user to monitor activity within ongoing discussion for important interaction. When the notification occurs by means of highlighting, the users loses a sense of rhythm. They may not know which changes are most recent. In a team environment it is important for authors to be confident that their postings will come to the attention of the relevant people so that they are acted upon. Current systems do not inspire

this confidence. The proposed visualization tries to provide the notification that allows the user to evaluate it in context of the other activity in the threaded discussion.

Current systems do not provide online users with a sense of rhythm of the activities, i.e. when information is read by other users , how quickly is response generated to a topic. These are important pieces of information in understanding the dynamics of a discussion. To get a feel of the rhythm of the discussion, users need to know what topics are active. A system that provides these functions will provide added value to the user.

This thesis proposes a visualization, based on software development work done in collaboration with Lotus Development Corporation. It is our belief that a visual overview of the ongoing threads of a discussion database can be constructed that will enable users to efficiently track the past and current contributions of different members. The work presented includes a user study designed to collect information on the needs of the users, and the development of a visualization that presents the existing data of a threaded discussion in a form that allows the users to focus their attention to the most relevant areas.

1.1 Overview of the Thesis

The remainder of this thesis is divided into three chapters. Chapter 2 provides background material covering visualization, human computer interface, and discussion databases. Chapter 3 describes the project work undertaken, including a description of the user studies, the data collected and displayed in the visualization and current prototypes in use. Chapter 4 presents possible extensions of this work and generalizations for use in all discussion groups.

Chapter 2

Background

2.1 Chapter overview

This chapter provides an overview of the concepts used in the rest of this thesis . Section 2 defines visualization and points to some work in the field that have been used to guide this process. The next section, 3, gives a brief overview of discussion databases. Human computer interaction, with specific reference to collaborative work and online discussion groups , is described in section 2.4. Section 2.5 discusses some areas in database visualization that influenced this thesis and finally section 2.6 refers to other works in the field that have shaped this thesis.

2.2 Visualization

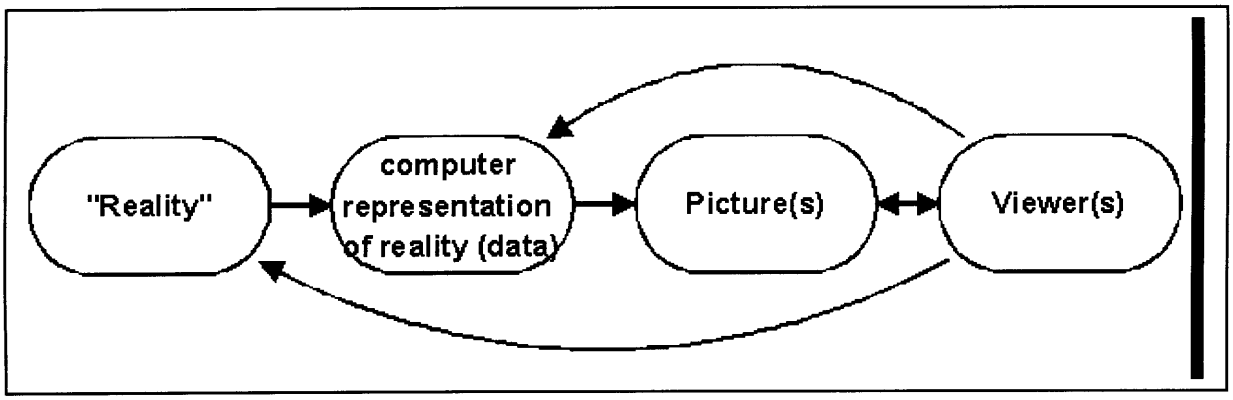
The Websters dictionary definition of visualization is : "*The formation of mental visual images, the act or process of interpreting in visual terms or of putting into visual form.*" A new definition is, "a tool or method for interpreting image data fed into a computer and for generating images from complex multidimensional data sets"[MCC87]. Richard Hamming wrote "The purpose of computing is insight, not numbers" [GER94] . Similarly, users of

discussion databases will like insight into the information. Hence visualization becomes an important tool.

There are several visualization models, called reference models. There exist two general concepts in building these models : the "top-down" and "bottom-up" concept.

"Compositional approaches can be though of as 'bottom up' , where the primitives are individually validated and then combined, but there is no guarantee that the composite display is perceptually valid". [ROB91]

"The approaches, based on decomposing an overall view or scene into its constituent components and using these components to represent the data variables can be thought of as 'top down' " [ROB 91].



A diagrammatic representation of the visualization process
mapping from computer representation to perceptual representation, choosing encoding techniques to maximize human understanding and communication
Figure 2.1

The design process in this thesis mixed both approaches in building a reference model. The problem was analyzed from a user perspective and various components were combined with user feedback to develop an effective prototype. The visualization prototypes are then tested for expressiveness and effectiveness.

As figure 2.1 depicts, *visualization is the graphical presentation of information* with the goal of providing a qualitative understanding of the informational content. [KEL93]

Information may be data, processes , relations or concepts. In this thesis, the information was mainly data (topic name, content, author, audience) and relations (between different messages and members of groups). A proper visualization captures all the characteristics of the data. The graphical presentation may entail manipulation of graphical entities (points, lines , shapes, text) and attributes (color, size, position, shape). These entities were used to create the most simple representation that captured the as much of the characteristics of the data as possible. To be judged as a successful visualization, there must be a qualitative understanding of the information content. [INS94].Understanding may involve detection, comparison, and interactive techniques. User feedback was used to gauge understanding in this thesis. Users were asked to explain the visualization and comment on its feel.

2.3 Discussion Threads/ Databases:

In this work a visualization was designed for a discussion database, specifically Lotus' Notes Discussion Databases and Lotus Instant! TeamRoom. Chapter 4 discusses the steps needed to apply this visualization to other discussion databases.

A *threaded discussion* will be defined as a log of remarks and opinions about a subject. Users submit their comments, and the database server maintains them in order of originating message and replies to that message. This gives rise to the concepts of threads and responses that creates a tree structure.

The Lotus Databases present this information to the users as a series of views. [see figures 3.1,3.3, 3.4]. The most widely used views are the main or "collapsed" view. Here the user sees the originating message and a number that indicates the number of replies to that message. The expanded view allows the user to see the original message and all replies. This is displayed as a tree structure.

The 'Instant! Teamroom' discussion database provides the additional feature of e-mail notification. Authors can choose to have other people notified by e-mail when saving changes to a discussion thread. All other databases have a small icon that informs the user if there was a change in state.

2.4 Human Computer Interface

To be effective, a data visualization system must be easy to use and not require sophisticated computer skills since many of the users will be domain specialists rather than computer scientists. It should be flexible to allow for applications to many different types of data analysis problems. It should also be extensible so new analysis techniques can be easily added.

There are several different aspects to the user interface for a data visualization system. However, the issues in Human Computer Interface that are especially important to this thesis are the cognitive and perceptual aspects.

Cognitive Issues:

The reason for having visualization systems is to help people solve problems. Thus , the area of cognitive psychology (the study of how people solve problems,) is highly relevant. It has been postulated that the semantics of the representation of a problem may determine how difficult the problem is to solve. Studies [DOM93][DOM94][HAB90]have shown when people are given isomorphic problem (identical in form) but with different semantic representation, there is little carry over in the problem solution process. This means users who have become used to a representation will have to relearn the new system. Hence any visual representation will have to be similar in feel to existing software.

Perceptual Issues:

There are several perceptual issues that are important in data visualization systems. A distinction must be made between issues involved in the display and communication of data and issues involved in the investigative and understanding phase of visualization. [GOR89] [DOM94]. In this thesis it was found that color and size were major perceptual issues.

2.5 Database Visualization:

As the complexity and variety of information increase through the use of object oriented data models, the need for clear ways of viewing this information also increases. Work in this area has grown through the availability of high performance graphics work stations.

In providing tools for prototyping visualizations, there is a limited amount of work. [COO92] has developed a configurable data modeling system. This thesis draws from the techniques used in the development of that system as well as various three dimentional (3D) scientific visualization systems. [ASI85][CRA90]

2.6 Other Works in The Field Of Visualization:

The importance of inter activity in visualizing databases and multivariate data has been noted by many researchers [KEI94] [SCN94]. [BES94][BRO92][BRY94]

The work of Edward R Tufte , Envisioning Information , [TUF90] influenced the design of the visualization presented in this thesis. The thesis attempted to use ideas he presented on layering and separation as well as those on color to produce an aesthetically pleasing and informative presentation. [GAL94] [ROT90][STA92]

Chapter 3

Project Description

3.1 Chapter Organization

In this chapter I describe the project work undertaken in this thesis. This description includes the user studies and the design and development of the visualization itself. I also give an overview of the feedback gathered from users of the visualization and finally I discuss some visualizations that were not prototyped.

The research that lead to this thesis was undertaken at Lotus Development Corporation. Its goal was to enrich the experience of the discussion databases users, specifically users of Lotus Instant! Teamroom. The purpose of this research was to study the needs of the users and design a effective solution that would cater to those needs.

3.2 User Studies.

The user studies were conducted on users of discussion database at Lotus. The members of the study had interacted with either Lotus Notes or Lotus Instant! Teamroom. The subjects included Lotus employees (administrative assistants, program managers , developers, researchers and support staff), MIT interns (developers) and members of a Lotus Business partner, i.e. another corporation (support staff and administrative assistants).

User Types

My user studies revealed the users of the discussion databases could be divided into three main groups: daily/frequent users, intermittent users and support users.

1 Daily users :

In the study, the people who use discussion databases on a daily basis are mostly developers and designers. These users are likely to attend discussions more frequently. They especially need to know that the information they post is being attended to by the desired people. Currently the only way they can currently ensure this is by contacting those involved and directing their attention to the documents .

2 Intermittent users:

These users tend to be generally administrative assistants, and users of social databases. Administrative assistants attend the discussions at the behest of their supervisors. They search the database for messages and items of interest for their supervisors. These items are copied and brought to the attention of the manager. Users of social databases tend to have their own communities, which share some level of interest. Again, the users search for items they consider interesting and bring it to the attention of their associates.

3 Support users

These users attend the discussions on a weekly or less frequent basis. Current systems usually bombard him/her with all the changes since he or she last attended the system.

These users are interested in monitoring the progress of discussion and determining if there are specific areas which interest them.

Interview results:

The participants of the user studies were asked questions relating to their daily interaction with discussion databases. This was used to extract a list of features the users will like to see implemented or added to the current software.

1) Notification:

The members of the study universally complained about the current method of notification. Any time a change was made, i.e., a document written or edited, they would either get an e-mail notification. Or the next time they attended a discussion, an icon was displayed to indicate a change in status. Users felt the e-mail notification was overwhelming. The icon conveyed even less information since the change could be anywhere in the database of discussions. Users wanted either an icon that contained more information or an attachment with the e-mail. They wanted to know when and where changes were made in the database but not be overwhelmed by the information. They preferred to have one view, icon or a message that displayed this information for all notifications.

2) Overview of information.

Users also requested a view that would provide summary information of the discussions to date. Currently users have the option of seeing the main topics, i.e. a collapsed view of the database or a fully expanded view of all the discussion [see Figures 1 and 4]. Users

wanted views that would show an expanded view of the most recent activity. They also requested that the threads be sorted so that those without activity after a set time would not be displayed as prominently.

3)Agents/Filters tools to focus important information/events.

Since users tended to interact with multiple discussion threads and other software tools in their jobs, there was a pressure to reduce the time it takes to check each database/ discussion for the relevant information. They asked for a tool or any agent that will highlight discussion of interest and hence facilitate effective use of their time. They also asked for a filter that would reduce the number of non relevant notification e-mails they received.

4)A sense of activity.

The way information is currently presented did not convey a sense of activity. Users missed this sense. They felt it important to see their discussions were being attended to in a timely fashion. In the virtual world, the discussion groups lost the shape and feel of interaction. They acknowledged that the e-mail notifications provided some sense of activity. However, since the e-mail systems were not necessarily viewed at the same time as the discussion, this sense of activity was detached. Due to network congestion e-mail notification may not accurately reflect the true activity in the discussion. Users also wished to know if their postings were being read. The current systems does not generate e-mail notification of this event.

3.3 Data Analysis:

After the user studies were conducted and user's needs were compiled , the study of the discussion databases was next undertaken. This study's goal was to identify the information currently presented to the users and see what additional data was being stored but not as easily accessible to the users. Three different types of discussion threads or databases were analyzed to get a global view of the data.

Databases Studied: Below are the databases studied and the information and patterns yielded by each of the databases. The database were chosen to extract information from as broad a field as possible.

a) **Research**: This discussion generally tends to be a summary of work done. Postings are infrequent. However, whenever there is a new posting there tends to be a flurry of activity shortly afterwards. People congratulating the researcher, and discussions spawned to address the new questions the work presents. Notifications do not happen very often.

However since research work tends to be interrelated, new posting also create new discussions in older threads. [i.e. previous research work].

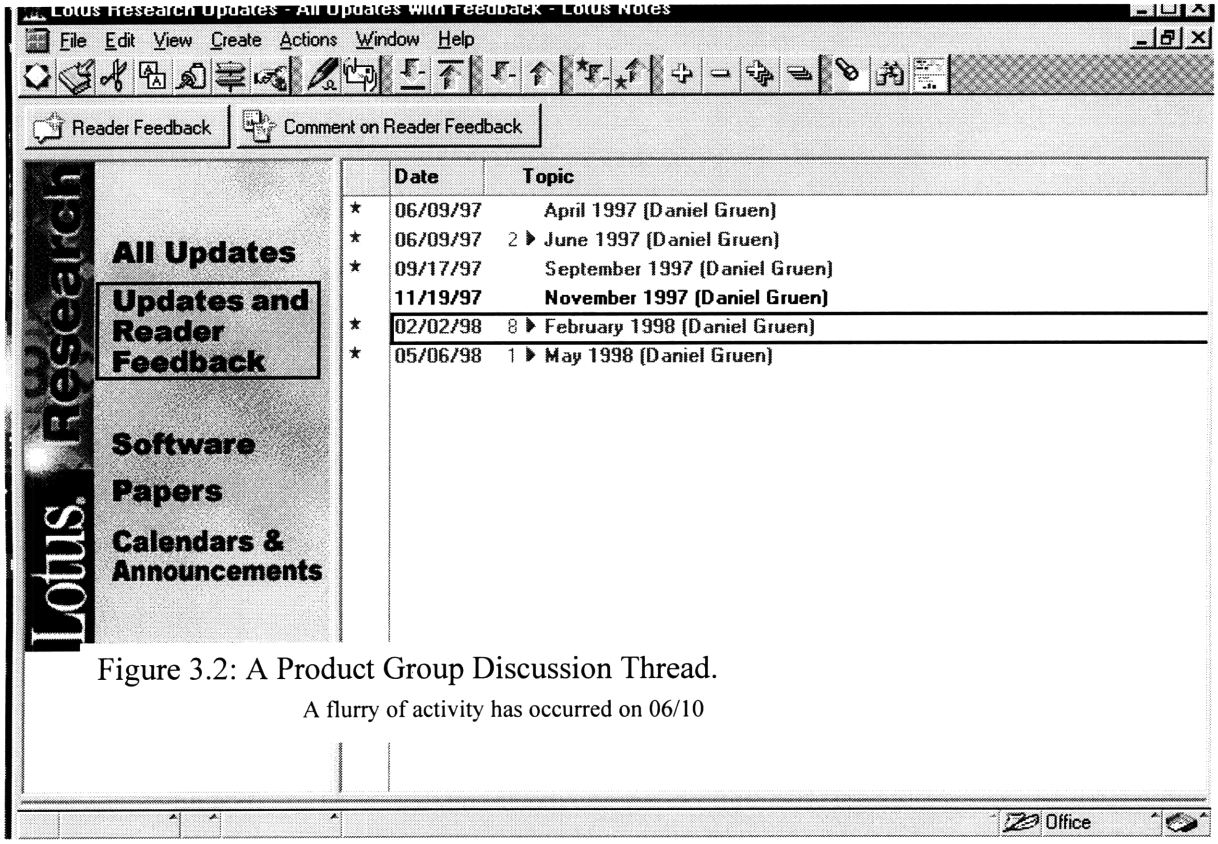


Figure 3.2: A Product Group Discussion Thread.
A flurry of activity has occurred on 06/10

Figure 3.1: A Research Database: Postings are infrequent.

b) **Product**: Product groups operate on development cycles and similarly their discussions then to follow the same cycle. The message are posted very regularly and often notifications are needed for subgroups.

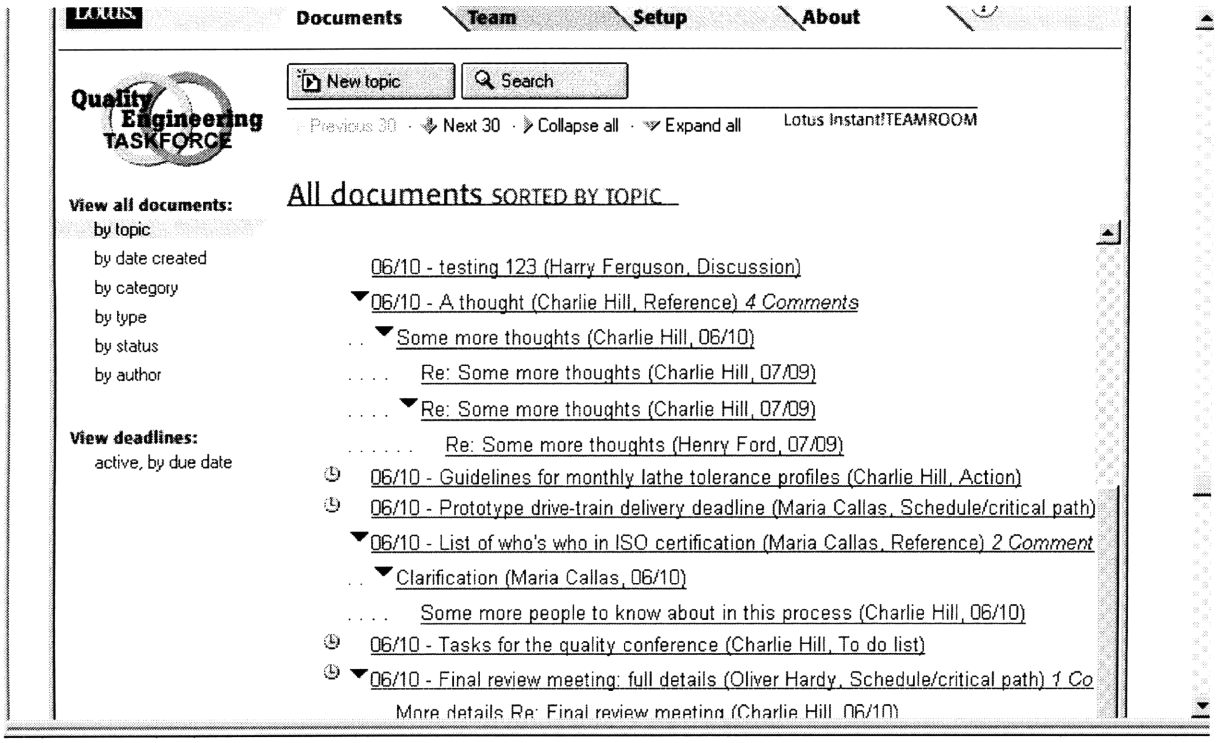


Figure 3.2 A Product Group Discussion Thread

A flury of activity has occurred on 06/10

c) **Social:** Threads in this database usually have the shortest life span but tend to be filled with activity while they are active. These messages are often filled with attached pictures, documents or links and often users perform some action [view the link, forward the document to a user, or post a response] after viewing these discussions.

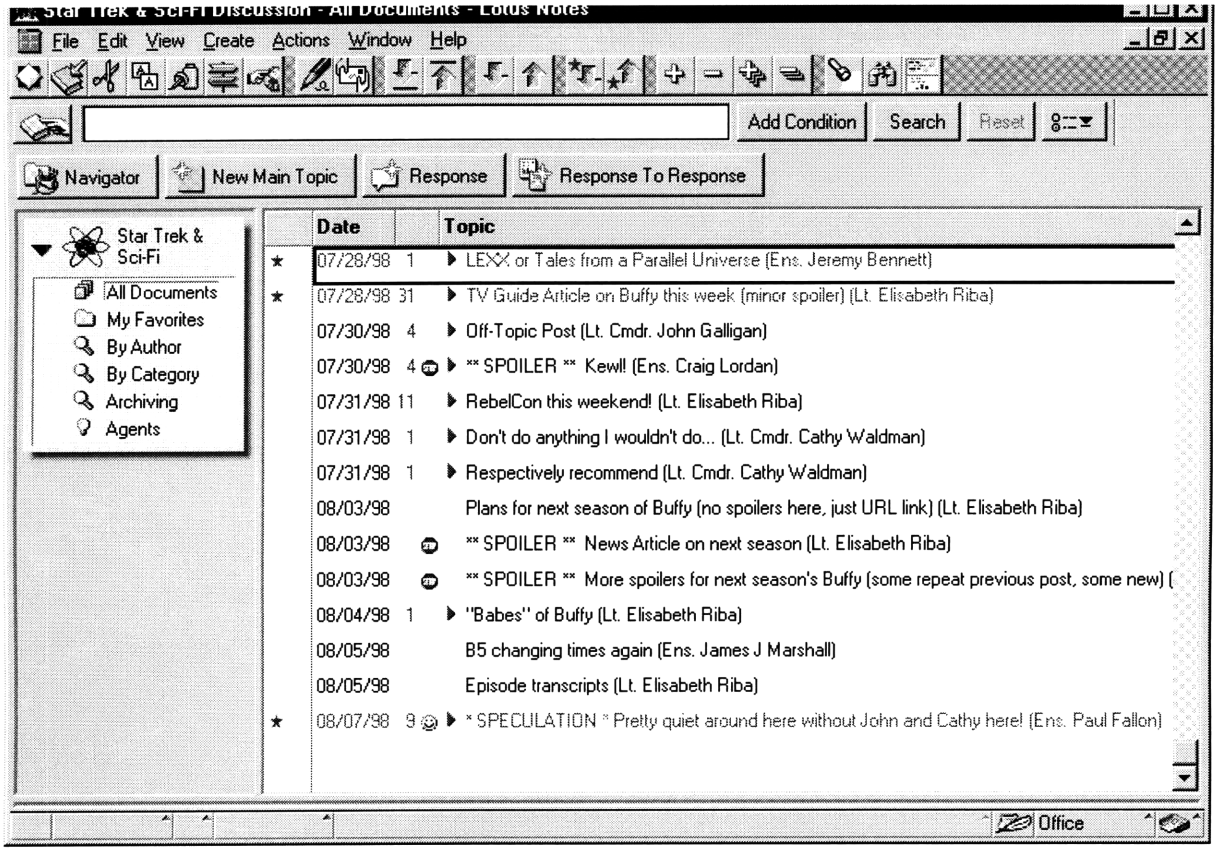


Figure 3.3: A Social Discusion Thread

This compressed view shows activity over a longer period
Topics with responses are identified by triangles

As can be seen from figures 3.1,3.2,3.3 the following information is present to the user in all the Lotus' discussion databases. The user upon looking at the main view can tell the name of the main thread and its author. The user is also able to determine the date the item

was posted, the number of responses, and whether there are any attachments to the main topic.

As can be seen in figure 3.4 (the expanded view), the user is now able to tell who authored the response, the date the response was posted and whether the response has any attachments.

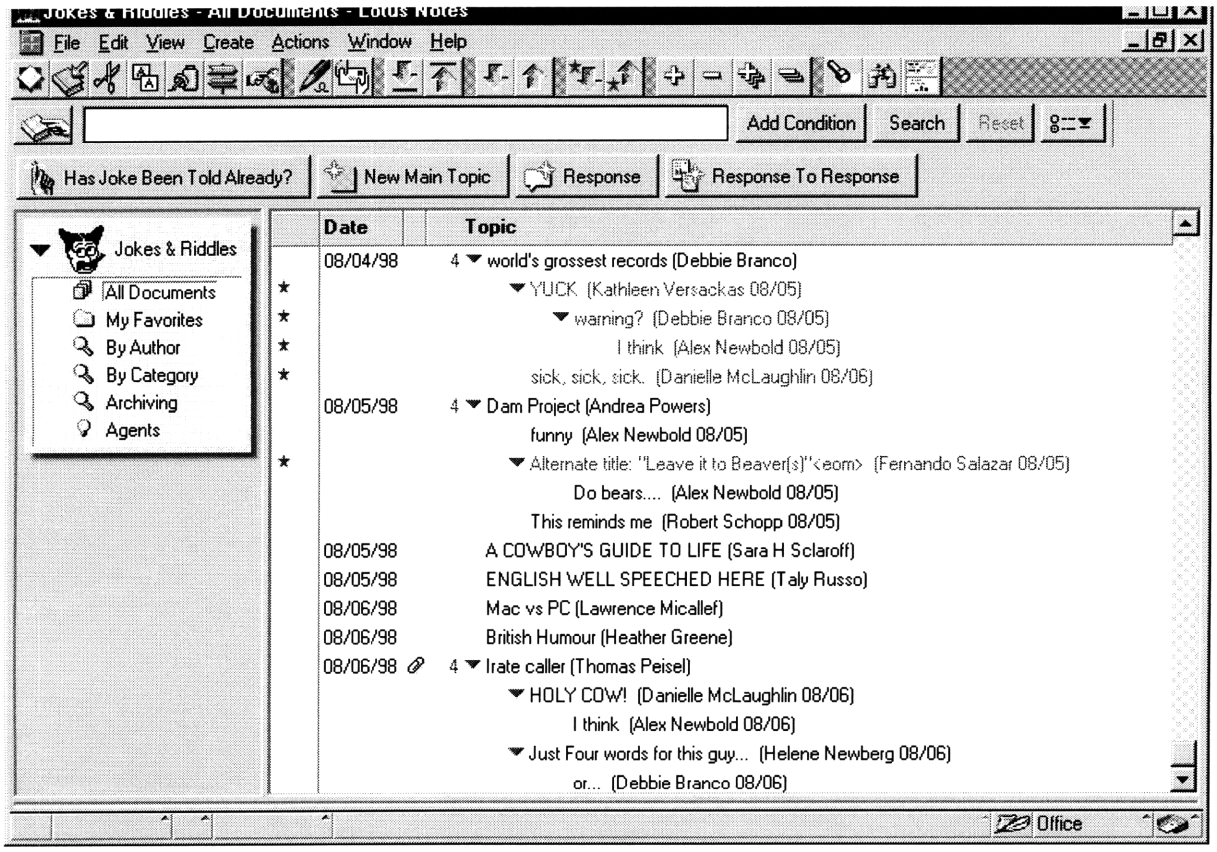


Figure 3.4: The Expanded View

The user can also determine by color differentiation , whether or not he/she has read the document [documents in red are unread, and those in black have already been viewed by the user]. The icon displayed in figure 3.5 can tell the user if there have been any changes since the last time the document was viewed.

The following information was stored on the server and accessible to the display client, however it was not displayed to the user. The server logged the time a document was created , edited and read. It also logged the name of the user who accessed the document. The server also stored information of attachments (if, there were file attachments or links).

Figure 3.5: The update Icon
The only signal of change in a discussion group currently

3.4 Design :

The analysis of the user needs and the information already captured by the discussion thread software suggested a visualization solution. The data already existed or could easily be generated, it just needed to be made visible. Various designs were initially suggested , however the thesis describes in detail the visualization that was the most successful. Section 3.7 discusses other visualizations. The design process was top down . The user needs and the data at hand were studied and a solution was proposed. The solution was created by putting various parts together and having users accept or reject the combinations. This subsection discussion the various parts of the design and the rational for any choices and compromises. The visualization design of this thesis comprises three related views, a main or compressed view, an expanded view and a notification view. These views are also described in this subsection.

Time line:

Since the users wanted to recapture a sense of activity, the view needed to include some type of a time axis. Existing views sorted the information by time. However it was not always possible to quickly get a sense of activity between related discussions in a database. As can be seen in figure 3.6, the proposed visualization includes a time axis. The current implementation has markers to display daily intervals. The next chapter discusses other implementations. The decision was taken to fit only a five day data set worth of activity into the visualization. It offered a reasonable compromise . The time period was long enough to cater to the different types of users. For each category the visualization allows the user to gain a sense of perspective and context for the activity and the related discussions. However the period was short enough to ensure that in an average use situation, the user was not bombarded with too much information.

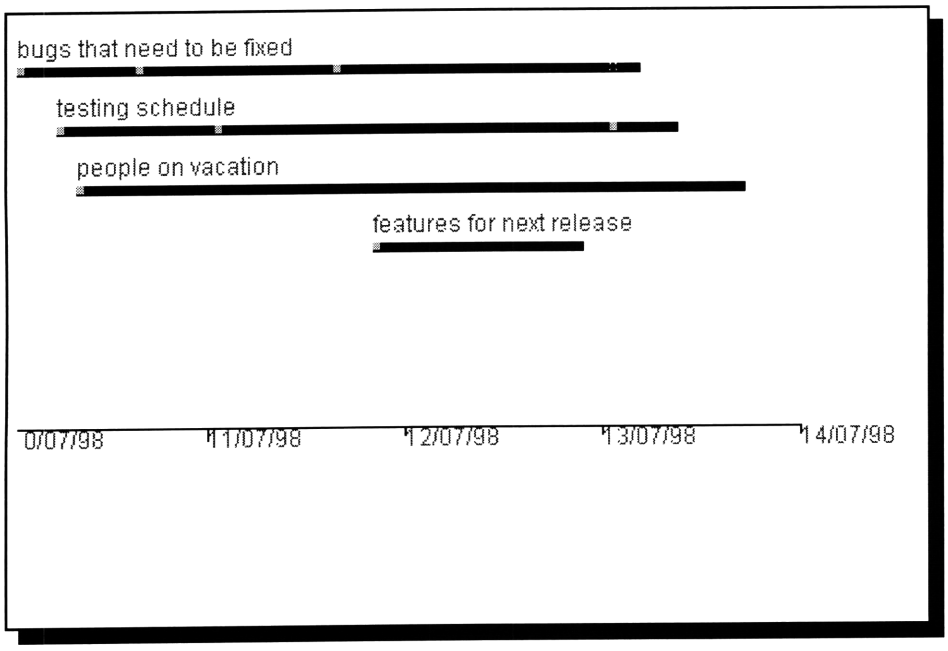


Figure 3.6
A collapsed view

As the screen scrolls the time line graphic is updated . The time line, as can be seen in figure 3.7, is also present in the expanded view and the notification view.

Structure:

The need to maintain the structure and shape of the discussion groups was an important design consideration. Users preferred that the solution be similar (in look and in feel) to the existing software. Hence the design has each new topic represented by a small bar , similar in width to the title space of the existing discussion databases. Above each bar is the tile of the main thread, as well as the author of the topic. The expanded view displays the tree structure of the discussion while maintaining temporal structure. As can be seen in Fig. 3.7, the expanded look at a main thread, responses to any thread is connected by a thinner line to help build the tree. . Again the name of the response are displayed in a fashion similar to that of the main topic [which is similar to the existing discussion formats].

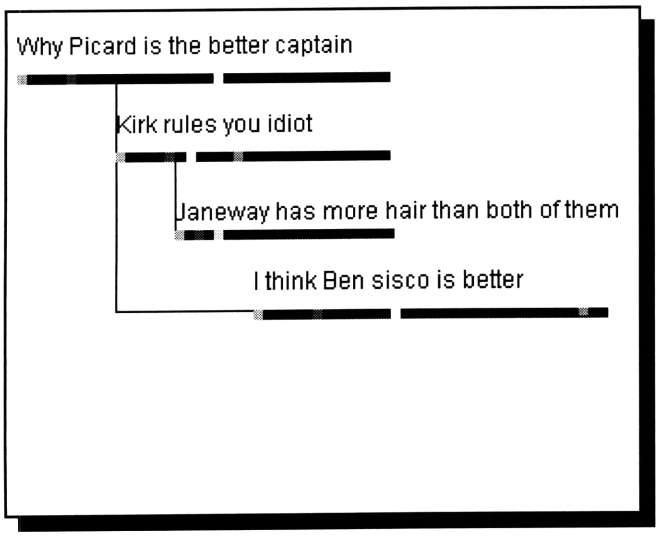


Figure 3.7:
The expanded view of the main thread "Why Picard is a better Captain."

Figure 3.7, the first response determines the position of the first vertical bar, responses at the same level are connected as shown. The start of each response is indicated by the start of a horizontal bar.

The notification visualization captures a subset of the structure, and as demonstrated by Figures 3.8 and 3.9 not the full structure. The design rationale for this view was as follows, the notification view tries to capture the structure of the notification relative to the main discussion. Hence it displays whether the item the user is notified about is a main topic, a response to a main topic or a response to a response to a response of a main topic. Only the names of the main topic, the item that the user is notified about and the authors of those events are displayed. A better implementation will also present the name of any sub- topic

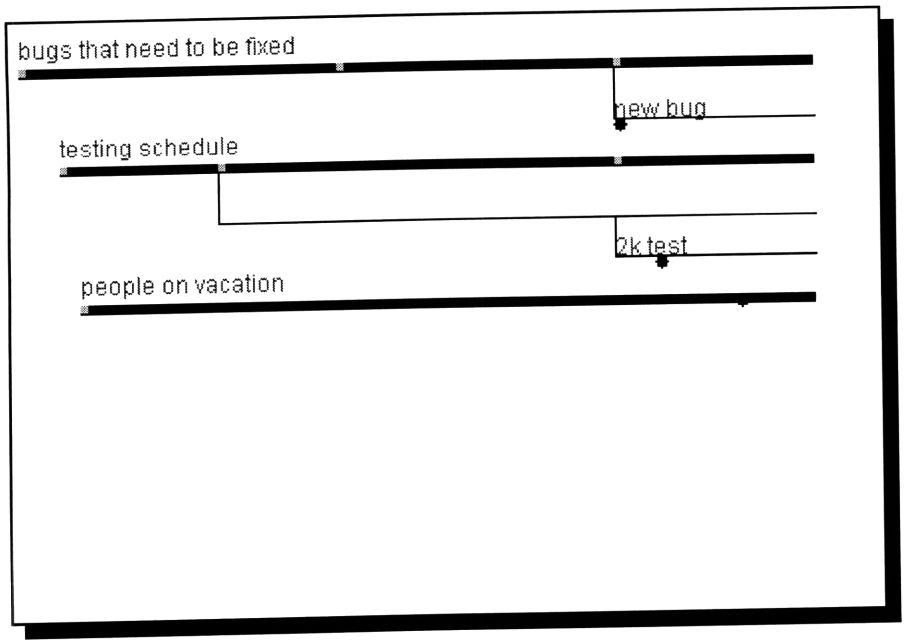
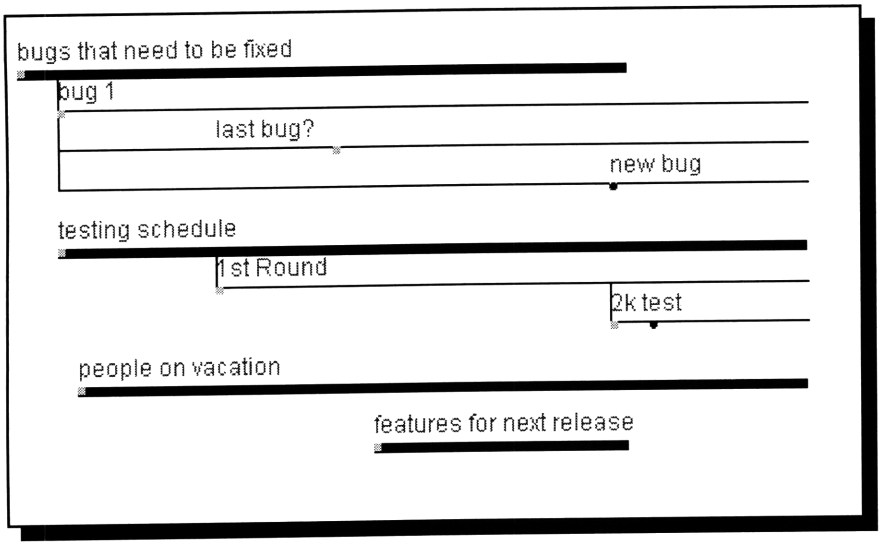


Figure 3.8:

A notification view. Not much structure is seen

along the path from the main topic to the notification. This idea is better developed in the next chapter.

Figure 3.9 more structure .



Color / shapes:

Activity needed to be captured in some means. The most concise way to display that information was through the use of icons of distinctive color and or shape. A careful look at the data found that activity could be generalized into five main categories, writing a document, reading a document, editing a document, notification about a document, and initiating another activity after reading a document. Another design consideration was the need to maintain the red-black color scheme with which the users were already familiar. This is , if a thread had an unread item as a sub-topic , the compressed view of that topic was colored red. The expanded version would only color red the new sub-topic, all other sub-topics were colored black.

User test found that shades of green were not appropriate choices since those users with red-green color blindness were not able to extract all the information displayed.

To signify a new document a small blue square was used, editing a document was represented by a purple square. The color was chosen since it was visually close to blue. The actions or creating a new document and editing a document are similar and hence an attempt was made to capture this closeness. A yellow square was used to indicate a document was read. Since it is possible for editing and reading of documents to overlap in time , the visualization was designed such that they user would not loose information if such an overlap occurred. Again a square icon was used to represent this activity.

To quickly draw attention to notification the visualization represented this information with a brighter richer color and an icon of bigger size than that of the others. First the icon used was diamond shaped (it appears bigger than a square of the same size) and twice the area of the square icons. The color used was bright orange. It was chosen because it was similar to color (red) that the users knew indicated new information. An Icon Key was present in each view to explain to users what each color represented.

User Identification:

The color patterns did indeed give the users a sense of activity, from the icons , they could indeed tell that their discussion were being addressed and get a rough idea of when attention was being paid. However users still desired more information. They needed to know that the relevant people were paying attention. They wanted to know who was responsible for which activity.

Hence the visualization needed to capture some sense of user identity. It was not possible for each icon to carry a user identification. The icons were too small to carry any useful user identification, especially for the average audience of current Teamroom discussions (on average 30 members per group). The visualization circumvented this problem by means of pop-up graphics. If the user moved the mouse over an icon of interest the user identification would pop-up. Hence the user is not overwhelmed by information and can selectively receive more information on topics of interest.

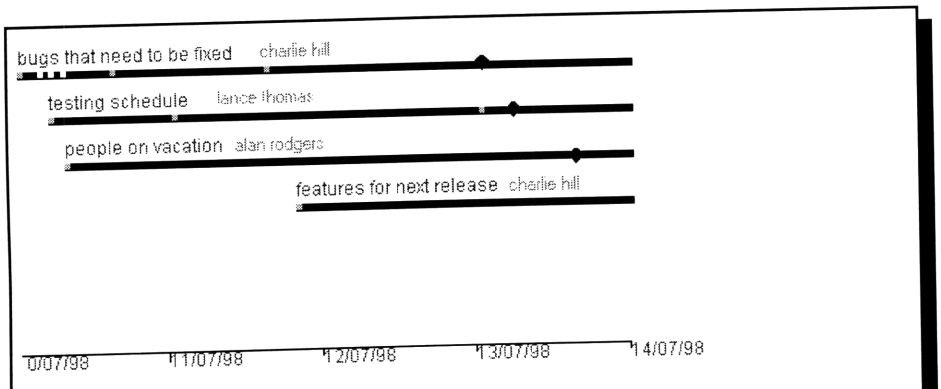


Figure 3.10 Visualization before the users passes the mouse over an item of interest.

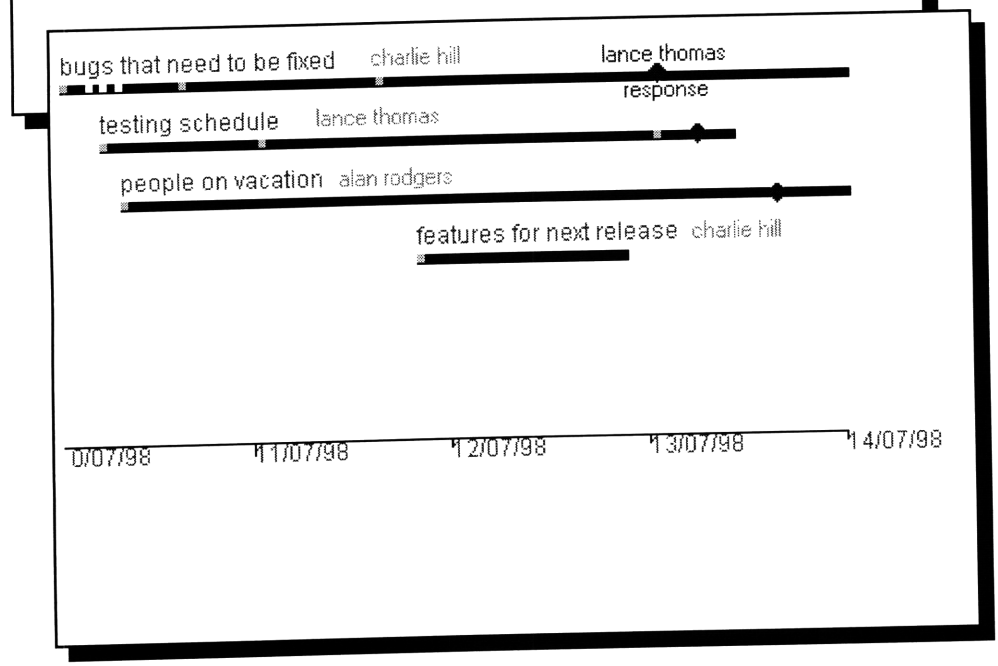


Figure 3.11 After the user moves the mouse over an item of interest the name of the person who sent the notification **(lance thomas)** becomes visible

3.5 The views :

As stated before the visualization is made up of three distinct views:

The collapsed view:

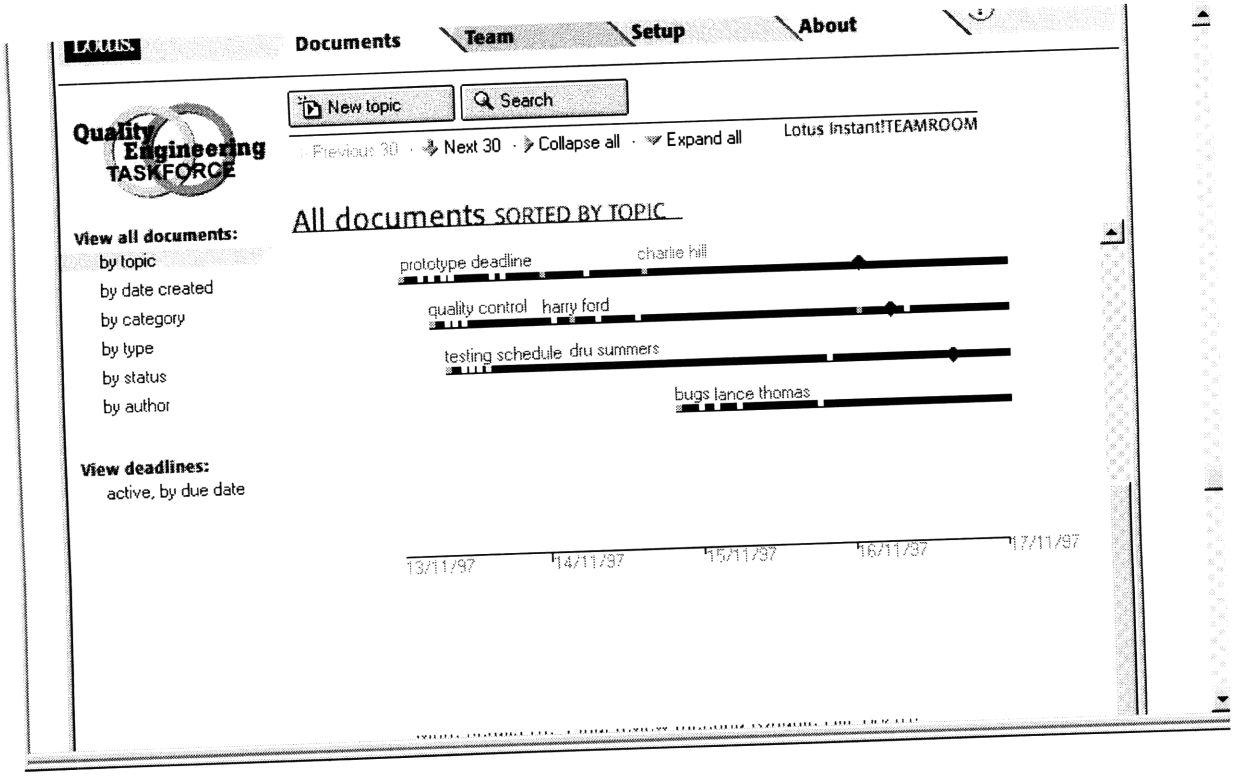


Figure 3.12: The visual Representation of a collapsed view.

This compresses all the main threads or topics into separate bars and overlay the activity on each bar. The name of each main topic and the author of that topic is also displayed. As stated before each view (in section 3.3) has a timeline so the user can get a sense of activity. This view is shown below figure . It can be seen from the figure that the main threads are staggered in time, i.e. the bar representing the information starts when the thread was started.

The expanded view:

The expanded view , as the name suggests , unfolds all the activity in all the discussions and presents it to the user. As described before, this view preserves the tree structure users are familiar with, as well as maintaining the temporal structure the users desired.

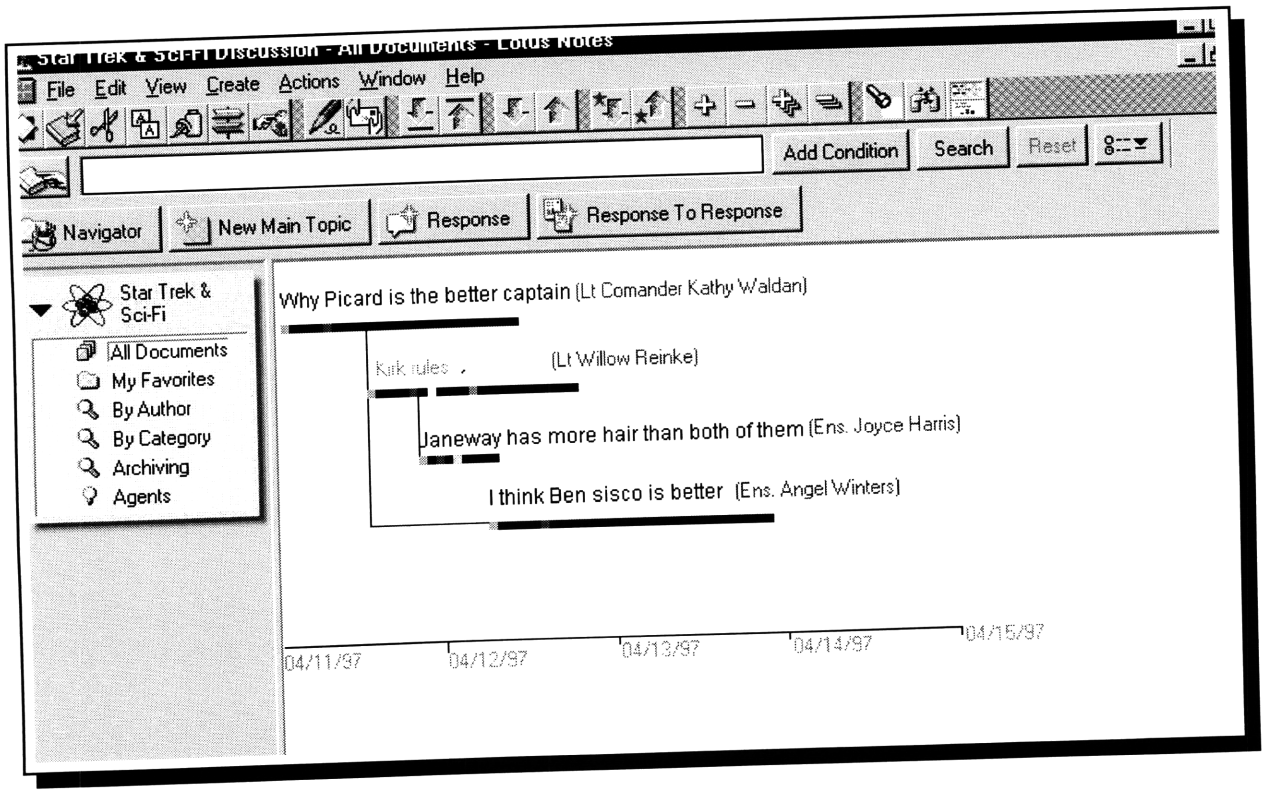


Figure 3.13 :The visual representation of an expanded view of a threaded discussion

The notification view:

This view allows the user to see all the events he or she has been notified of and the event's relation to its parent thread. This view can be though of as a hybrid view. The visualization filters the threads and only displays threads where notification events have occurred.

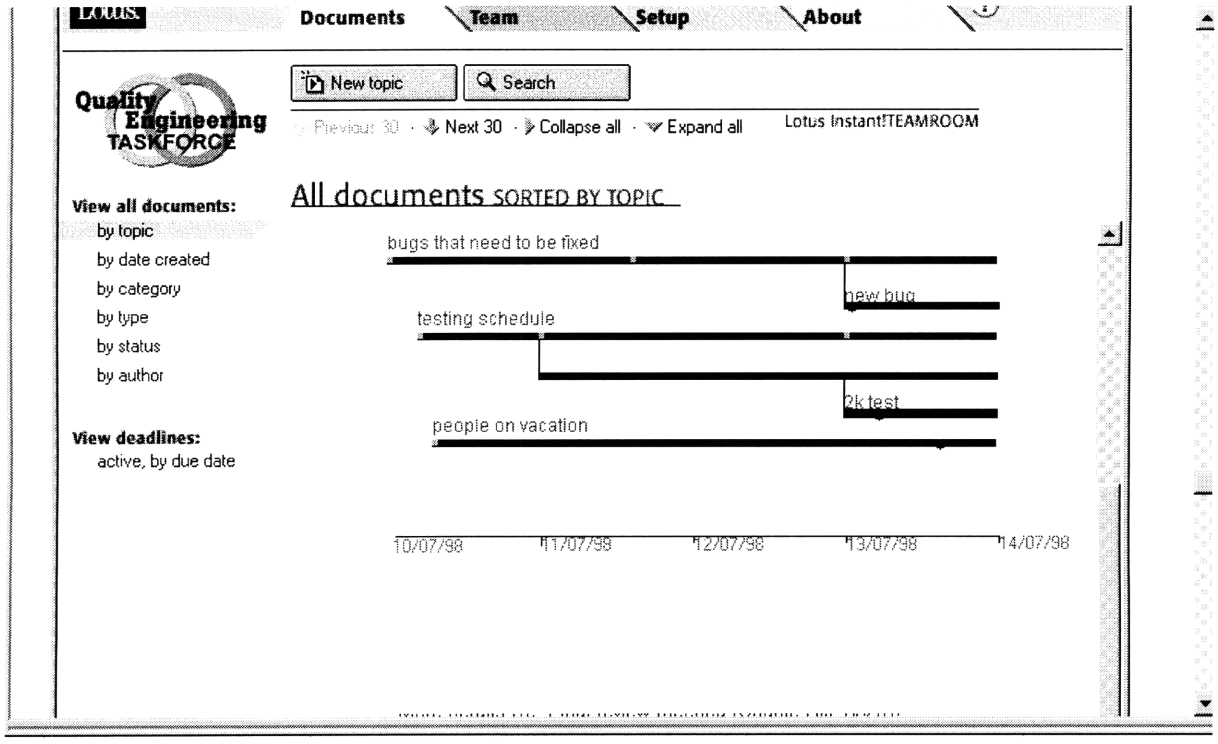


Figure 3.14: A new visual representation of notification events

3.6 User Feedback:

The goal of this exercise was to determine the users' qualitative understanding of the information presented. Sample users, who had not been consulted in the design phase were selected from the three groups that made up the user study.[Lotus employees (administrative assistants, program managers , developers, researchers and support staff), MIT interns (developers) and members of a Lotus Business partner (support staff and administrative assistants).] These users were allowed to interact with the visualization and then asked to comment about its feel and to comment on the information presented.

Users initially described the visualization as a new method of viewing a database. They were able to tell identify the main topics and their authors. They accurately deduced that the time line indicated the time of creation of the documents. From reading the icon key, users explained the icons in the compressed view. After interacting with the representation and switching between the compressed and expanded views the users described the visualization as a representation of the level of use of a threaded discussion. These test users quickly investigated the notification icon. They acknowledged that it caught their attention quickly, and appreciated the fact that it provided more information about where some changes actually occurred. Users were able to determine to the same level of accuracy (i.e. the date) when an event occurred. Users liked the new visualization, they however offered some suggestion of improvements that could be made, e.g. a scaleable time line . These suggestions are discussed as possible improvements in Chapter 4.

3.7 Other Visualizations : This section discusses some other visualization that did not gain favorable user feedback:

People Centric Visualization: Discussion threads are made up of both messages and people who interact with these messages. The people centric visualization presented the members of a discussion as the "main topics". A user could access a person and hence see what documents that person wrote, read, etc. This view gave the users a tool to monitor activity of team members but not the discussion itself. This representation did not maintain the structure of the discussion thread. As a result test users found it unfamiliar and difficult to use. Users also felt it removed a sense of privacy.

Tabular Visualizations: Users reacted unfavorably to tabular representations of the information. They complained that this view required more reading . The structured nature of a table did not give the users a sense of rhythm of the threads. Users complained it was harder to identify active threads.

Chapter 4

4.1 Chapter Organization:

This chapter discusses possible ways to improve the visualization and any issues raised in the research. Section 4.2 discusses possible future improvements and extensions of this visualization. Section 4.3 discusses the steps that would be needed to apply this visualization to a general threaded discussion.

4.2 Possible improvements and extensions:

The goal of this project was to create a visualization that would present data in a compelling way to allow users to focus their interest. The following are possible improvements to the current visualization that would enrich the user experience. From user feedback a possible improvement would be a richer set of icons. Users suggested that the expanded view could have used more icons since a threaded discussion in this view occupied more screen real-estate. Collaborative groups are moving towards having real time functions such as chats stored in their discussion databases. For the visualization to remain effective it will have to be extended to these functions.

Another extension of this visualization would be a variable time line. That is one in which the user can zoom in or out on the activity and hence choose the perspective that best suits his/her needs. This improvement would not require storing or collecting any additional data , it simply needs a better graphical rendering program.

To further enhance the sense of activity in the database or threaded discussion the visualization could be extended to include a representation of the members currently active and attending discussions. Hence users would have both an idea of past and current activity. [BRY94]

Users also requested the inclusion of filters or agents to present only a selective set of pertinent information.

4.3 Generalizations:

The databases used in this thesis were Lotus Notes databases, however the data used in creating the visualization was not inherently tied to the database used. For the visualization to be extended to others one would need to store a log of the user activity. One would need to capture the users name and the activity performed when in the database [a read, a write or an edit]. These actions and their accompanying time stamps could be used to create the visualization for a generic threaded discussion group.

The visualization is more appropriate to communities where the electronic community is of a fixed (less than 50 members) size. In these environments there is some use derived from observing a pattern of activity.

Chapter 5

Conclusion

In this thesis , a new visualization for a threaded discussion group is presented. From user feedback it can be concluded that the representation prototyped, allowed users to gain a sense of the rhythm of activity in a threaded discussion. Users were able to identify active threads more quickly and hence were able to attend discussion in a more timely fashion.

The visualization presents notifications in the same view as the discussion threads. Users said they derived some level of benefit from the new notification view.

However as stated in Chapter 4 , there are improvements to the visualization that can be made to increase the benefit to the user. These improvements include a variable time axis and the inclusion of filters.

Users were able to qualitative understand the information content presented by the visualization. They were able to accurately detail the information presented and to detect the link to existing systems. It can thus be concluded that the visualization presented was indeed a success.

Trademarks

References

[ASI85] D. Asimov, The Grand Tour: A Tool for Viewing Multidimensional Data. SIAM J. Sci. Statistical Computing, Vol. 6, No.1, 1985, pp. 128-143.

[BES94] C. Beshers and S. Feiner, Automated Design of Data Visualization, in Scientific Visualization, 1994, Advances and Challenges, Ed: L. Rosenblum, R.A. Earnshaw, J. Encarnacao, H. Hagen, A. Kaufman, S. Klimenko, G. Nielson, F. Post, D. Thalmann , Academic Press.

[BRO84] M.H. Brown and R. Sedgewick, A System for Algorithm Animation, Computer Graphics, Vol. 18, No. 3, July 1984.

[BRO92] K.W. Brodlie, L.A. Carpenter, R.A. Earnshaw, J.R. Gallop, R.J. Hubbard, A.M. Mumford, C.D. Osland, P. Quarendon (eds), Scientific Visualization, Techniques and Applications, 1992, Springer-Verlag.

[BRY94] S. Bryson, Real-Time Exploratory Scientific Visualization and Virtual Reality, in Scientific Visualization, 1994, Advances and Challenges, Ed: L. Rosenblum, R.A. Earnshaw, J. Encarnacao, H. Hagen, A. Kaufman, S. Klimenko, G. Nielson, F. Post, D. Thalmann , Academic Press.

[CRA90] Stuart L. Crawford and Thomas C. Fall, 'Projection Pursuit Techniques for Visualizing High-Dimensional Data Sets', in Visualization in Scientific Computing, G. M. Nielson, B. Shriver and L.J. Rosenblum (eds), IEEE Computer Society Press.

[COO92] Cooper,R. Qin,Z. 1992, An implementation of the IFO Data Model. International Conference on System Sciences.

[DIX93] Dix, A, Finlay, J., Abowd, G., Beale, R. 1993. Human-Computer Interaction . Prentice-Hall

[DON95] Donath, J. 1995. ACM Multimedia 95 - Electronic Proceedings November 5-9, 1995, The Visual Who.

[DOM93] Domik, G., 1993, A Paradigm for Visual Representations, University of Colorado, Department of Computer Science, Boulder, CO. 80309-0430, USA.

[DOM94] G. Domik and B. Gutkauf, 1994, User Modeling for Adaptive Visualization Systems, Proceedings of IEEE Visualization '94, IEEE Computer Society Press, pp. 217-223.

[FOS95] L.D. Fosdick, E.R. Jessup, C. J.C. Schauble, and G. Domik, An Introduction to High-Performance Scientific Computing, to appear by MIT Press in December 1995.

[GAL94]J. Gallop, Underlying Data Models and Structures for Visualization, in Scientific Visualization, 1994, Advances and Challenges, Ed: L. Rosenblum, R.A. Earnshaw, J.

Encarnacao, H. Hagen, A. Kaufman, S. Klimenko, G. Nielson, F. Post, D. Thalmann , Academic Press.

[GER94] N. Gershon, From Perception to Visualization, in Scientific Visualization, 1994, Advances and Challenges, Ed: L. Rosenblum, R.A. Earnshaw, J. Encarnacao, H. Hagen, A. Kaufman, S. Klimenko, G. Nielson, F. Post, D. Thalmann , Academic Press.

[GOR89] I. E. Gordon, Theories of Visual Perception, 1989, John Wiley & Sons.

[HAB90] R.B. Haber, and D. A. McNabb, Visualization Idioms: A Conceptual Model for Scientific Visualization Systems, in Visualization in Scientific Computing, G. M. Nielson, B. Shriver and L.J. Rosenblum (eds), IEEE Computer Society Press.

[HAB94]Haber, E.M., Ioannidis, Y.E., Livny, M., 1994. Foundations of Visual Metaphors for Schema Display,Journal Of Intelligent Information Systems:Special Issue on Management of Visual Information.3.

[INS94] A. Inselberg (panel chair), G. Grinstein, T. Mihalisin, H. Hinterberger, A. Inselberg (panelists), 1994, Visualizing Multidimensional (Multivariate) Data and Relations, Proc. of IEEE Conf. VISUALIZATION '94, pp. 404-409.

[KEL93] P. Keller and M. Keller, Visual Cues, 1994, IEEE Computer Society Press.

[KEI94] Keim, D.A. and Kriegel, H-P. 1994. Database exploration using multidimensional visualization.IEEE Computer Graphics and Applications, Sept. 40-49.

[MCC87] McCormick, B.H., T.A. DeFanti, M.D. Brown (ed), Visualization in Scientific Computing, Computer Graphics Vol. 21, No. 6, November 1987

[MON94]Monk, S, 1994. A Graphical User Interface For Schema Evolution in an Object-Oriented Database, 2nd International Workshop on Interfaces to Database Systems.

[ROB91] Robertson, P.K. , 1991, A Methodology for Choosing Data Representations, IEEE Computer Graphics and Applications, Vol. 11, No. 3, May 1991, pp. 56-68.

[ROB94]P. Robertson and L. De Ferrari, Systematic Approaches to Visualization: Is a Reference Model Needed? in Scientific Visualization, 1994, Advances and Challenges, Ed: L. Rosenblum, R.A. Earnshaw, J. Encarnacao, H. Hagen, A. Kaufman, S. Klimenko, G. Nielson, F. Post, D. Thalmann , Academic Press.

[ROT90] Roth, S. and Mattis, J., 1990, Data characteristization for intelligent graphics presentation. In Proceedings CHI '90, April, pp. 193-200. ACM Press.

[SHN94]Shneiderman, Ben. 1994. Dynamic queries for visual information seeking. University of Maryland Tech Report CS-TR-3022 [26] Simmel, G. 1971. On Individuality and Social Forms. (D. Levine, ed). Chicago: The University of Chicago Press.

[SPR94] Springer -Verlag. Paton, N.W., al-Qaimari, G.,Doan,K., Kilgour, A.C.,1994 Techniques for Effective Evaluation of Database Interfaces, 2nd International Workshop on Interfaces to Databases Systesms.

[STA92] J. T. Stasko and Ch. Patterson, 1992, Understanding and Characterizing Software Visualization Systems, Proc. of 1992 IEEE Workshop on Visual Languages, IEEE Computer Society Press.

[TUF83]Tufte, E. R. 1983. The Visual Display of Quantitative Information. Cheshire, CT: Graphics Press.

[TUF90] Tufte, E. R. 1990. Envisioning Information. Cheshire, CT: Graphics Press.