Envisioning Discussion

Designing CTools Discussion Visualizations

Information Visualization
Fall 2004
University of Michigan
School of Information

Mike Beasley
Min Young Chang
Stephen Cotterill
Cari Rottenberg
Eunkyung Yoo

Executive Summary

CTools is course management software at the University of Michigan, offering several tools including discussion. The current discussion tool offers limited functionality and is difficult to use for large discussions because of the linear way it visualizes a discussion.

Our team offers three new visualizations to serve as candidates for a redesign of the discussion tool. CTools has users with many roles and varied levels of ability; we chose to offer a suite of alternatives rather than a single design so that CTools would be able to decide upon how it would like to balance power against approachability.

The designs can be arranged from the easiest to use and least powerful to the most difficult to use and most powerful. Specifically, we offer:

- ThreadView: A variation of the current linear way of displaying a discussion, with older posts reduced in size and brightness. Additional views offer easy access to search results, bookmarks, etc.
- TreeView: The discussion is displayed in the form of nodes on a tree. This design packs more information into each node, and also offers the same additional views as the previous design.
- BarView: Instead of a tree, the discussion is displayed as bars on horizontal lines representing the passage of time. This visualization allows the user to zoom in to a specific area of the discussion but maintains a thumbnail of the entire discussion in a separate view. This is the most complex and unfamiliar of the three designs.

We recognize that choosing among the three visualizations is not an easy choice. Strengths and weaknesses of the three designs is discussed in this report. Ultimately, we chose TreeView, but it is nonetheless a compromise and still may not completely address the important issue of approachability.

This report leaves a number of open questions that we could not address during this project. Foremost are the issues of feasibility and accessibility. As we created our designs, we did not look into whether it would be possible for them to be implemented in CTools. Moreover, these designs would require a great deal of work to make them accessible to users with visual and motor impairment. Lastly, user testing is necessary to address whether these designs are usable and useful.

Introduction

The System: CTools discussion tool

CTools is a collaborative working and learning environment at the University of Michigan. Students, faculty, and staff use it to assist their work in class and on projects. As Sheard (2004) stated, various studies have shown the importance of providing facilities to enable learners working online to interact with other learners and with their educators. Asynchronous discussion is a widely used mechanism for this purpose (see Appendix A). The CTools discussion tool in particular allows users to converse asynchronously on a number of topics for any purpose and to organize discussions (albeit in inflexible ways).

Context of Use

The major users of CTools discussion tool are instructors, Graduate Student Instructors (GSIs), and students. Instructors and GSIs commonly have the ability to manage the settings, such as category and topic creation, deleting posts, and editing their own posts through the discussion tool. On the other hand, students can reply to existing posts, but do not have the ability to delete or edit any of them. No users are able to copy and paste the posts elsewhere in the discussion space.

Students can have mandatory or optional discussions with other classmates on course-related subjects. In this way, discussions enable students to obtain help from instructors or other students, and to contribute ideas to other students (Sheard et al, 2003). The discussion space is therefore used as a question and answer repository, general knowledge-base, or as a discussion.

The Problem

Functionality and interactivity within the discussion tool is limited. Currently, it displays discussions in one format: One area shows the discussion tree and another shows the currently selected post. The two areas can be viewed side-by-side or one on top of the other, but are fixed in scale to 850 x 600 (side-by-side) and 870 x 400 (top and bottom) regardless of the browser size or screen resolution. As a discussion grows, it quickly extends beyond the boundaries of its display area, forcing users to scroll vertically and sometimes horizontally to view the entire tree. Likewise, discussions do not scale well.

In addition, the structure of the discussion is purely synthetic, in that it is chosen by the administrator of the discussion and is unaffected by the content or usage of the discussion. The administrator has the full control of which functionalities to use in the discussion tool. For example, the administrator can change whether the students and GSIs can create, reply, and edit the posts. Also, the information about posts is also limited, and the interface is inflexible. There is no specific information about users, patterns of activity, or where in the whole discussions specific search keywords are located. The only views for the discussion are discussion threads and the selected post.

Most importantly, it is hard to quickly find specific posts. Navigating through the thread to find specific posts requires a great deal of effort because it is purely text based, requiring the user to read through the information. The search function does not allow users to choose the aspect of what they want to find, such as author, category, or topic. By employing a more visual representation of the discussion, we would provide users with a mechanism to “see information that is hidden or unavailable in a textual representation” (Viegas et al, 1999).

Our Scope

We decided to focus upon students as our target users. Among the various kinds of discussion activities for the students, we mainly targeted quickly finding a desired post in the discussion thread and easily adding a new post or reply to an existing post, with the support of interactions with information, usability, and system performance.

We also chose to present three designs to the CTools staff in order to further examine issues outside of our scope: accessibility, feasibility of implementation, usability, and the instructor side of the tool.

Methodology

Literature Review

To aid the formulation of new visualizations, we conducted research on the work that has been done by others on this problem and similar ones. We focused our work in two areas: Solutions that others have found to the problem of visualizing discussions, and the behavior of participants in discussions. The following are the most relevant of the papers we examined:

Visualizing Discussions

- "Visualization Components for Persistent Conversations" (Smith & Fiore, 2001).
- "Visualizing Conversation" (Viegas & Donath, 1999).
- "Navigating Very Large-Scale Conversations" (Sack, 2000).
- Chat Circle (Viegas & Donath, 1999).
- "Anthropomorphic Visualization: A New Approach for Depicting Participants in Online Spaces" (Perry & Donath, 2004).
- "Conversation Thumbnails for Large-Scale Discussions" (Wattenberg & Millen, 2003).
- "Visualizing the Pulse of a Classroom" (Chen, 2003).

User Behavior

- "Electronic Learning Communities: Strategies for Establishment and Management" (Sheard, 2004).
- "Supporting Informal Communication via Ephemeral Interest Groups" (Brothers et al, 1992).
- "Web-based Discussion Forums: The Staff Perspective" (Sheard et al, 2003).
- "Socialware: Multiagent Systems for Supporting Network Communities" (Hattori et al, 1999).

Heuristic Evaluation

In order to understand the problems facing the current discussion tool, we performed an Heuristic Evaluation (see Appendix B). Heuristic Evaluation is a method for the examination of the interface to identify how well it complies with recognized usability principles. We evaluated the CTools' discussion tool using Jakob Nielsen's list of ten usability principles (http://www.useit.com/). We attempted to go beyond usability issues, which are not directly in the scope of our project, in order to see how the current visualization addresses the user tasks we have previously described.

Our group also examined the cognitive processes that occur while performing common user tasks. We adapted the cognitive walkthrough evaluation sheet developed by D. E. and Rhoades, D.G. (1992) and designed our own evaluation form. This Cognitive Walkthrough allowed us to discover usability issues and patterns of confusion when using the system.

Interviews

The group interviewed ten representative users of discussion tools (see Appendix C). We also watched two of the users interact with the discussion tool to get a better understanding of their user needs. Through the interviews of both undergraduate and graduate students, we were able to identify users' likes, dislikes, and needs when using discussion tools.

Comparative Evaluation

We performed a Comparative Evaluation of five products with similar offerings. We were able to develop a metric to measure discussion tools' functionality based on common features. We evaluated the following competing or complementing products and graded their features as 'adoptable,' 'good,' and 'bad.': CourseTools, DiscusWare Support Forum, Yabb, Tapped In, and WebBoard (see Appendix D).

User Needs

Personas and Scenarios

We developed six personas based on our user interviews and chose the most applicable persona developed by CTools for use in the project. These personas include undergraduate and graduate students, as well as graduate student instructors. In addition, we developed seven scenarios of those personas using discussion tool. By developing personas and scenarios of our target users, we could apply a user-centered approach in identifying user tasks and needs, and refer to them as we proceeded with developing our visualizations (see Appendix E).

Unified Questions

From the scenarios of actual users' activity in context, we reduced their needs to the following unified questions:

- Where are my posts?
    - Who replied to my posts?
- Where are the important posts?
    - Instructor/GSI posts
- Where is a particular post that I read before?
- What is new that I haven't seen before?
- Who wrote this post?
- Where are the search results located?
- What other posts are related to this one?

User Tasks

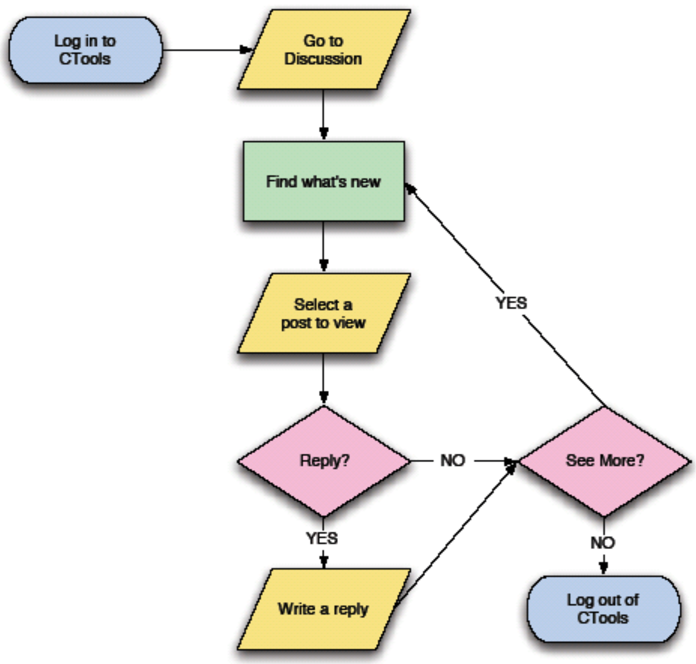
Based on the unified questions, we identified a set of detailed tasks in terms of the users' overall goals. These are the tasks at low level of granularity, but in designing a complete model of the overall user needs, we combined specific tasks. The following are the major user tasks:

- Ask a question of the community
- Inform the community of some new information
- Find information to help in studying or writing a paper
- Answer a question (in a public forum)
- React to information that someone has put out there in a public way
- Learn what others have to say about course concepts
- View responses to my questions
- View responses of others to someone else's questions

User Models

Based on the user tasks and unified questions, we found common patterns of user behavior and developed two basic models of users' interaction with the discussion tool:

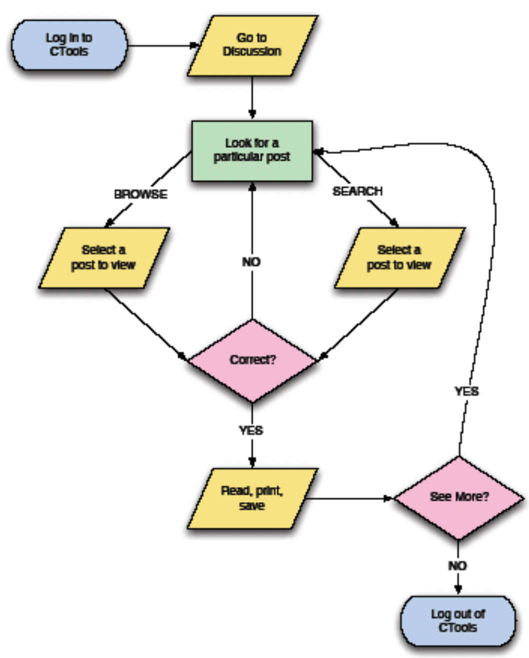
Find Out What's New



The user begins by logging in to CTools and going to the discussion tool. The primary activity when finding out what new information has been added to the discussion is to select a post to view. The user then decides whether he or she wishes to reply to a post, based upon its content. This cycle of selecting a post and decided whether or not to reply to it continues until either the user is satisfied that he or she has uncovered all new information, or decides that the benefits of continued investigation outweigh the effort.

Find a particular post

The user looks for a particular post by browsing and searching. Whether the user chooses to browse or search, the user select a post to view and continues to do so until satisfied. When the user finds the correct post, she reads, prints, and saves the post. The user may decide to see more and continues this cycle.



Design Challenges

Why 3 Designs

Early in the process of designing our visualizations, we realized that our designs had to strike the right balance of usefulness and usability. It occurred to us that we could design a solution which presented the most information possible, but that would likely be unapproachable at best. We considered building a solution which would be familiar and easy to use, but we feared that it would not reveal significantly more information about a discussion than the current system—it would be an incremental improvement. We considered both sides of the issue and ultimately came to the conclusion that there could not be a single solution. We decided instead that it would be better to propose a set of solutions, each situated at different points on the continuum between information availability and information usability. Our rationale was that the client would ultimately have to make the decision for the CTools system and its users.

Core Functionality

With a new goal of designing not one, but at least three solutions, we needed to ensure that each design met certain criteria. Our user interviews and research helped us to determine the key features necessary for discussion visualization. We divided the features and characteristics we thought would improve the visualization of the discussion into two categories: required and optional. We named the required set "Core Functionality." We believe that these features should be included in each of our designs:

Posts

Each design must have a way of displaying the posts which comprise a discussion These could be questions, answers, comments, statements, replies, or concerns authored by instructors, site administrators, participants, etc. in the discussion. Along with viewing, users must have a method for replying to and editing posts.

Time

In research conducted by Smith and Fiore (2001) users stated that the date of a message were one of the three most important criterion for determining whether or not to read a particular post. No matter how one chooses to view a discussion, one factor will always play a critical role: Time. Clearly, the meaning (both latent and literal) of a post changes dramatically depending on its temporal position. All of our designs had to incorporate some sense of time scale.

My Posts

We decided that since each user in a CTools discussion would be working independently, he or she would take a self-centric approach to the discussion space. Therefore, we felt it necessary to have a way for users to easily locate and view their own posts and the reactions they elicit.

Search

Any system that aims to manage a scalable corpus of material must include an information retrieval system so that the wheat can be separated from the chaff, so to speak. All of our designs include some way of directing users to posts which meet their search criteria.

Peer vs. Authority

In the majority of CTools discussions, some participants serve a more authoritative role than others. The most common example of this would be the professor and GSI in a class discussion. Under the assumption that these users' posts would be considered more important than others, we decided that our designs should all have a way of making "authoritative posts" easy to identify in a discussion visualization.

User Info

One of the first problems we noticed about the current CTools discussion system was the lack of user information. We realized that most discussion systems list a user's name or handle but do not include other metadata such as that user's contact information or group affiliation. Because the latent social information in a discussion has great influence over the direction and protocol of the discussion, we decided to include more of this information.

Level of Detail

Discussion spaces can quickly and easily grow beyond a comfortable size for information digestion. This is one of the primary reasons why they are a good target for information visualization in the first place. In order to provide users with focus and context simultaneously, we knew that we had to include a method for them to select the amount of material they wish to view and to change the threshold for that amount. This takes form in both "zooming" and alternate "zoomed views."

How to satisfy Challenges

Wayfinding support

We set out to make our designs as easy to use as possible. A key part of this ease of use is facilitating wayfinding (Darken, 1995). Each of our visualizations has a point-and-click navigation system as well as operators for traveling through the discussion along its structural links. We tried to represent information scent by visually arranging posts so that the discussion structure is apparent and we chose information retrieval cues which reflect the nature of information scent. Our designs use a combination of multiple views and user-controllable scope to provide both focus and context. Finally, each of our designs features the ability to bookmark posts for future reference, allowing users to quickly revisit important information.

Sensemaking

To aid users in making sense of their discussions, we tried to make our designs as easy to learn, understand, and use as possible. Like Smith & Fiore (2001) who in designing the Netscan Dashboard who determined that "grasping the nature and extent of interaction in a complex conversation from just one kind of interface is difficult or impossible", we decided to employ multiple views in our visualization. We intended for these views to be tightly coupled so that users will get the sense that they truly are viewing the same model through different views. We felt it necessary to give the users as much control over these views as possible so that they can easily maintain a clear mental model of what they see and manipulate the system to help them best understand the information on display.

Data Ordeals

In order to manage the data for clear understanding, we knew that we could not drastically change the main visualization during the course of the users' interactions. For this reason, we chose to implement information filtering through visual additions rather than subtractions. Key information is highlighted when necessary, leaving secondary information visible on screen. We used distinctive colors to represent similar posts because of the effectiveness of color for "nominal information coding" (Ware, 2004). We felt it necessary to maintain the concept of time in the discussion, so our complex visualizations are all arranged with respect to time as the primary domain.

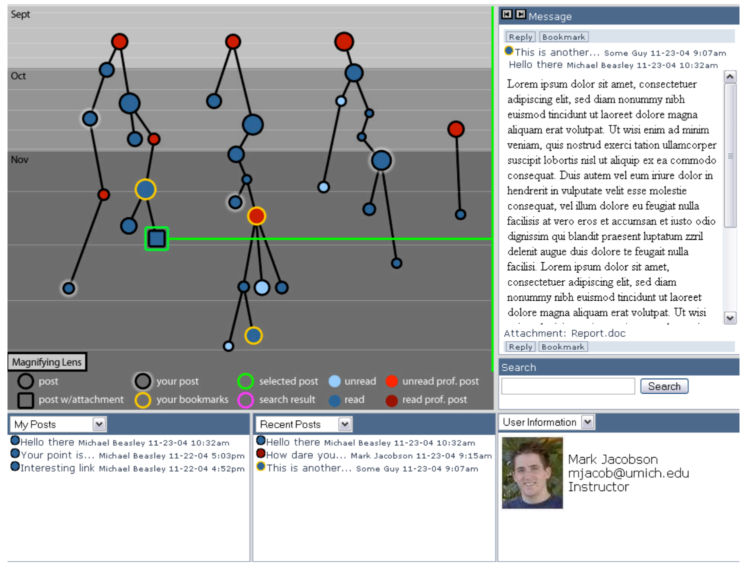
Usability

To make our visualization designs as usable as possible, we employed integrated help. Our solutions include legends for reference and adhere to an internal common color palette. This consistency should help users to understand what they are looking at without a high cognitive load. We faced problems similar to Viegas and Donath (1999) in which we not only needed to identify which data to represent through the visualization, but how to represent it in an intuitive fashion. We used color combinations, fonts, and views to keep the designs legible for users. We took advantage of contrast in our color palettes and the primary light colors (red, green, and magenta) to draw attention to important elements of the display. Finally, we focused on dynamic manipulations like "zooming" so that the users could understand the translation of the data; thus avoiding surprise or shock due to suddenly seeing a different visual.

Designs

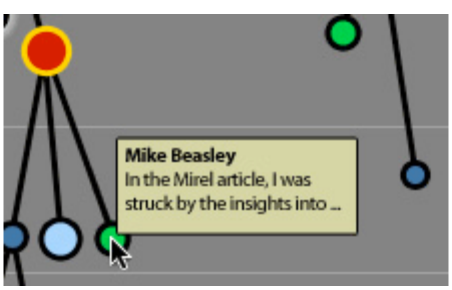
TreeView

This visualization was inspired by Microsoft's Netscan (Smith & Fiore, 2001) interface which employs an assortment of elements to convey discussion activity and structure. We thought the tree concept would fit the structure of a hierarchical conversation, and multiple views would enable users to see social information and actual posts in the same screen. We encoded more information within the tree than the Microsoft design, and designed the additional views according to our defined user models (see Appendix F and G).



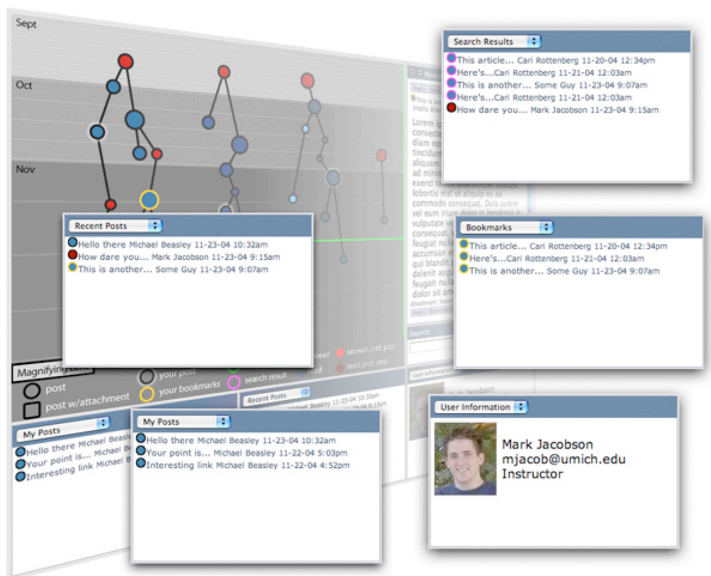
Information Scent

We wanted to provide users with a broad view of the discussion in order to see the overall patterns. In order for the visualization to be useful while displaying the entire discussion, it was necessary to encode great deal of metadata into it. This metadata provides a hint of what the different posts contain and makes browsing of the tree more manageable. We used features that can be pre-attentively processed such as color, 2D position, and shape to make certain posts and this metadata easier to visually identify (Ware, 2004). We chose brighter colors to make the more recent posts pop out. Our design for the nodes was inspired in part by Chat Circles (Viegas et al, 1999), in which circles represented messages, the size of the circle is proportional to the length of the message, and user posts were outlined in white. Authoritative users' posts are in red, regular users' posts in blue.



The tree design limited our ability to put text within each node, but a user would want to know more about a specific post prior to opening its contents. To solve this problem, we provided tooltips containing a preview of the post body when a user moves his or her mouse over a specific node. Moreover, like in the Microsoft Netscan (Smith & Fiore, 2001), all posts by a particular author light-up in green when the one of his or her posts has been selected.

Linked Views



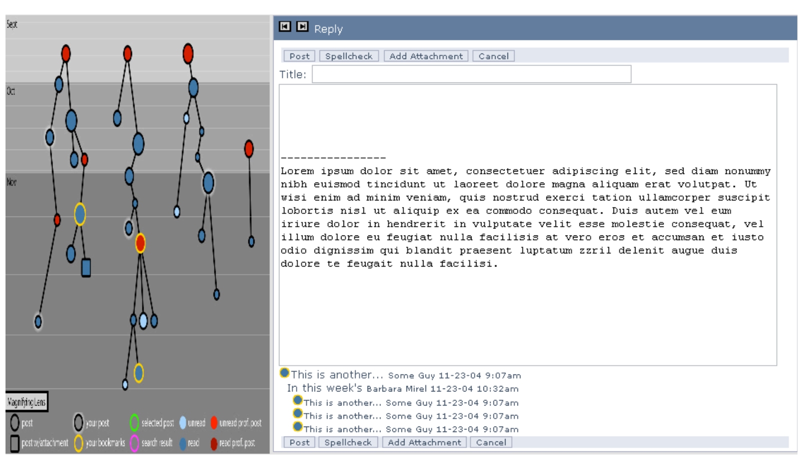
The TreeView is comprised of the complex visualization of the discussion as a tree and many peripheral views which surround it. The peripheral views display a post's content, metadata about selected posts, users, and links to other posts. Each of these views is based on the same data model, so they are inherently linked.

We employed matching glyphs to visually connect each peripheral view with its corresponding nodes in the complex visualization. We took an extra step to visually link the post content pane with the tree by extending the outline of the selected node across the tree to the edge of the message view.

Filtering

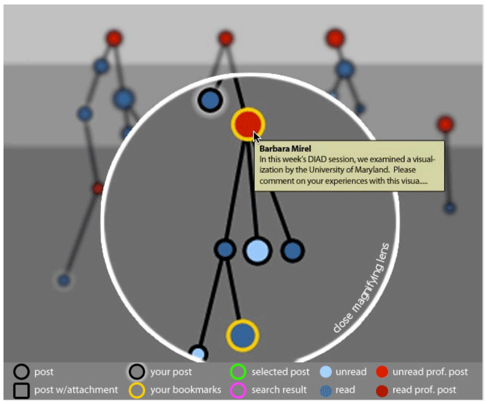
In accordance with our user models, we had to support both browsing and searching methods of information seeking behavior. To maintain the context in which the search results occur, the results are highlighted in the tree visualization, rather than replacing the tree. By maintaining the context, users can look for posts through "spatial navigation" (Sack, 2000), whereby the use of a bright pink color causes allows for pre-attentive processing of the search results. Search results are also shown as a list in one of the peripheral panes. Presenting the results in tandem allows users to use the tree visualization for other purposes while keeping their list of search results in the periphery.

Content vs. Context



Search is one example of our attempt to make the whole discussion space visible, yet manageable. We chose not to attempt to predict a user's information need by displaying only part of the discussion. We decided instead to display the discussion in its entirety, arranged in its native structure. This would allow users to find the information they desire in an unbiased discussion space.

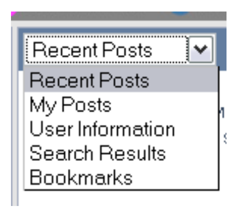
When replying to a post, the content of the post to which a user is replying appears in the text area, like in e-mail. Borrowing this metaphor provides users with a familiar interaction experience, and aids recall of the content of the post to which the user is replying. Below the reply box, the section of the thread in which this post occurs is shown. We modeled this element after iDiag (Ackerman, 2003). Lastly, we shrunk the TreeView to leave more space for reading and writing text, but we felt it necessary to keep the tree visible in order to maintain the discussion's context. However, this behavior is default; we leave to the user the option to change the proportions of the tree and message views.



As the discussion grows, users may have a difficult time finding a specific post in this broad overview. One of our solutions was to devote more of the real estate of the visualization to the newer posts at the bottom. The earlier posts are condensed near the top. The other solution is a magnification lens, allowing users to zoom in on a particular section of the discussion. We blurred the areas of the tree outside of the lens to create a focal point, emphasizing the function of the magnifying lens. By maintaining the original view in the background, we are allowing users to move the lens to their points of interest in the discussion.

User Control

Common sense claims, and our user observations and interviews confirm, that users have differing needs. To accommodate those needs we allowed for customization and user control. Users have the option of choosing three of five information panes to put at the bottom of the screen. They can be changed at anytime by using the pop-up menus in each pane.



One problem with the existing system and inherent in multiple views is a lack of space for any one view. This problem is most apparent in the post content pane, in which the post body is to be displayed and read. We put arrows in the heading of this pane which, when clicked, expand or collapse the pane, and the tree scales to fit the adjacent space. This lets users customize their workspace to best fit their workflow.

We provided two ways of selecting a post to be read. Users may either choose a post by clicking on a node in the tree visualization or by clicking a link in any of the peripheral panes. Users can also see a preview of a post's content by holding the mouse pointer over a node on the tree. These methods afford users the option of viewing a post from any of its references or to save time by seeing a preview without having to open a post.

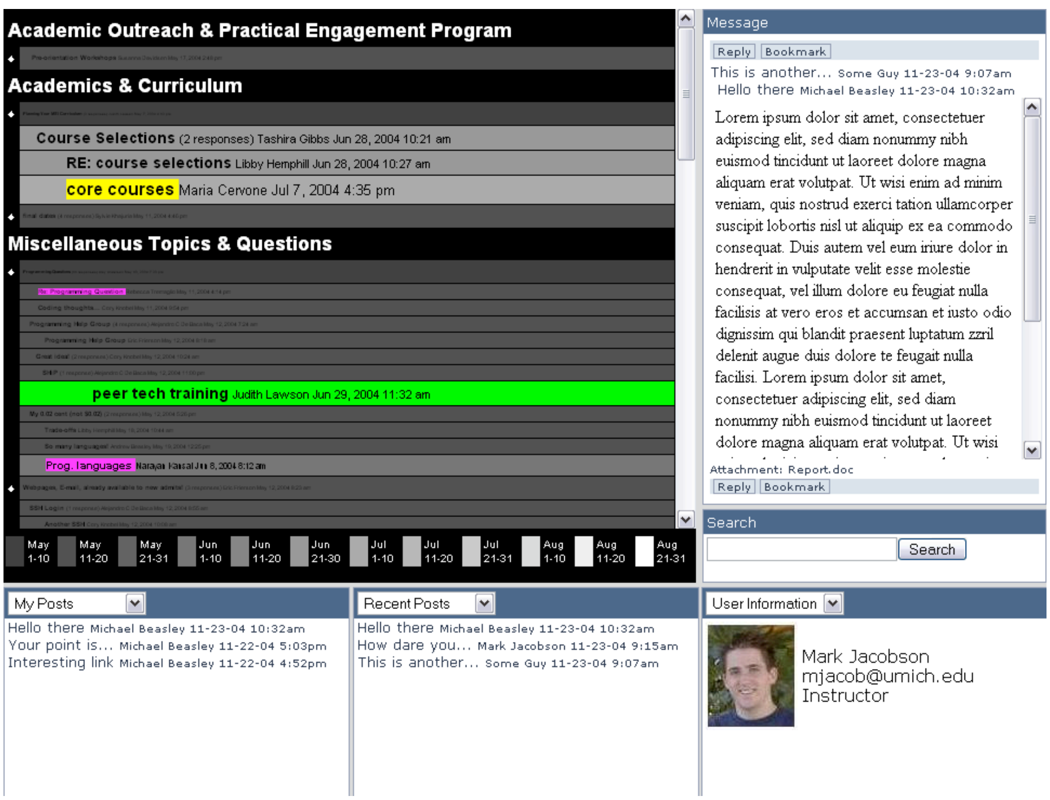
Other New Features

From our user interviews and observation we learned a number of key features to include in our designs. One major requirement, especially for international students, is the ability to spell-check their posts, so we included a spell-check button in the reply menu. Our users also wanted more information about the other participants in the discussion such as real and nicknames, e-mail address, and university affiliation. We answered this need by including this user information in one of the peripheral panes.

Another major feature we added was the ability to bookmark particular posts. When users come across a post that is especially good and will help in studying for a test or writing a paper, a user can bookmark it so that he or she can easily find it at a later time. The bookmarking feature will assist recall in subsequent visits to the CTools discussion.

ThreadView

We wanted to provide CTools with an option that was not too different from their current design, but still offered a rich visual and interactive display. The ThreadView is the simplest of our designs and will likely be most familiar to users because of its similarities to traditional online discussion forums. As a text-based option it also would be the easiest design to bring to accessibility compliance. We chose to adapt a threaded text-based structure because that is the current format and the most popular of the discussions we evaluated in our competitive evaluation. By encoding visual cues besides just the thread structure, we highlighted the potentially more relevant messages (Wattenberg & Millen, 2003). We used contrast and size to express the ages of posts in the discussion. We chose to combine this ThreadView with the same panes as the TreeView because the visualization of the threaded discussion alone can neither fully support the users' tasks nor satisfy our set of core functionality (see Appendix H and I).



Information Scent

With the limitations of a text-based design we had to focus on how to encode more information into the visualization. For this design we chose to make the newest posts stand out through stronger text-to-background contrast and larger text size. Through highlighting, background color, and font size, we were able to provide a greater indication of which posts are newer than others. This method draws the user's attention toward the newer posts through the use of "pop-out" (Ware, 2004) and away from older ones while simultaneously condensing the older posts since they are less likely to be important to the user. Yellow highlighting indicates bookmarked posts and magenta highlighting indicates search results. One problem with the use of text size and contrast to highlight new posts is that older posts become harder to read. We addressed this problem by providing tooltips so that when a user moves the mouse over the title of a post, the post's title appears. Obviously, post titles are often not very indicative of the post's content, but it would be trivial to add a preview of the content to these tooltips.

Linked Views

This visualization is the most disjointed of our designs in terms of indicating how the views are linked together. The threaded visualization has a different color scheme and looks somewhat separate from the other views. We had the difficulty of deciding whether or not to match the color of the threads to the CTools-style (used in the peripheral panes). We chose to use grayscale because the contrast is greater and causes the brighter posts to stand out more. We visually linked the selected post in the ThreadView to its content by highlighting it all the way across the visualization.

Filtering

With the low contrast and small text of older posts, it would be difficult for users to find particular posts. This concern was expressed by students at our in-class workshop. We chose to implement a search function and highlighted the search results in magenta on the threaded view. Like the TreeView visualization we also included the option of a pane which lists the search results.

Content vs. Context

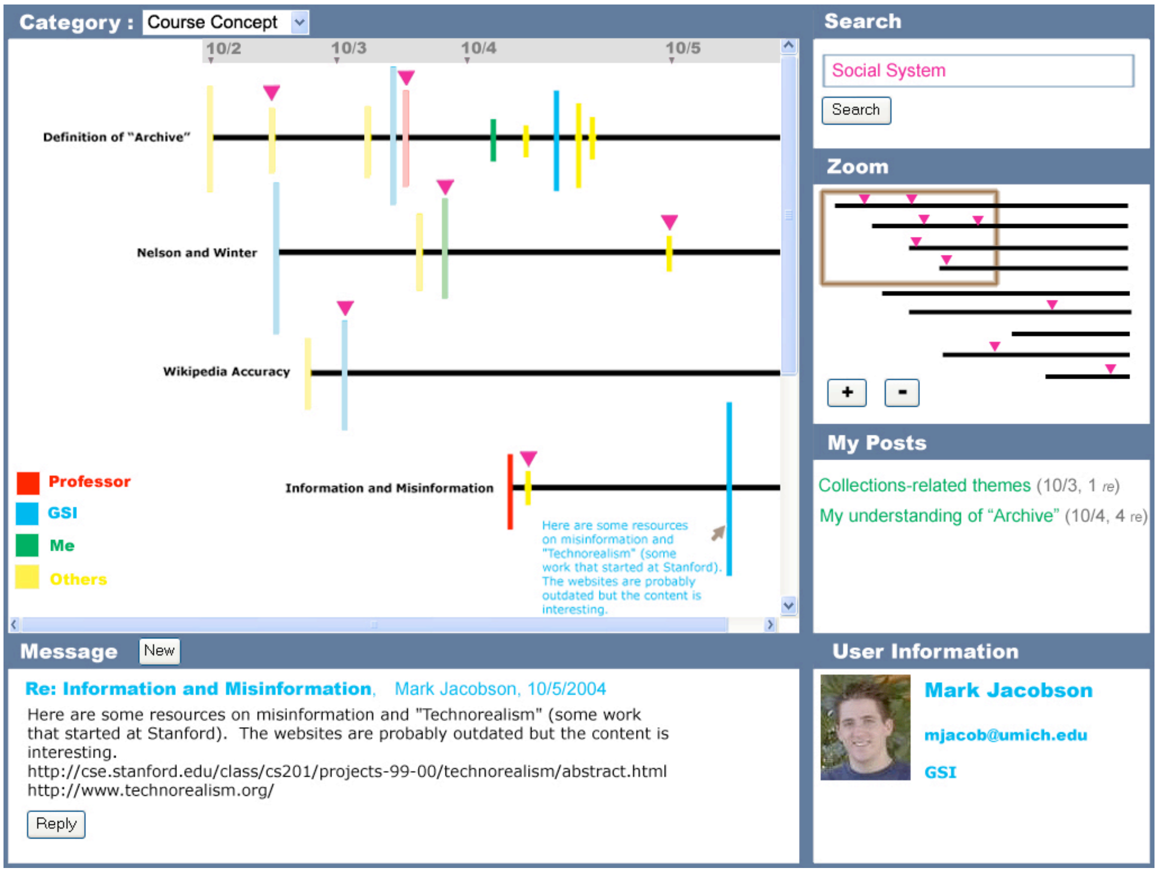
We chose to present the search results on the ThreadView to preserve the context of the discussion. The reply would work the same way as the TreeView in which the text of the post to which the user is replying appears in the text area and the discussion visualization pane appears narrower to preserve the context of the post.

User Control

Like the TreeView visualization, we chose to give the users control of the information panes. They may choose to display any three of the following five options: search results, bookmarks, my posts, recent posts, and user information. They also have the ability to expand the post pane or the thread pane to make it easier to read the information while still preserving the overall discussion context. Because longer discussions require a lot of scrolling to see all the information they contain, we provided the additional option of eliminating the two bottom information panes to allow for more vertical space to devote to the ThreadView.

BarView

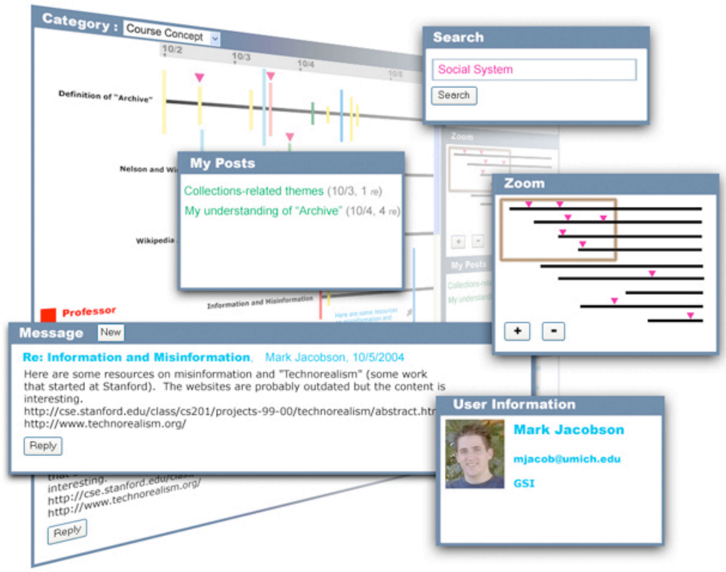
We were inspired by the representation in Chat Circles' archive (Viegas & Donath, 1999), "Conversation Landscape," and by Conversation Thumbnail Viewer, so we chose to adapt it to suit the purposes of an asynchronous discussion visualization. In our BarView, we use bars to represent posts. The length of a bar is proportional to its content length, and its color is related to its author (see Appendix J and K).



Information Scent

Since we used bars to represent comments in the conversation, it was important for each bar to provide some hint as to what the post would contain. When a user moves the mouse over a bar, a tooltip appears showing a preview of the post. Longer bars signal larger posts and vice versa. The color indicates information about the author, where blue indicates a GSI, red indicates a professor, and green indicates the user's posts. A magenta arrow above a bar signifies that the particular post is a search result. The brighter posts are unread and the more faded posts have already been read. This design was particularly difficult because we wanted to encode as much information as possible into the bars and threads, but we also wanted to keep it relatively simple in order to keep the user's cognitive load light.

Linked Views



The BarView uses consistent color-coding to link the multiple windows together. In the post content pane, the title of the post matches the color of its bar, the text in the user information pane, and its tooltip. The color coding also extends to the search functionality in which the color of the text in the search box matches the color of the arrows to the posts in both the visualization pane and the discussion thumbnail pane. The links in the My Posts pane also match the colors of their bars. The discussion thumbnail pane, which was inspired by the "Conversation Thumbnail Viewer", is also visually linked to the BarView through a brown square around the area of the discussion on display in the BarView. Maintaining the connections between different views keeps the user informed of the meaning of each view and prevents the user from having to change his or her mental model of the discussion.

Filtering

Consistent with our other designs, the BarView offers search capabilities to find particular posts. This design also features a "category" pop-up menu which the user can use to select a particular section of the conversation he or she wants to see. The zooming capabilities allow the user browse to a particular post by zooming in on the part of the discussion in which they are interested. By providing these two methods of information seeking, we give user's the freedom to either find a specific post or one they weren't aware of, but which fulfills their information need.

Content vs. Context

Of all the designs, the BarView does the best job of representing content *and* context of the discussion at the same time. The bar pane shows the focus of the discussion with particular posts and the metadata associated with each post. At the same time, the discussion thumbnail view shows the larger context in which the discussion occurs. The brown box helps to show which section of the discussion is in view, and what other information is available. The context of search results is also present in the discussion thumbnail view.

User Control

This design offers the least control to the users. The discussion thumbnail pane takes up some of the space that the peripheral panes inhabited in the other designs. Users have a large amount of control in terms of zooming and panning in the discussion space. We chose to fill the peripheral panes with a somewhat fixed set of information, but naturally, the content of those panes can be changed. We do, however, allow for users to customize the color-coding of the bars. This enables users to choose which discussion members they want to be able to find easily within the discussion and tag them and their posts with a unique color.

Design Implications

Strengths and Weaknesses

We recommend the implementation of the TreeView design. Further, we recommend that CTools maintains the current discussion tool or a similar design so that users will continue to have a familiar and more accessible alternative, if they are unable to use our proposed visualization. This design presents a compromise between power and approachability—whereas it presents a great deal more information to the user than the ThreadView design, it still gives users ways to interact with the discussion beyond using the main view. Further, the tree structure is not as esoteric as the BarView visualization and as a result, it may be easier to learn for users.

Ultimately, though, the decision of which design to use or which elements to use is up to CTools. All three designs have strengths and weaknesses and, by extension, elements that CTools may wish to harvest to make their own redesign of the discussion tool. The next several sections describe these strengths and weaknesses for each design, starting with general ones that are common to all three. When making a decision, the most important theme to keep in mind is that as the amount of information one gains from the visualization increases, the more complex it becomes. A more advanced visualization of the discussion will necessarily be more difficult to learn.

General Strengths

- Multiple ways to interact with discussion
    - Bookmarks
    - Track recent posts
    - User information
- Visual display of post metadata
- Interactivity and user control of visualization
- Customization of peripheral views

When we set out to create our designs, we established a core set of tasks that users would be able to perform in using our designs. Therefore, in all three designs, there are multiple ways to interact with the discussion—all three have a way to bookmark posts for later viewing, a way to track recent posts, and a way to present user information. Users are therefore able to interact with the discussion in the way that suits their personal needs.

These designs take the metadata that is bundled with every post (such as the timestamp, author, what post it is a reply to) and makes it more visible to users. All three designs show the user how old posts are, and the two more exotic designs also include information about who posted a post and how long the post is. The designs also include an area to display information about a selected user.

Our visualizations also offer the user control over their layout and functionality. This allows users to structure their workspace in a way that better suits their needs.

General Weaknesses

- Crowded interface
- Accessibility
- Feasibility

The unfortunate side effect of using multiple views in all of our designs is that each of the designs suffers from being crowded. The main view and the post display could both be useful in a larger form, for example, but are instead fit into smaller panes in order to accommodate other information. In this way, our designs do not address one of the concerns raised during our research of the current discussion tool's problems.

Accessibility and feasibility are both issues that our designs face. We address them in greater detail in the Open Questions section.

ThreadView Strengths

- Similar to common discussion tools
- filters out less relevant information

Among our three designs, this one has the most similarity to common discussion tools. As a result, users' experiences with other systems will help inform their use of this one. The approachability of this design is a major strength that the other two do not have.

Where this visualization is different is that it filters out older and theoretically less relevant posts by reducing their size and brightness. This strength addresses the scalability problems of the current discussion tool.

ThreadView Weaknesses

- Cannot view the entire conversation at once
- lots of scrolling
- can not scan old posts easily
- Search results don't all appear in same visualization
- Vertical axis does not map to time

Unfortunately, this design does not completely address the issues of scalability. In large discussions, the main view cannot contain all of the posts and the user must do a great deal of scrolling in order to see the entire discussion. In addition, though older posts collapse, they do still take up space, and there may be new posts separated by great distance in the list of posts. This property makes it difficult to scan a discussion when it grows large. Also, one cannot see all of the search results in the main view at one time if the hits are far apart in the visualization.

This design also does not address a problem in the current design that is counterintuitive: Though the posts are arranged along a vertical axis, the vertical axis is not a measure of time across the entire discussion. Rather, within each topic, the vertical axis implies that one post occurs before another. However, each topic is arranged on the vertical axis according to the order in which they are posted.

BarView Strengths

- Take in entire discussion at once
- Zoom in and preserve context
- Can scan more info at one time.

Unlike the current discussion tool and the ThreadView design, BarView lets the user see the entire discussion at one time. No matter where the user zooms in the main view, there is always another view showing the user's location in the conversation. In fact, the zoom feature lets the user show as much or as little of the conversation as he or she wants.

Also, this design allows the user to gain a great deal of information about posts compared to the current discussion tool; the user can also learn who posted the post at a glance, as well as the size and when it was posted in relation to other posts. Wattenberg and Millen found that their Conversation Thumbnail viewer, upon which this design draws, was easy for users to understand. Specifically, "initial results indicate that users easily grasp the thumbnail metaphor and can navigate more rapidly than with a standard web interface" (Wattenberg & Millen, 2003).

BarView Weaknesses

- Unfamiliar visualization of discussion
- Default size of post view is small
- colors are hard to see
- issues of controlling the magnified view—search results
- user must take action to view post title

BarView prominently features a way of visualizing a discussion that will probably be unfamiliar to most users. Moreover, the main view in this visualization is a custom composite inspired by multiple visualizations. Users will probably never have seen anything like this. CTools already receives a sizable number of complaints about users finding it difficult to use; CTools may not with to roll out a difficult new discussion tool.

Further, the crowdedness of multiple views comes into play in the post view, which defaults to a smaller size than in the other two designs. Though the layout of this visualization can be customized, that requires effort on the part of the user.

Colors are an important feature of this design; however, not all colors are as visible as others against a white background. There may be too many colors for a user to make sense of at one glance, the colors may have connotations (yellow for happy, red for angry) or the user may even have difficulty seeing certain colors.

When performing a search, hits are marked all over the discussion by pink triangles. These triangles are visible in the thumbnail and in the main view. However, when the user has magnified a portion of the discussion in the main view, a search must either expand the magnified area to encompass all hits, or some hits will not be visible in the main view because the magnified area is left untouched. Either solution is problematic.

Lastly, the user must perform an action in order to view a posts title and find out whether it is worth reading. Rolling the mouse over a bar requires only a small amount of effort, but it is one further step than is required in the current discussion tool. Also, depending on the magnification, the bar for a specific post may present a small target to users.

TreeView Strengths

- Take in entire discussion at once
- Zoom in and preserve context
- scan more in one go

Like the BarView, TreeView lets the user take in the entire discussion at a glance. Even when the user zooms in on a part of the discussion, context is preserved in the periphery of the magnified area. However, when magnifying a portion of the discussion, the entire discussion cannot be seen in detail, unlike BarView.

Also like in BarView, this design leverages gestalt principles to make more information available to the user at a glance. The same information that is available in BarView is also available in this visualization, and this design also lends itself to displaying a more complex discussion where a single post can spawn multiple responses.

This visualization also makes use of color in ways that will make the glyphs more visible to the user. The background of the main view is not bright white, and the colored circles are surrounded by either a black or a brightly colored circle that stands out against the background.

TreeView Weaknesses

- Unfamiliar visualization of discussion
- User must take action in order to view the title of a post
- Scalability

This design shares problems with BarView with regard to familiarity and the need for user action to view posts. However, as we stated earlier, this visualization will be more familiar to users.

In addition, this design may encounter problems when the discussion grows large and spans several months. Currently, previous months are compressed but remain in view. What happens when a discussion lasts more than four months, for example? What happens when there are many topics in a discussion? Currently, this visualization would face a great deal of congestion in these situations. As the tree grows more complex, each circle will grow smaller and will present a more difficult target. While magnification will solve this problem, it creates a new problem in that the user must undertake an additional step when accessing posts.

Open Questions

Feasibility

A large question that remains in these designs is feasibility. Can any of them be implemented in CTools? As the designs become more complex, it is apparent that they will be more taxing to the system, which is already stretched. Will CTools be able to devote resources to the development of a new interface for the discussion tool?

Further, will a visualization this complex be usable if it is delivered through a browser? At the least, one may require additional software to plug in to the browser, and at worst, the user may have to download the discussion tool as a separate application.

How will the visualization fit in with CTools?

In addition to actually implementing the visualization, whatever design CTools chooses will have to fit in with the rest of the system. For example, CTools has a specific style guide that the discussion tool would have to conform to. Currently, all of CTools' content fits into a relatively small area of the page, surrounded by the left navigation bar and a large header across the top. Our designs will not be useful in this small of an area, and would require the reimplementation of "undocking" present in previous versions of CTools.

How will help be added to the system?

Currently, CTools' help can be accessed through a menu option in the left navigation bar. This link opens a brief FAQ, and gives the user access to an extensive help guide that can be opened in a separate browser window. Will CTools wish to keep this model of help for the new visualization, or integrate help into what will likely be a complex new design?

Accessibility

For two of our three designs, a fundamental problem that was not addressed during this project is the issue of accessibility. The ThreadView design, with its similarities to common discussion tools and lack of graphics, presents the fewest problems for incorporating accessibility.

For BarView and TreeView, it is not clear how those designs could be made more accessible. The interface is broken into multiple frames and the primary method of interacting with the discussion is through the use of a large image representing the discussion, which creates a problem for the vision impaired. Even if these visualizations could be made accessible, how could they still confer benefits to people using screen readers? Colorblind users will not get the full benefit of our visualizations, but will still be able to make use of them.

Another problem that maybe come up in our designs (mostly in TreeView and BarView) is that they make extensive use of the mouse. It is not clear how to implement a keyboard-only interface for these designs. For not only vision-impaired users, but also for people whose motor skills prevent the use of a mouse, these visualizations will be difficult, if not impossible, to use.

It is obvious that our two designs that incorporate graphics cannot completely replace text-only visualizations of the discussion. In order to accommodate all users (such as those that need screen readers or cannot handle the cognitive load of such an information-rich system), our designs would have to be used to supplement another visualization—possibly even the one that is already in place.

What usability issues will user testing unearth?

During the course of our project, we did not have time to adequately test the designs for usability. It will be important for CTools to test any new visualization before rolling it out. Obviously, it will have to be tested in terms of usability. However, it will also be important to test whether any new design is useful to users (see Appendix L).

Will users accept a new design?

Finally, an important question is whether users will accept a new design for the discussion tool. CTools has a public relations problem with regard to the perception that it is buggy, difficult to use, and keeps changing. Realistically, implementing one of our visualizations will play to all three of these perceptions.

Conclusion

We began our project by examining both the current CTools discussion system and similar solutions. We researched user behavior to determine in what ways the system failed to meet the users' expectations. We created a list of features a discussion system should have in order to fulfill the needs of the users. By combining current information visualization research with our creative problem solving skills, we were able to produce design concepts to facilitate a more productive user experience. Our proposed solution set reflects the wide array of design directions in which the CTools discussion tool can move. Ultimately, we are not the ones who will build a new CTools discussion tool. Instead, this work is meant to aid the CTools development team in discovering new ways to improve the discussion tool. Our research and designs are intended to be food for thought – to seed the idea space with new opportunities for improvement.

References

1. Ackerman, M. S., Swenson, A., Cotterill, S., & DeMaagd, K. (2003). I-DIAG: From community discussion to knowledge distillation.

2. Anderson, J. R. (2000). Cognitive psychology and its implications: Fifth edition. New York: Worth Publishing.

3. Chen, M. (2003). Visualizing the pulse of a classroom. *Proceedings of the eleventh ACM international conference on Multimedia*, p. 555-561.

4. Darken, R. P. (1995). Wayfinding in large-scale virtual worlds. *Conference companion ACM SIGCHI `95,* p. 45-46.

5. Donath, J., Karahalios, K., & Viegas, F. (1999). Visualizing conversation. *Proceedings of the 32nd annual Hawaii International Conference on system sciences, volume 2*, p. 2023.

6. Hattori, F., Ohguro, T., Yokoo, M., Matsubara, S., & Yoshida, S. (1999). Socialware: Multiagent systems for supporting network communities. *Communications of the ACM*, *volume 42*, p.55-ff.

7. Laurence Brothers, Hollan, J., Neilsen, J., Stornetta, S., Abney, S., Furnas, G., et al. (1992). Supporting informal communication via ephemeral interest groups. *Proceedings of the 1992 ACM conference on Computer-supported cooperative work*, p. 84-90.

8. Nielsen, J. (1994). *Heuristics for user interface design*. Retrieved Dec. 13, 2004, from http://useit.com/papers/heuristic/heuristic_list.html.

9. *Perry, E. & Donath, J. (2004). Anthropomorphic visualization: A new approach for depicting* participants in online spaces. *Extended abstracts of the 2004 conference on Human factors and computing systems*, p. 1115-1118.

10. Sack, W. (2000). Discourse diagrams: Interface design for very large-scale conversations. *Proceedings of the 33rd Hawaii International Conference on system sciences, volume 3*, p. 3034.

11. Sheard, J. (2004). Electronic learning communities: Strategies for establishment and management. *Proceedings of the 9th annual SIGCSE conference on Innovation and technology in computer science education, Leeds, United Kingdom.*

12. Sheard, J., Miller, J., & Ramakrishnan, S. (2003). Web-based discussion forums: The staff perspective. *Proceedings of the 8th annual conference on Innovation and technology in computer science education*.

13. Smith, M. A., Fiore, A. T. (2001). Visualization components for persistent conversations. *Proceedings of the SIGCHI conference on human factors in computing systems*, p. 136-143.

14. Viegas, F. B., Donath, J. S. (1999). Chat circles. *Proceedings of the SIGCHI conference on human factors in computing systems: the CHI is the limit*, p. 9-16.

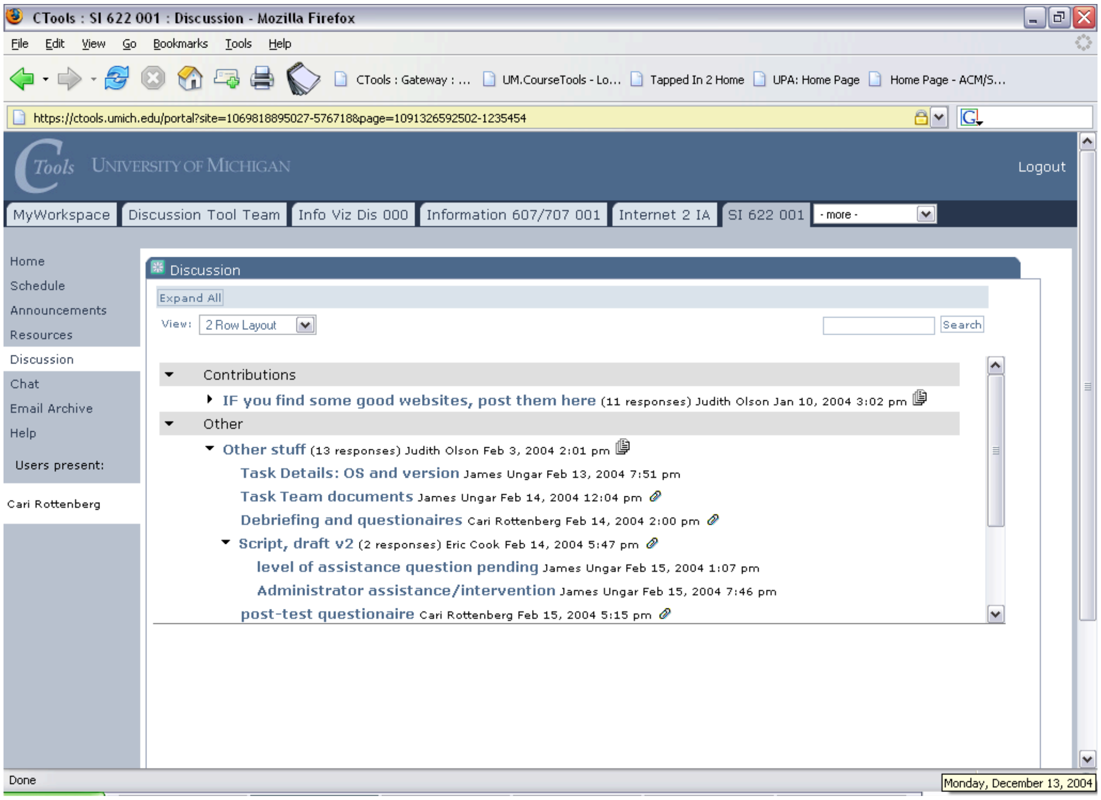
15. Ware, C. (2004). *Information visualization: Perception for design.* Amsterdam: Morgan Kaufmann Publishers.

16. Wattenberg, M. & Millen, D. (2003). Conversation thumbnails for large-scale discussions. *CHI '03 extended abstracts on Human factors in computing systems*, p. 742-743.

Appendices:

Table of Contents:

Appendix A: Current CTools Discussion Tool Screenshot:



Appendix B: Heuristic Evaluation

Heuristic Analysis

In order to understand the problems facing the current discussion tool, we undertook a heuristic analysis. We took a look at the discussion tool using Jakob Nielsen's list of ten usability principles (www.useit.com). We attempted to go beyond usability issues, which are not directly in the scope of our project, and try to see how the current visualization addresses the user tasks we have previously described.

Visibility of System Status

- Barring errors, the discussion tool does not provide many opportunities to show the system status; reading and posting messages are supposed to happen instantly, and when they do not, it is due to delays in the connection or problems with the server.
- When the user is reading messages, it is obvious because there is a message on the screen. Similarly, when the user is composing a reply, it is obvious because there is a composition form
- When the system encounters problems, there are error messages that appear at the top of pages. They are not always highly visible or highly informative.

Match between system and the real world

- Individually, the concept of "Category" and "Topic" make sense, but the actual organization within the tool doesn't necessarily make sense. The hierarchy is Category → Topic → Response, and they have to appear in that order.
- Responses to Topics don't seem to have an explicit name. People used to discussion boards may refer to them as posts, but that term isn't used. The closest one gets is that the button to start a post is called "Reply," and the button to actual finish a post is called "Post."
- Post, Preview, Save Draft, and Cancel (the buttons when composing a response) all fit in with terminology in other message boards.
- Add Attachment button makes sense
- New Topic and New Category buttons are, of course, problematic for the aforementioned reason.
- Someone who wants to make a post about a brand new topic can't just do so—must first choose or create a category, and then make a new topic to hold that information.

User Control and Freedom

- There is a cancel button if you accidentally try to reply to a message, change permissions. Most actions are not irrevocable, though, because most of the interface is just reading.
- Can't create a topic without creating a category first.
- No way to get stats on how users are using the system
- No way to revise posts

Consistency and Standards

- There are no apparent problems with consistency

Error Prevention

- Students are not permitted to do anything dangerous to the system; the only irrevocable action is the act of posting.
- The permissions system is poorly explained and permit a instructor to really screw up the site
- There aren't many other opportunities for errors that will break the system

Recognition rather than Recall

- The number of actions that users can take is limited; labels are descriptive unless one is unfamiliar with discussion boards.
- The option to view an entire thread and to delete messages/topics/category is just an unlabeled icon
- Otherwise, the system doesn't seem so bad. There really isn't that much you can do with the system, as it is.

Flexibility and efficiency of use

- There is a View Entire Thread button
- Otherwise, there is only one way to do everything

Aesthetic and minimalist design

- The design is minimalist. Everything on the screen is there for a purpose (with the exception of within permissions)

Help users recognize, diagnose, and recover from errors

- There is very little that the user can do to recover from errors. The error messages in CTools are good about telling the user what went wrong and do not use weird codes.

Help and Documentation

- Options for instructors are fairly well described. Students have little that they can do. There is an extensive help guide in CTools

Cognitive Walkthrough

Information:

Posts organized in tree format, Categories > Topics > Posts/Replies
Categories listed in alphabetical order
Topics listed in chronological order

Operators:

New Topic
New Category
Expand All/Collapse All
View as rows/columns

Search
Expand/Collapse Post
Show topic content (flat view)
Next Message
Previous Message

Usability Observations:

Help is not contextual (nothing about using discussion tools)
Expand/Collapse Post links only on icon, not on post/topic name
What is a topic? What is a category?
Post metadata shown in the discussion tree is too verbose and not neatly aligned
Button to return to tree from flat view is at the bottom of a potentially long page
Clicking on a topic/post allows you to view its content, but does not expand its position in the tree
Expanding the tree requires a refresh, but does not return you to the same position in the tree
It is easy to get lost in the discussion tree… Where am I? Where is that other topic?
Next Message on an unexpanded post won't expand it
Completely erratic behavior of discussion tree (constant refresh spasms)

Ideas for use:

Which posts are mine?
Who has replied to my posts and when?

Appendix C: Interview Questions

In order to conduct our user interviews we established the following list of common questions:

- Why would you want to use the discussion tool?
- Have you ever used it? How have you used it?
- What do you like/dislike?
- Do you require its use in your class? / Is its use required in your class?
- What information do you want/need to get from the discussion?
- What do you think of the concept of the discussion tool?
- What would you like to do with the discussion tool?
- If you don't use it, why not?
- Extra Comments

Appendix D: Comparative Evaluation

Competing systems:

- CourseTools Discussion
- Dartmouth College History 53 Discussions
- DiscusWare Support Forum
- Yabb
- Tapped In
- WebBoard

Strengths of the Systems:

- Sort function: View By Category, By Topic, By Author, By Date, Recent
- Readers: can choose from “For Everybody” or “For Instructor”
- +Hotlist (Add to Hotlist) ←→ -Hotlist (Remove from Hotlist)
- Save Options: Preview or Post
- Resource Link (link to the already uploaded resources)
- Shows hierarchy of where located in discussion at top of page.
- Posts show picture and information about the person who posted.
- Icons show new posts.
- Can get info about poster and send an e-mail to the person.
- Shows information of number of replies and post information in chart format.
- Can change to tree view from Linear layout of topic view.
- Windows Explore metaphor: Tree view in the left side (you can hide the tree view)
- Breadcrumb for hierarchy
- Icons with labels: e-mail, profile, reply, new topic, etc – easy to understand
- Hypertext, emoticon, font style (looks like standard word processor) available
- User e-mail, profile with picture, the number of posting by the user and message rating are shown in left, discussion body in right.
- Quick menu – dropdown box for quick access to different category
- The number of replies next to the title of topic and categories

Weaknesses:

- Respond vs. Respond Direct → confusing!
- Feedback given on the same page→ Dialog box would be more convenient for users
- No visual linking of related posts other than all supposedly for same topic.
- Lot of scrolling needed.
- Can’t see rest of discussion thread while reading a particular post.
- When you hide the tree view, hard to go back to the list without breadcrumb, ‘previous/next topic’ icon or back button

Appendix E: Personas and Scenarios

Personas

Sarah Kim

Age: 22
Gender: Female
Year: Senior
Major: History

Sarah is a senior at the University of Michigan and is majoring in History. She is from Grand Rapids, Michigan and is very close to her parents and younger brother. She lived at South Quad dorm for her first three years of school and moved to a small apartment with her best friend for her last year of school. Sarah has always loved history and dreams of becoming a professor at a major university someday. She spent the previous two summers as an intern in Washington DC. She fell in love with the city and wants to attend Georgetown for her PHD.

In her spare time Sarah tutors high school students at the local high school. She also plays the violin in the university's symphony orchestra. Sarah usually does her homework at the library or in her apartment. She takes her Dell laptop with her everywhere and is constantly checking her e-mail. She has been using computers for years and is very familiar with the Internet. Sarah uses CTools for all of her classes to obtain materials and submit her assignments. In one of her classes there is an ongoing electronic discussion on CTools. This course is an advanced topic in American History, her passion. It is very important to Sarah to take an active role in this conversation and to see how others respond to her comments.

Steven Williams

Age: 18
Gender: Male
Year: Freshman
Major: Undecided

Steven is a freshman at the University of Michigan. He is originally from Manchester, New Hampshire. Steven lives at Markley in a small room with a roommate from a small town in Northern Michigan. Steven is the youngest of three brothers, and his parents are divorced. Steven plays IM soccer and football with his dorm. He played the guitar in high school and is thinking of joining a band with his new friends from the dorm. Steven prefers to socialize than to do his homework, and generally procrastinates. He still does not know what he wants to study, so he is taking introductory classes and basic university requirements for LS&A.

Steven uses his mother's old Macintosh computer in his room to do his work, but mostly uses the computer to surf the internet and chat with his friends. One of his classes uses CTools, but he is still learning how to use it correctly. The class is his English class, and it requires him to post a comment in the discussion on a weekly basis. Steven generally does not know what to say and does not like the fact that everyone in the class can read his comments. He also wants to be able to post his comment in the correct place quickly so he can get back to chatting with his friends or practicing sports.

Becky Smith

Age: 26
Gender: Female
Year: 2nd Year Grad School
Major: School of Information, ARM

Becky is a 2nd year student at the University of Michigan School of Information where she is specializing in Archives, Records, and Management. She is originally from San Jose, California. She attended University of California, Davis where she majored in art history. Following her graduation, Becky worked at the Crocker Art Museum in Sacramento for three years. She has always been passionate about art and preservation of artifacts from the past. Therefore, she decided to apply to the University of Michigan to learn about how to preserve digital archives of art collections. After coming to the University of Michigan, Becky got a part time job at the art museum where she is working on the digital catalogue.

While Becky owns a computer, she is not as proficient with it as she would like to be. She has learned a lot about computers since coming to the School of Information and is currently taking a course entitled Networked Computing. She is not that interested in the subject matter, but it is a prerequisite to a course she really wants to take. Becky has been using CTools since she started at the University of Michigan, but she still is confused by some of its components. Particularly, she has a difficult time viewing posts in the discussion for her networked computing class. Students in the class are required to post a comment on a weekly basis. In order to study for the midterm, Becky wants to easily find important posts and to see some of the common themes that emerged during the course of the semester.

Ed Rosenstein

Age: 41
Gender: Male
Year: 1st Year Grad School
Major: Ford School of Public Policy

Ed is originally from a small town in Ohio where he had a large family of three sisters and two brothers. Ed attended Oberlin College where he majored in business. After graduation, Ed got a job in the real estate industry and worked there for two years before marrying his college girlfriend and moving to a suburb outside of Cleveland. He got a new job there with a different real estate agency. He worked there for the next several years and received several promotions. His wife worked for a local bank. Ed proceeded to get involved in local government activities in his town. He and his wife had two children. After a while, he decided that he was more interested in policy and government issues than real estate. Ed decided to apply to graduate school in public policy to change careers.

Ed and his family moved to Ann Arbor so that he could attend school. His wife got a new job at Comerica bank and enrolled their children in Ann Arbor schools. Ed is proficient in computers with the ability to surf the Internet, check his e-mail, and use Microsoft Office programs. He also has limited time to complete his homework as he must attend to familial obligations. CTools is Ed's first experience with courseware, and he often has difficulties using it. Ed is quite interested in the class discussions that occur online, but it usually takes him a while to read through all the messages and to sift through the ones of most interest to him. He also wanted to respond to a particular post last week, but could not figure out how to do it.

Wei Han

Wei Han is 31 year old 1st year PhD student in the Education department at the University of Michigan. This is the first time for her to be out of Taiwan where she worked as an elementary school teacher. Living in family housing, she is married to a PhD student in Mechanical Engineering department at the University of Michigan and does not have any kids yet.

She owns a one year old Sony Vaio laptop computer with Windows XP and taking it with her all the time. She does not have any computer at home because her husband also has his own laptop for his study. She usually deals with MS word, Acrobat, PowerPoint for creating documents and Photoshop for some graphic work on computer. She is between novice and intermediate about computer hardware but she knows about applications good enough for her work.

She attends a regular meeting with her colleagues every Wednesday. Since this is the first year of PhD, she has to attend several classes for the coursework. She spends most of her time doing reading and assignments for the classes at her office. In her classes in Education department, all students are suggested to post their profile and class related questions, such as new concepts or terminologies, in discussion section on CTools. She is always nervous to click post button because English is her second language that can cause miscommunication. Whenever she finds typo after posting, she wish there was a spell check function before posting or edit feature that enables her to modify the articles after posting. She also frequently use search function to find past articles with keyword.

Mark Jacobson

Mark Jacobson is a 22-year-old senior student at the University of Michigan, majoring in Computer Science. He is living in the dormitory with one male roommate but his family is in Denver. As a hobby, he runs an ftp server to share mp3 music and movie files with close friends. In weekend, Mark likes to invite people to have a party or eat out in downtown Ann Arbor with his friends.

Mark owns two computers. One is the FTP server, 2-year-old Dell desktop with Windows 2000 Server operating system, located in next to his desk with high speed internet connection in his room. It is always running for the convenience of file transferring and its status is usually checked once a week. He also has a laptop computer, IBM T40 with Windows XP, 512 Ram, and wireless availability, bringing it everyday in his backpack for the classes, assignments, and other activities. He usually works in library or his room for assignments. As he has been using computer for seven years, he is very confident in dealing with computer.

He is a part time technical consultant in the local consulting firm. Since Mark wants to stay here after graduation, he works 30 hours a week and attends only 2 classes this semester. To keep up with the other students who spend most time on campus, he uses CTools a lot after work to download course materials, submit assignments and ask questions through discussion board. Due to limited time, he wants to find the desired thread of topics quickly and easily.

Aarti Kumar

Aarti is a 21-year-old junior student, majoring in Psychology at the University of Michigan. He was from Flint, Michigan and lives with his close friend in a dormitory which is located 5 minutes away from Shapiro Undergraduate Library. Aarti's family immigrated from India when he was 10 years old. His parents are still living in Flint and his sister is studying at Michigan State University. He is a volunteer research assistant for a professor who specialized in Counseling. Aarti wants to pursue graduate study on Counseling after graduation, since he thinks he likes to help people by listening their problems and giving advices, and wants to develop methodologies for better counseling.

Since Aarti does not own any computer at home due to budget limitation to buy personal computer, he uses public computers at the dormitory, library, and campus computing sites, in particular, one in angel hall, for his assignments, e-mail or Internet. He likes to use discussion on CTools because he can involve in the class actively even though he does not in-class discussion due to his introspective personality. He asks many questions related to assignments or some concept he could not understand in readings, read recently posted messages and replies them. He wants to find active discussion topics so that he can add comments as many as possible within limited time so that he can go to his room and take a rest. He is also interested in the virtual interaction with other students, who commented his posting or to whom he commented.

Scenarios

Scenario 1: Sarah Kim

Sarah Kim participates in several newsgroups related to American History. She received an interesting article link through this newsgroup and thinks it is particularly relevant to her advanced class in American History. She is also curious what her classmates think of this article. She decides to post the link as an item in the course's CTools discussion. She hasn't been to CTools in a few days and upon logging in, looks at the Discussion to see if there are any new messages of interest to her. She notices that there are several responses to her post a few days earlier. She decides to read those before posting the link. She disagrees with something in one of the replies and decides to write a response to it. Sarah then wants to find where the article link would fit in the overall discussion. She does a search for the main subject matter to see if there is anything already in the discussion that would relate to her article. She finds a few posts on the same subject matter as the article and creates a new post that she links to those other posts.

Scenario 2: Steven Williams

Steven Williams is doing his homework and realized that he needs to post a comment on his CTools discussion for his English class before tomorrow. He has not done the readings for this week and decides to skim this week's chapter in the book before making a post. He signs into CTools and then goes to the discussion section. He looks for the newest posts because he would rather reply to another student's comments than start a new idea to discuss. He sees that his friend from his IM soccer team posted a comment, so he decides to read that one. He decides to reply because this post makes sense to him and he could relate it to the reading relatively easily. He writes his response and posts it. He then logs off of CTools and goes to visit a neighbor in his hall.

Scenario 3: Wei Han

Wei Han is in her office doing reading assignments for one of her Ph.D. seminar called Learning Technology. As she reads the article, she finds new concepts and terminologies with which she cannot completely understand. Since it is in the middle of the night and nobody in her seminar class is near her, she decides to ask questions in discussion section of CTools. She logs into CTools seminar website and first search the discussion to see if there are any posts related to her questions. She founds no items that match her keywords. She creates a new post, but after posting, she finds two typos. However, she is unable to modify this already written post because CTools does not offer revise function for discussion tool. She has no option but to reply to her own message saying that she mistyped two particular words. Finally, she adds her comment at the end of the message that she would love to have spell check or edit features in the discussion tool.

Scenario 4: Becky Smith

At Sunday night, Becky Smith realizes she needs to write something on her Networked Computing course website. Students in the class are required to post a comment on a weekly basis, and Becky has not posted any this week yet. She quickly starts her computer and logs into CTools discussion tool of Networked Computing course. Because everyone in her class posts his or her comments weekly, there are many new posts with various topics she has not read yet. She has a difficult time viewing all the new posts in the discussion. She eventually gives up reading them all, and she just searches some keywords from the last week's lecture on Google and creates a new message providing links to interesting articles. Now she is worried about her midterm exam that will be given in two weeks. Since she's been slacking off in this class, she wants to take advantage of the discussion tool for her exams. She needs to easily find important posts and see some of the common themes. However, she still is confused by some of its components to view important posts.

Scenario 5: Mark Jacobson

After work, Mark logs in CTools and goes to discussion. He checks his previous postings first to see if someone replied to them while he was working out of campus. Mark finds two replies, reads them and finds one of them contains very useful information for his question about the mid-term paper. Mark wants to know about the poster so he clicks the poster name and the user metadata is shown. Mark knows about the poster, Jennifer, a junior mechanical engineering student, by the information. He also can see the posts she made and click some of them. Mark now knows some about her and thinks that he will say hello when he sees Jennifer in next class. He sends private reply to one of them for appreciation because it is personal thank you note that everyone in the class does not need to see.

Then, Mark tries to find recent posts since his last login. Because the new posts are highlighted in different colors by topics or categories, he finds them easily and reads the new posts. When he thinks that he has something to add, he posts comments to some of the posts. Now Mark writes a new post about a cool site, which he learned during morning meeting at the company and has great example of what he learned in class, in Related information category to inform the rest of class about this.

While doing an assignment, Mark gets stumped by one concept. He did not finish reading article related to the concept a few weeks ago but remembers that there were some threads of discussion related to this concept. Mark logs in CTools and goes to discussion. He seeks the discussions by choosing each week in the timeframe, and finds one of them in a thread of 2 weeks ago timeframe. He reads the whole posts but they were not enough so he tries search function. Aarti enters key word and search results are highlighted. Therefore, he can read all related posts and finishes the assignment.

Scenario 6: Yu Jin Jeong

Yu Jin Jeong is a GSI for STAT 114, an introductory statistics course. He is not enthusiastic about pedagogy, but being a GSI pays the bills this semester. STAT 114 has a CTools site for assignments, sharing files, and also for its discussion tool. The discussion tool gets a great deal of use because it's a place where students post questions about the homework and help each other, as well as receive assistance from the instructors.

Yu Jin Jeong has been assigned Monday, Thursday, and Sunday nights for getting onto CTools and answering new questions that students have posted on discussion. Yu Jin is busy with his own classes and dissertation, though, and wants to get this part of his job over with as quickly as possible. Basically, he wants to get onto the CTools site, quickly figure out what new questions have been posted, and answer them. Similarly, if students have asked follow up questions about anything he has written or what another instructor has written, he wants to address those questions as well.

He logs on to CTools, goes to the STAT 114 site, and opens the discussion tool. Within discussion, he has set aside one category for questions about homework, and within that category, a separate topic has been set up for each assignment. Yu Jin waits for the page to load, and when it is finished, scrolls down through the first few categories to get to the homework category. Luckily, the topics that he does not want to look at are collapsed. Unluckily, the topics in the assignments category are collapsed. Yu Jin selects the current homework assignment and clicks on the icon that expands that thread. To his constant annoyance, when the page refreshes with the newly open topic, he is back at the top of the page and must scroll down.

He sees that two students have posted new questions under this topic, and it appears that a student has asked a follow-up question to a message that another GSI had posted yesterday. Yu Jin clicks on the subject line of one of the new questions, and reads it. It looks like another student has already posted a reply to this question, so he clicks on the subject of that post, and reads it as well. He then clicks on the first post, and hits reply, and then composes his message. When he is finished, the page refreshes and he is again at the top of the page. Once again, he scrolls down.

Yu Jin repeats this process two more times, for the new posts. Finally, his work on the site is finished for the night, and he clicks the Log Out link and exits his browser.

Scenario 7: Ed Rosenstein

It's the middle of the term and Ed is really feeling the pressure from all of his classes. Thanksgiving is approaching and many of Ed's group members will be taking the whole week off so they can be with their families. Ed knows from the past 2 years that after Thanksgiving break, classes become unforgiving. He has learned that he needs to have all his projects in order before December.

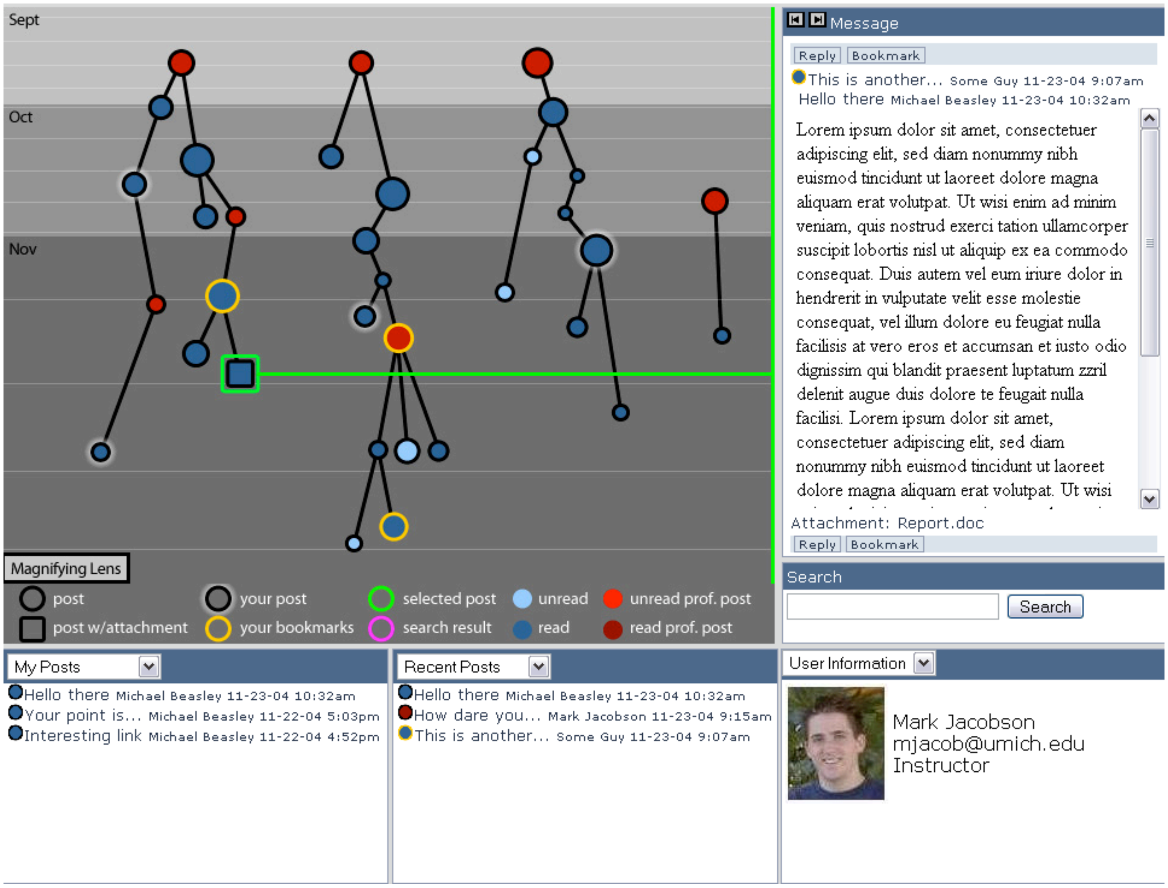
Ed and his group members are diligently working to meet their personal deadlines so that they don't let the rest of the group down. With little time left, Ed can't call any more group meetings, so the groups will have to work individually and report their progress on CTools. Ed uses CTools discussion to keep on top of his groups. He has had problems with his e-mail this semester, so he tries to keep current by checking the discussion.

Things are changing every hour, so Ed decides to check the discussion between classes. He needs to find if:

Susan (one of his group members) has answered his question about the final presentation
His history group isn't happy with his section of their report
Any new problems have suddenly popped up

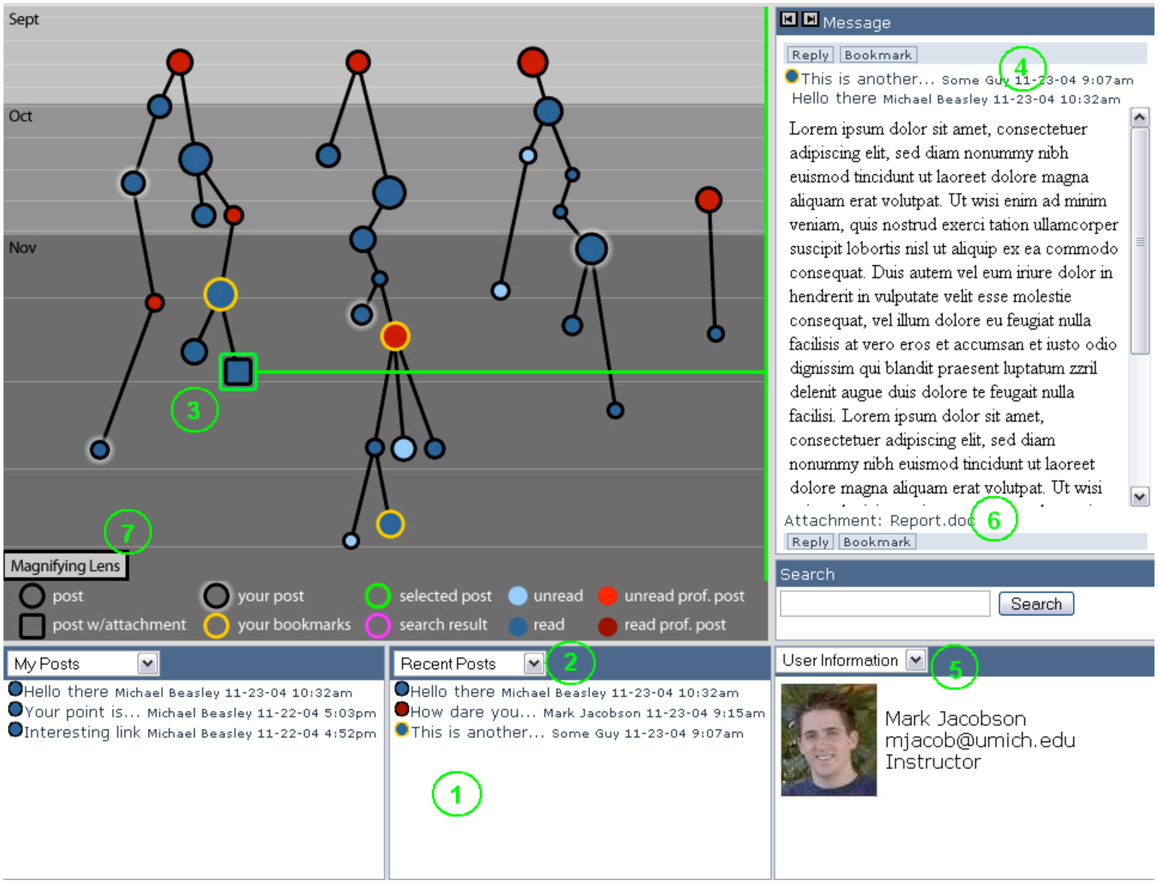
To do this, Ed needs to know if there have been any new posts (specifically any in response to his posts) and where in the discussion those posts are. Since these discussions have been going on all semester long, they are very large. In the few minutes that Ed can devote to reading these discussions, he needs to find this information quickly. Time is a factor. Ed would like to have a brief summarization of what has happened since he last looked at the discussions.

Appendix F: TreeView Screenshot

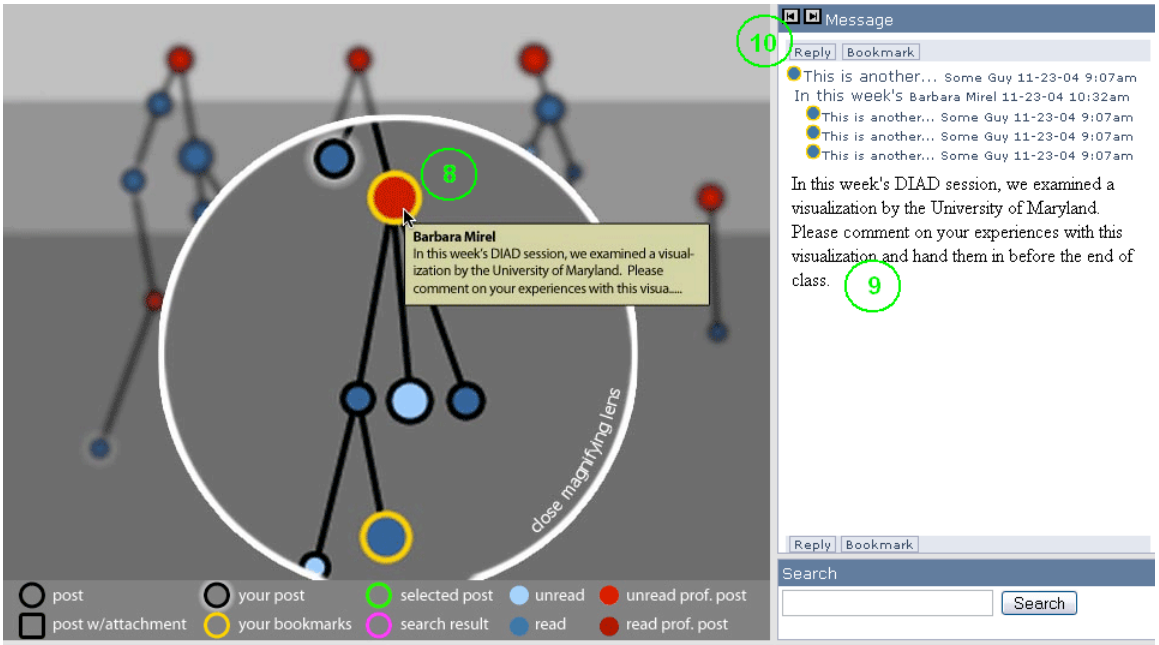


Appendix G: Walkthrough of TreeView

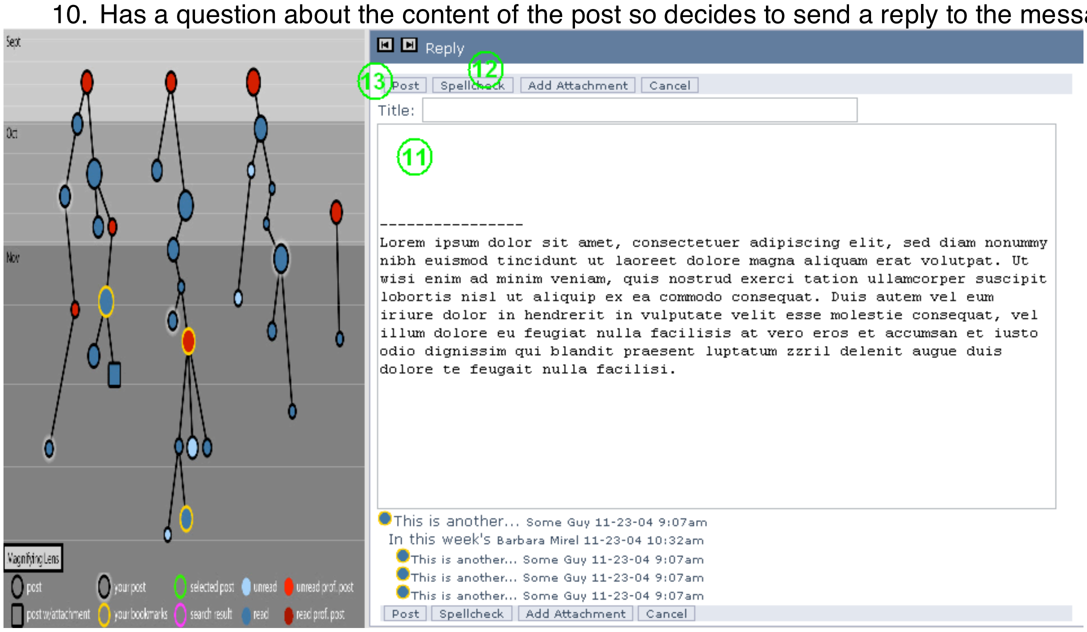
Michael Beasley, a second-year HCI student in Information Visualization is writing his individual paper. He goes to the discussion to find posts that may help him in putting together his report. He logs into CTools and goes to the class discussion.



1. See if any recent posts have not already read
2. Since no new posts interested in, changes this pane to Bookmarks
3. Remember classmate made a post with attachment to an article that may be useful for paper. So looks for square node and clicks it.
4. Reads the heading of the post and not sure if knows the person who posted the message
5. Looks at user information
6. Reads message and clicks attachment to save it to disk
7. Notices an area of lots of activity so zooms in to that area

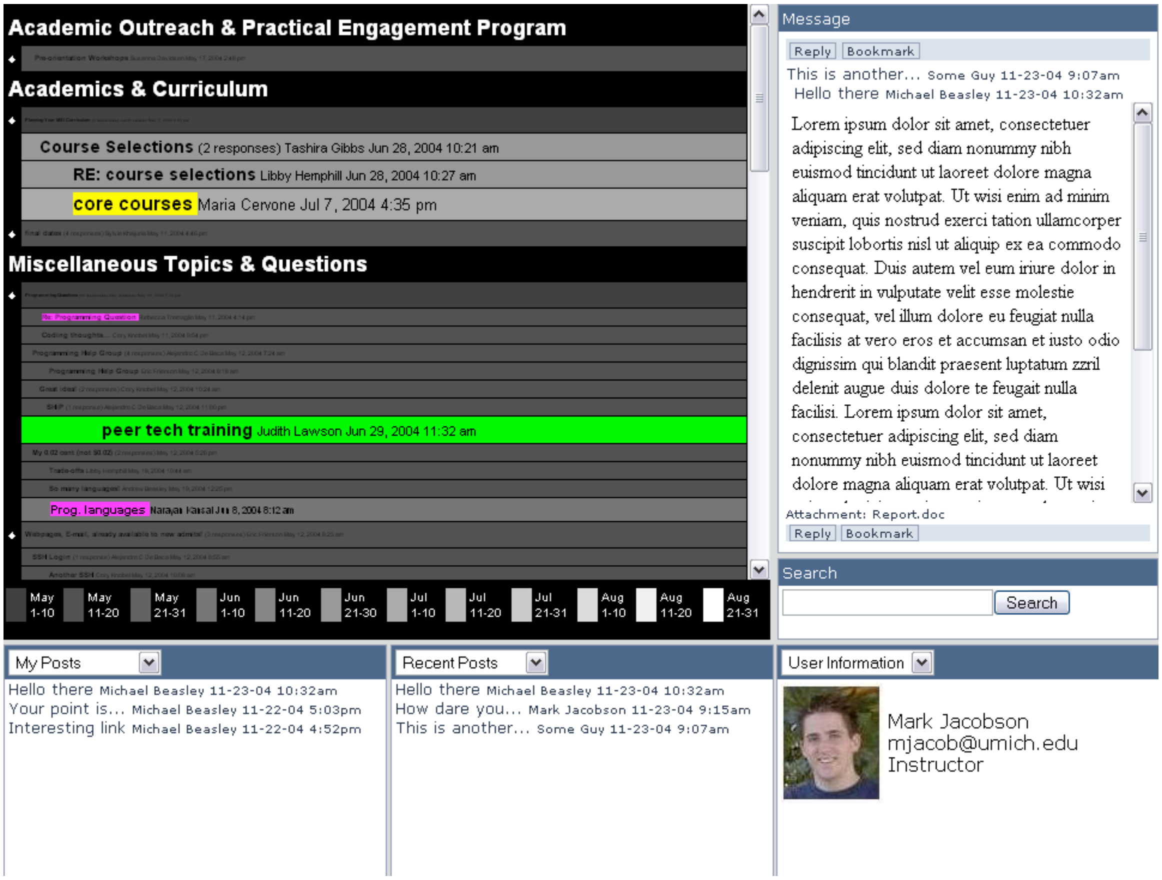


8. Mouses over the post that is a professor post and bookmarked, then selects it
9. Reads the message.
10. Has a question about the content of the post so decides to send a reply to the message.



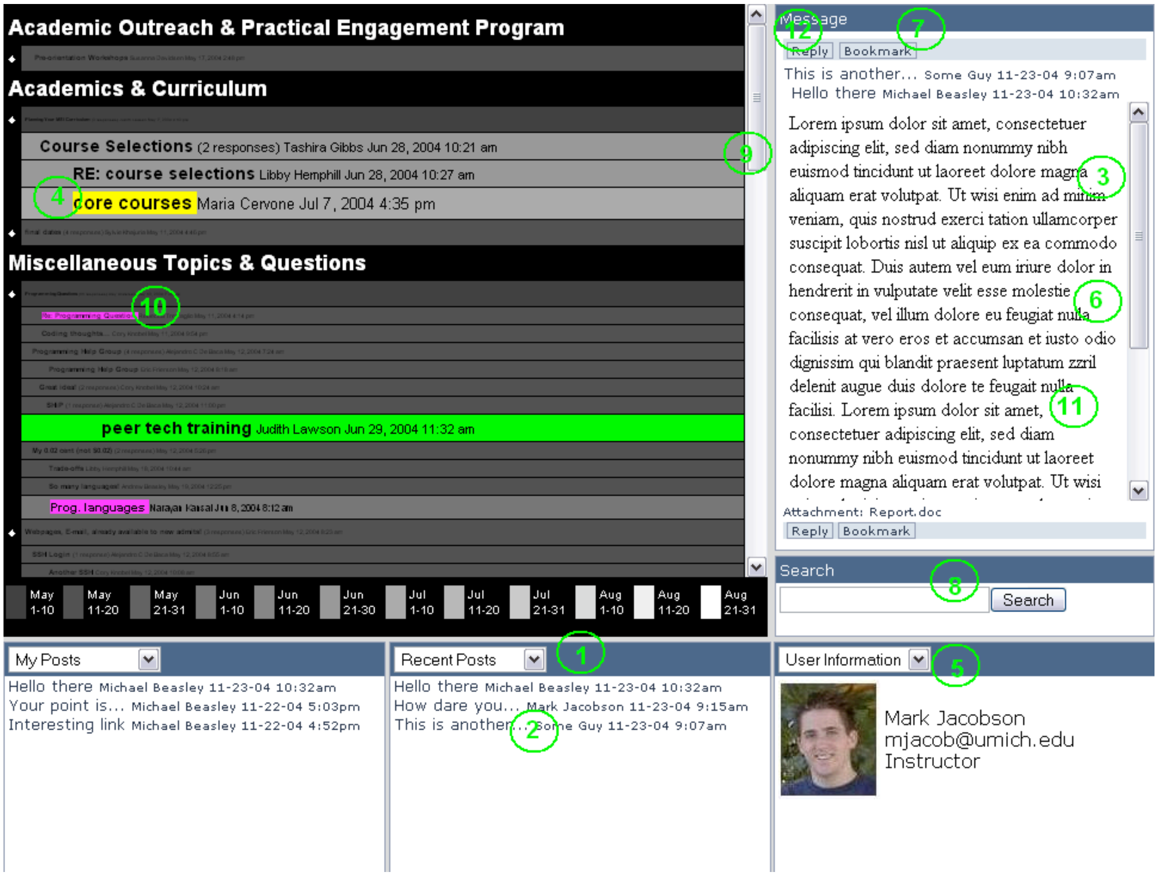
11. Writes the message
12. Runs a spell-check
13. Sends the message

Appendix H: ThreadView Screenshot



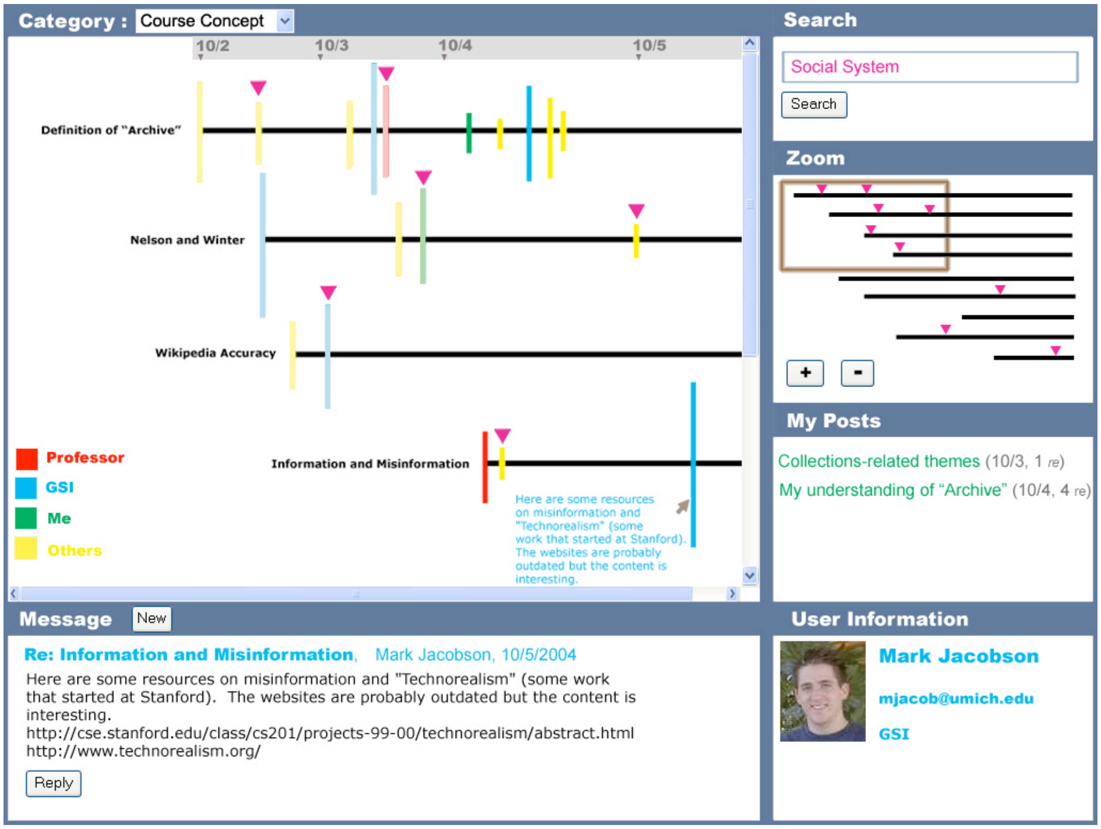
Appendix I: Walkthrough of ThreadView

David Kim, a senior computer science student, is studying for his final exam and goes to the CTools discussion to find some important things discussed during the course of the semester.



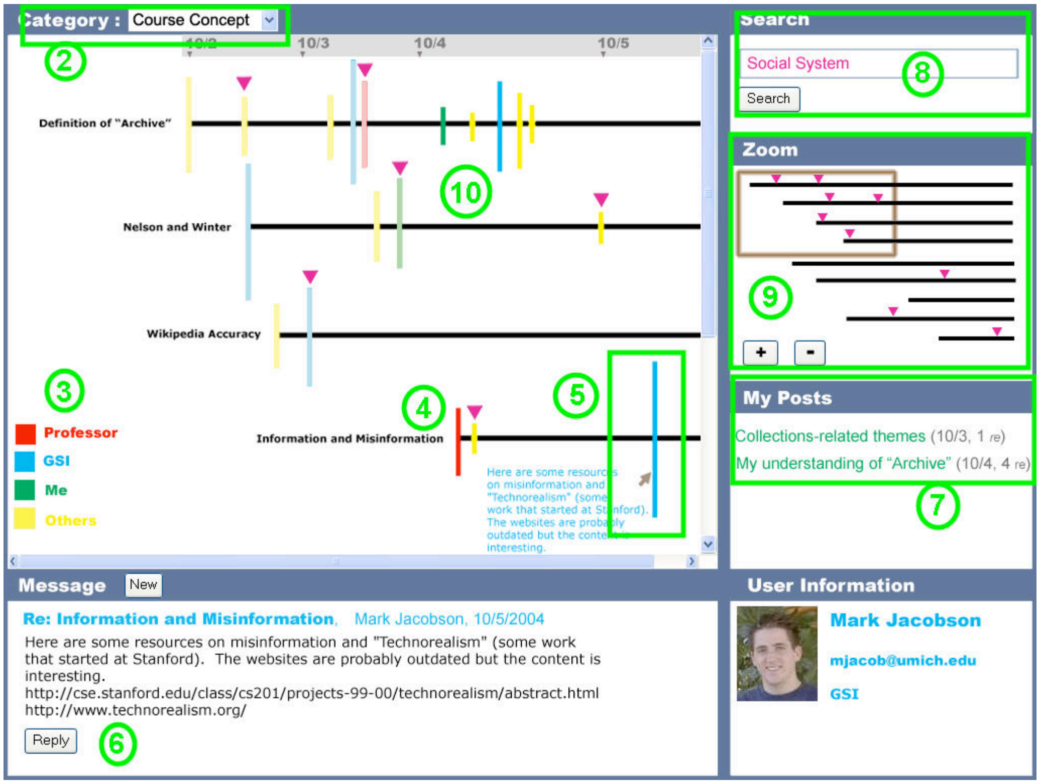
1. See if any recent posts have not already read
2. There is one that hasn't previously read so clicks on it.
3. Reads the message
4. Likes it so decides to bookmark it
5. Notices a bookmarked post in the thread so decides to see if it really is relevant and clicks on it
6. Reads the user information
7. Reads the message and reminds of other important course concept
8. Does a search for "programming"
9. Scrolls through the discussion to find what post is most relevant
10. Thinks the first one is most relevant so decides to select it
11. Reads the post and has a question about it
12. Sends a reply to the message.

Appendix J: BarView Screenshot



Appendix K: Walkthrough of BarView

Becky Smith, a first year MSI student, specializing Archive Records Management is studying for her final exam in SI 504 "Social Systems and Collections. The following is her interaction with the BarView design:



1. Becky logs into CTools and goes to SI 504 "Social Systems and Collections" class discussion tool.
2. Goes to the category drop-down menu and selects the "Course Concept" category. She sees the major threads including the four topics: Definition of "Archive", Nelson and Winter, Wikipedia Accuracy, and Information and Misinformation
3. In preparation for her midterm exam, she wants to find the important posts in the bar pane, so she looks at the legend.
4. Becky moves her mouse over the professor and GSI posts and reads the tooltips associated with each.
5. She selects one of the GSI's posts and click on this message bar to see the entire message.
6. Something in the post confuses Becky, so she replies to GSI's message to ask him about the content.
7. Then, Becky checks to see if anybody in her class has replied to her posts. There are no additional responses since the last time she logged into the discussion.
8. Becky now wants to figure out how all of the course concepts relate to "Social System," so she searches for the phrase "Social Systems".
9. The results appear and she zooms in where she sees a lot of results indicated in the Zoom pane.
10. She then goes through the search results in the ThreadView.

Appendix L: Usability Testing Tasks

These are tasks that we had hoped to use to test our static mockups with users. Unfortunately, we were unable to carry out these tests.

TreeView

Page 1 – Can you tell what the significance of the green square is?
Page 2 – What is the purpose of this large window in the upper right corner?
Page 3 – Point out other posts in the discussion that are also by Michael Beasley
Page 4 – How many of the search results are your own posts?
Page 5 – How would you navigate to any of the posts that are responses to this one?

ThreadView

BarView

1 – How many replies has your post in “The Definition of Archives” gotten?
2 – What do the pink arrows represent?
3 – Indicate where you would go to find posts from later in the semester
4 – What does the length of the vertical bars represent?
5 – How would you reply to the current message?