Gather, Store, and Organize

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I. Abstract
Bhavin Shah and Chris Walsh designed and prototyped a knowledge acquisition tool for the World Wide Web called “Zurbo.” In short, Zurbo significantly improves the process of capturing, storing, organizing, and retrieving information gathered from the Web.

Shah and Walsh conducted a detailed analysis of existing knowledge management/acquisition products and found many products that addressed some of the needs of knowledge workers but none that paid close attention to how research on the web is actually conducted. After conducting formal and informal interviews with various knowledge workers, they uncovered the following learning problems:

1. Web researchers constantly gather materials but often forget the relevance of an item (ex. They bookmark a site and forget why it was important because the web page’s title is confusing or meaningless.)
2. Researchers have difficulty capturing “information fragments” on a web page (ex. They may want just a paragraph of text, so they copy and paste a few key sentences from the web page into a word processing document.)
3. Important reference information is commonly forgotten or lost (ex. They copy a quote from a web site, but fail to record the URL, author, date, or source name for their bibliography.)
4. Web researchers frequently change the structure of their search as they gather (ex. They gather all sorts of items—text, images, PDFs, URLs—and create new organizational folders “on the fly” to account for new ideas and interests.)

To address these problems, Shah and Walsh designed and tested Zurbo. This Web-based tool allows users to quickly capture a Web “object” (piece of text, an image, a web page, etc.) by pushing one button on their browsers. The object (and its associated properties – URL, time of capture, etc.) is immediately sent to the Zurbo server. The user is then prompted with a series of quick questions that help them note the significance of an item and organize it for future reference. Although Zurbo has a number of default prompts, the user can easily create and modify their own research structure so that objects are acquired in a meaningful way. A user can view, organize, and download any of their objects/notations by logging into their personal account on the Zurbo website.

Although their prototype still has minimal functionality, Shah and Walsh are encouraged by the results of their initial user tests. All users expressed tremendous satisfaction with the ability to centrally locate “information fragments” and quickly make meaningful notations. There is also preliminary evidence to suggest that Zurbo is a more efficient way to gather and retrieve Web-based information. Future development on the project will focus on improved data mining techniques, ability to capture even more Web objects, and improved customization features.

II. Our Changing Society
In this new Internet-based society, the amount of information that people have accessible to them is growing at an exponential rate. With Metcalf’s Law\(^1\) in full force, management of knowledge is becoming a higher priority for many organizations and individuals. Combine this phenomenon to the trend of increasing employee churn rate and you have a situation where capturing, storing, codifying and making knowledge easily accessible is paramount for any organization wishing to maintain its institutional memory.

\(^1\) Metcalf’s Law states that the value of the network doubles with the number of nodes, the square of the number of nodes in the network. For the purposes of this report, we feel that the law still holds true if we replace the word “value” with “knowledge.”
For individuals this development means less preparatory learning and more “just-in-time” (JIT) learning. Being able to look up a fact or learn a process at the time it is needed has been cumbersome at best before the Internet. Today, people can access libraries and databases containing more information than the Library of Congress, through a few clicks of a mouse.

This shifts the skills that people must have in order to be effective knowledge workers. Knowing how to access and find a wide range of information can be more valuable than understanding and retaining a small amount of information. JIT learning however, requires support, both technologically and cognitively.

A pure treatment of JIT learning would situate all knowledge external to the individual. But the reality and practicality of the situation is that people must maintain their own small repositories of knowledge for those items which must be frequently accessed or those that must be accessed at a later time (for which storing is more time effective than re-accessing the information). For many endeavors, such as writing a report or researching a topic, the process is bifurcated into a research phase and a writing/synthesizing phase. Because the writing/synthesizing phase may occur several weeks after the research phase, individuals need tools that will allow them to make the information they gathered previous, easy to access and cognitively easy to recall its importance.

To address this need, we created a tool that would help people capture knowledge, quickly access it when it was relevant, and offload the cognitive burden involved with remembering its significance or ancillary information relevant to it.

Before describing what the tool does and how it achieves these goals, we will take you through the process that we went through to arrive at the conclusion that we did, which lead to the development of Zurbo.

III. The Learning Problem
As people search the Internet, they are typically either surfing with a purpose, or they are surfing aimlessly. In either case, whether they come across a bit of information intentionally or serendipitously, they need a way to tag the information so that they can revisit it at a later time or a way to capture the specific information they need without having to revisit it.

From our personal experiences with researching on the web, the only tool that we had accessible to tag information on the web was to use bookmarks. While bookmarks are good at earmarking an entire web site, we found their value quickly diminishes when an object of interest is of smaller granularity such as a paragraph or a quotation.

After doing a quick cursory examination of the tools available, we discovered that there was a large disconnect between tools that facilitate gathering and storing of information off the web, and tools that help people organize their knowledge and research.

To understand the problem, we assessed the needs of people who used the web as a knowledge resource to help us better define the learning problem. We interviewed and surveyed 20 people, ranging from 18-60 years old, and discovered several distinct problems that people experience while researching on the web. They are:

1. Forget why they gathered an item – They forget an item's relevance when they revisit it several weeks after initially archiving it.
2. Aren’t able to capture information fragments – The current granularity of most web capturing tools allows people to only capture entire web pages or bookmark entire sites. People can’t efficiently capture just a sentence or paragraph or a chart. Many people we talked to use
Microsoft's Word when they are researching on the web and use the copy/paste feature to capture text fragments from the web over a Microsoft Word document where they paste it.

3. Lose important reference information – For research reports and academic documents, it is imperative to properly site sources. Individuals who used the method mentioned above with Microsoft Word, would often copy a piece of text but then would forget to gather the meta-data necessary to generate a bibliography for the source.

4. Change the structure of their research as they gather more information – The ontology and structure that they would use to organize their findings would evolve as they learned more about the topic. As a result, the current tools, such as bookmarks, became very unwieldy to organize and reorganize.

After acquiring the information that they were seeking from the web, we discovered that people were manually bridging the gap between their acquisition tools and their organization tools. People would either manually re-typing the information that they had gathered from the web into their knowledge management tool, such as Nudist, or would use the copy/paste feature to extract their information from Microsoft Word documents (in which they temporarily stored their information) into their knowledge management tool.

IV. The Broader Context
We took a closer look at the current market for knowledge acquisition tools and knowledge management tools. Since we are more interested in solving problems faced by individuals, we quickly ascertained that the tools available for knowledge management were more suited for entire organizations than individuals.

After evaluating the existing products and tools that were available on the market, we found several that addressed the needs and problems mentioned above. However, many of these products were distributed via CD-ROM and required client side installation. Additionally, they had a steep learning curve, that wasn't time effective for casual users.

Most of the people that we interviewed for the needs assessment were not familiar with these products. Those that were, spent an exorbitant amount of time researching on the web and therefore had a reason to install and learn the more complicated products.

The problem with the products that required a client-side installation was that individuals could only do their research and knowledge acquisition from one computer. Because computers are becoming more ubiquitous, we learned from our study that half of the people regularly researched from more than one computer. From talking to K-12 teachers, we learned that K-12 students would research from multiple computers at school and would rarely use the same computer twice.

Many of the programs that existed, assumed that individuals would be using a sole computer while engaging in their research activities. This model has changed, however since the advent of the Internet. Computing has become much more ubiquitous. In companies and universities, it is becoming difficult to find a computer that is not connected to the Internet. People are using whichever computer is nearby. These programs which require client-side installation are highly limiting and do not address the social culture of computing in the 21 century.

Looking at products that were entirely Internet-based, we discovered several offerings. The following is a table listing the features offered by the other web-based knowledge acquisition and knowledge management tools that we reviewed. While these were much more reflective and sensitive to the nature in which people research on the Internet, none of them addressed all of the problems that our study revealed.
V. Theoretical Framework

To address the problems above, we turned to several learning theories and technologies to provide a foundation on which to construct a solution.

To address the problem that people were forgetting why they had captured or saved a piece of text or a paper, etc. we turned to the designers of knowledge management (KM) systems. KM covers the entire spectrum of gathering, storing, communicating, synthesizing, and disseminating knowledge within an organization. Because our scope is at the individual level, we fit into the gathering and storage components of a KM system.

Within knowledge management systems, the phase of gathering is known as knowledge acquisition (KA). KM researchers suggest that in order to effectively build a KA tool, one must draw on people’s short-term memory and capture tacit knowledge in order to facilitate the development of concrete knowledge. The notion of prompting individuals with specific questions related to a subject was shown in many research studies to be an effective way of gathering and documenting people’s knowledge. In a study conducted at Rolls-Royce, employees used a web-based knowledge acquisition tool to help them gather information they would be needing to build a particular engine. The tool was structured to prompt the user with questions when the user gathered new information on the process. As a result, the study showed that the prompting questions reduced the amount of time the employees spent referring back to the information’s source by a factor of ten. This dramatically reduced the amount of time expended by an employee to learn a new process.

Using this suggestion, we decided to prompt the user while he/she was gathering information to be able to draw on the individuals short-term memory and understanding of what they are gathering when they gather it.

To address the issue that people’s research structure changes as they progress we turned to the theory of self-regulated learning, specifically planning. Self-regulating cognition and monitoring are the types of activities that an individual engages in to adapt and change their cognition or behavior. Self-regulation is significant because it can influence other factors such as motivation, volition, effort. Because many research activities are done individually, we needed to come up with a way that people could structure their own findings. Kozma argues that external structure, such as adjunct questions, can only help learners develop their own metacognitive skills, of which planning and self-regulation are a part. We decided to allow the user to regulate the questions that they would need

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to answer when they captured a piece of knowledge. This enables self-regulated and self-evoked reflections on the information that they are gathering.

An important element of self-regulation that we focused on is planning which involves the setting of goals. Planning, though it is most often assumed to occur before starting a task, but can occur at any point during. Because of the importance of self-regulation and planning we wanted to make sure that Zurbo allowed for dynamic planning.

VI. Technological Framework

Using technology, we solved several of the other problems that arose in our needs assessment.

First we ensured the tool was completely web-based. This allows users to do research at any time from anywhere with access to all of their findings and their research from any computer. From our needs assessment, we discovered that students, especially in K-12, do research from a variety of different computers – from their home, from the library, from the classroom, from the computer lab, etc. By using JavaScript we eliminate the need of having to install the program on every computer.

The server-side technology was enabled by an Access database running on NT's Internet Information Server. This underlying database stores the captured objects and accommodates the three main modes that users will be able to view their captured objects. The database is flexible so that captured objects can be modified and reorganized into different bins after the initial capture. As capture objects are moved from bin to bin or moved into multiple bins, the database prompts the user with additional questions that are associated with the new bins. As a result, the database dynamically grows and shrinks the responses and questions associated with capture objects as they are organized and re-organized into bins. The Backend Architecture diagram on the next page describes in-detail the relationships that are needed for the proper interaction to take place at the user level.

We took care of some of the minor problems such as losing important reference information, by automatically capturing it for the user. As a result, we were able to provide an automatic bibliography generator for the user.

Lastly, we enabled the capturing of information fragments by utilizing the features of the document object model (DOM) used by web browsers.
Backend Architecture

Entity Set
(set of attributes)

Relationship

1

M

One to Many

M

Many to One

M

Many to Many

owns

creates

is stored in

is associated with

are answers to

has

is associated with

owns

creates

is stored in

is associated with

are answers to

has

is associated with

owns

creates

is stored in

is associated with

are answers to

has
VII. The Final Design

Our final design was a working prototype that implemented our most important features. It was important for us to create a working prototype rather than a mock-up or demo, because we wanted to see exactly how our new knowledge acquisition process would be used under real-life circumstances. As a result, we had to focus our implementation efforts on two key functionalities: capture and view.

The screenshots on the following pages display the various elements to our design.

Step 1: Capture

While browsing a web page, a user highlights a section of text to be captured and clicks the "Zurbo" button in the Links bar. This action immediately calls a client-side javascript that captures important meta-data from the page and sends it to a script on the Zurbo server.
Step 2: Login
If the user is not logged in yet, he is asked to supply his username and password now. Once logged in, the user has 30 minutes before being automatically logged out, or he can manually log himself out at any time.

Step 3: Organization
Here the user can verify the item being captured and select a specific location for the item to be stored (remember – all folders are custom created by the user on the main Zurbo website).

The user also has the option of giving this captured item a Title and assigning Keywords – two important elements for later organizing and viewing items.

At this point, the user must decide if he is finished or wants to continue with more prompts.
Step 4a: Custom Prompt
If the user has created custom prompts for this category/folder, he will be prompted for the first custom question now.

He has the option of answering the question or leaving it blank and can choose to continue or finish.

This sample question requires a text response.

Step 4b: Custom Prompt
If the user has another custom prompt for this category/folder, he will be prompted for the next custom question now.

He has the option of answering the question or leaving it blank and can choose to continue or finish.

This sample question requires a multiple-choice response.
**Step 4c: Custom Prompt**

If the user has another custom prompt for this category/folder, he will be prompted for the next custom question now.

He has the option of answering the question or leaving it blank and can choose to continue or finish.

This sample question requires a pull down menu response.

**Step 5: Finish Capture**

Once all custom prompts have been exhausted or the user elects to finish the process, the user is given a feedback screen to verify that his data has been captured.

At this point, he can choose to continue capturing objects, he can elect to view all his captured objects on the Zurbo website, or he can close the window and continue working on anything else.
Step 6: Main Page Login

Anytime a user is logged out and wants to view items in his account, he needs to go to the Zurbo homepage and login.
Step 7a: View Mode
Once logged in, the user is automatically entered into View mode where he can view all of his items in an easy to read table. He can click on the Type icon or the [view] link to see the details of each object. The user can customize this view to look at all folders or a specific folder, and he can also sort objects by specific attributes.

<table>
<thead>
<tr>
<th>Type</th>
<th>Date</th>
<th>Title</th>
<th>Captured Item</th>
<th>Battle</th>
<th>Blame</th>
<th>Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5/12/00</td>
<td>Gettysburg Fact</td>
<td>The Battle of Gettysburg opened on July 1, 1863 and closed two days later with the climactic ... [view]</td>
<td>Gettysburg</td>
<td>South</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>5/11/00</td>
<td>(untitled) from Leno... [view]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5/9/00</td>
<td>(untitled) On April 16, 1861, Brig. Gen. Beauregard, in command of the provisional Confederate forces at Charleston ... [view]</td>
<td>Sumter</td>
<td>South</td>
<td>Medium</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5/9/00</td>
<td>Trivia</td>
<td>3 million fought - 600,000 died ... [view]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5/5/00</td>
<td>Fast Civil War Site</td>
<td>&quot;There are the times that try men's souls.&quot; - Abraham Lincoln ... [view]</td>
<td>Gettysburg</td>
<td>South</td>
<td>Prof. Leo Atkins, SMU</td>
</tr>
</tbody>
</table>

**General**

<table>
<thead>
<tr>
<th>Type</th>
<th>Date</th>
<th>Title</th>
<th>Captured Item</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5/11/00</td>
<td>viscom pen stuff</td>
<td>Quickdictionary-voice automatically displays the translation of the scanned English word and pronounces ... [view]</td>
</tr>
</tbody>
</table>

**Civil War Research**
### Step 7b: Detailed View

The specific details of each item can be seen in this mode, and the user also has access to customization options such as edit, export, share, or delete.

<table>
<thead>
<tr>
<th>Title</th>
<th>Gettysburg Fact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date</td>
<td>5/12/00</td>
</tr>
<tr>
<td>Folder</td>
<td>Civil War Research</td>
</tr>
<tr>
<td>Keywords</td>
<td>Pickett</td>
</tr>
<tr>
<td>Type</td>
<td>Text</td>
</tr>
<tr>
<td>Source URL</td>
<td><a href="http://www.nps.gov/gett/">http://www.nps.gov/gett/</a></td>
</tr>
<tr>
<td>Source Title</td>
<td>Gettysburg National Military Park Welcome Page</td>
</tr>
<tr>
<td>Selection</td>
<td>The Battle of Gettysburg opened on July 1, 1863 and closed two days later with the climactic battle of Gettysburg.</td>
</tr>
<tr>
<td>Battle</td>
<td>South</td>
</tr>
<tr>
<td>Quality</td>
<td>High</td>
</tr>
</tbody>
</table>
Step 8: Organize

The Organize section of the website is the launching point for modifying folders and items. It is also where you can export and import items, including an automated bibliography.
Step 9: Find
One of the most important features of Zurbo is the ability to search for specific items based on specific criteria. In this mode, you can provide text parameters to search on and filter results to include only certain types of items.
Step 10a: Create New Folder

The real value of Zurbo is that it allows you to create a custom structure for your data, so that you can quickly add and organize information fragments in a meaningful way. To accomplish this, a user needs to create their own folders and assign custom questions to each folder. In step one of this process, the user assigns a title to the folder and decides if they want to use our preset categories of questions or build their own questions from scratch.
Step 10b: Capture

Once the user decides to create or modify a question, he is asked to complete a series of fields that will create the format and possible responses to his own question. This is done so that the user can quickly select his own options during the capturing process.
Step 11: Account Settings
It is also important for the user to be able to modify his own account settings at any time. In this mode, the user can make changes to his password, name, email, and personal information which is automatically updated upon submission.
VIII. Learning and Zurbo

The above screenshots show that, first and foremost, ZURBO is an organization tool. It helps learners organize information that they gather from a variety of web-based resources. More specifically, it is a tool that allows researchers and others to easily gather materials (URLs, text clippings, whole web pages, images, sounds, and video) from multiple sources, place them in one single storage bin, and organizing them for future use.

When a student conducts research, he or she often has to keep track of many factors for each piece of data or knowledge that he or she gathers. This task can quickly become overwhelming as the student gathers large amounts of data, or gathers information over a lengthy period. For example, a student might be reading an article and come across a quote that they would like to use in their upcoming research report. Since this article is on the web, the student will need to keep track of ancillary information (the URL, the author, etc.) as well as direct information about the quote (whether it supports the pro or con argument of their paper, the significance of the quote, etc.).

With ZURBO, students can simply highlight the piece of text or graphic that they would like to “clip” or save and simply push the “ZURBO” button on their browser. This will trigger the system to immediately store the selection on the ZURBO web site while prompting the user to fill in a form that will help the student record the direct information about the selection. As a means of reducing the cognitive burden of the student, ZURBO will automatically capture important meta-data such as name, date, location, and type of resource so materials can be referenced and shared easily.

If the student goes to the main ZURBO website, he or she can view all of the research that he or she has gathered along with the direct and ancillary information that was recorded at the time of capture. This allows the student to organize and view all of the data together in one place. It helps users quickly find, access and share their gathered resources via the web from any computer or web-enabled device. All materials can be compiled into customized groups and exported for use in other desktop programs such as Word, PowerPoint, Photoshop, etc. This allows students to organize their research based on their own cognitive understanding of how the research is relevant to their needs.

To better understand exactly how Zurbo enables learning, look at the Feature Set chart on the following page.
## Feature Set

<table>
<thead>
<tr>
<th>Feature</th>
<th>Description</th>
<th>Learning Opportunity</th>
</tr>
</thead>
<tbody>
<tr>
<td>One Button Capture</td>
<td>Saves highlighted text, images, audio, video, and whole pages to your personal file cabinet with one click in the web browser.</td>
<td>There is a unique moment when a researcher decides to capture information. This moment happens extremely fast, so it is necessary to have a simple tool that supports this decision.</td>
</tr>
<tr>
<td>Auto Capture of Meta-Data</td>
<td>Automatically grabs the URL, time, date, title of the page and any other summary information available.</td>
<td>Web researchers commonly forget to log important information such as the date and location of the information source. Zurbo quietly captures this “meta-data” when the capture button is selected.</td>
</tr>
<tr>
<td>Organizational Prompts</td>
<td>At the moment an item is captured, you are prompted to specify what it is, where it should go, set reminders &amp; note significance.</td>
<td>Researchers need to structure information in ways that are meaningful to their own specific needs, and there is no better time to note the potential significance of an item than at the moment of capture.</td>
</tr>
<tr>
<td>Quick View</td>
<td>Once logged into the Zurbo website, all of your captured resources are listed in a quick summary list so it’s easy to find any item.</td>
<td>Researchers need a quick way to select stored information and to organize it by categories.</td>
</tr>
<tr>
<td>Powerful Search</td>
<td>You can quickly find any item by type of resource, title, date, annotation, URL, etc.</td>
<td>Researchers need to find specific information items based on special criteria.</td>
</tr>
<tr>
<td>Custom Organization</td>
<td>Create new folders and titles at time of capture or from within Zurbo website. Rename, move, copy, or delete items and folders.</td>
<td>Researchers need to modify and move information so it fits their evolving organizational needs.</td>
</tr>
<tr>
<td>Custom Prompts</td>
<td>Create new prompts that are tailored to your specific research needs. Associate prompts with any type of resource.</td>
<td>The most difficult thing about gathering information is determining a structure for that information after it has been collected. Zurbo enables that structure to be designed ahead of time so that all information items are placed in their proper category at the moment of capture.</td>
</tr>
<tr>
<td>Export Wizard</td>
<td>Export individual or groups of items to be downloaded to your desktop. Choose from all standardized formats.</td>
<td>Information is gathered and stored in multiple locations. Users need the ability to integrate web-based information with offline resources.</td>
</tr>
<tr>
<td>Import Wizard</td>
<td>Import items being stored on your desktop computer to your Zurbo account.</td>
<td>Researchers like to have all their resources in one location. Zurbo allows you to store all your resources and structure their organization in a common format.</td>
</tr>
<tr>
<td>Automated Bibliography</td>
<td>APA style bibliography of all your resources is always up-to-date and one click away. Export to any word processor.</td>
<td>Researchers spend a great deal of time gathering references for their resources. Zurbo automates this process.</td>
</tr>
<tr>
<td>Shareable Resources</td>
<td>Ability to share your resources with colleagues or the general public. Self-controlled security.</td>
<td>Many researchers like to share their resources with others.</td>
</tr>
</tbody>
</table>
IX. Design Process

General Design Principles

ZURBO is a user-centered tool. Therefore, it is important that the tool allow the user to customize it. The user must be able to easily construct questions that he or she would like ZURBO to prompt them with when the student captures a piece of information. Also, the user must be given the freedom to organize the information that the student has captured in a variety of different formats and provide ways to facilitate their uses of it.

The following are general design principles that were considered in the design and construction of ZURBO.

- Learning happens when a person is engaged in a specific task that they buy into
- Learners need scaffolding and structure, especially when trying to learn new material (i.e. research)
- Reading on the web (and on a computer) is fundamentally different than paper-based reading; with electronic text, scanning and searching is much more preferable than linear reading; therefore, there is greater need for an organizational system that makes sense of information “pieces”
- Learners need to make their own connections to the learning situation and build a procedure that allows them to carry this personal understanding into the next learning activity
- Learners need tools that help them build on their previous knowledge

Visual Design Principles

The visual display of Zurbo relied heavily on the work of Edward Tufte\(^6\). Although Tufte does not generally like the medium of the World Wide Web, Zurbo was designed to incorporate a number of Tufte’s design principles. First, the Zurbo interface uses color sparingly. When used at all, most colors are warm and natural, and bright colors are limited to small doses. Tufte is also a fan of designs that allow both a macro and micro view, because they mirror the complex layers of the human experience. Zurbo accomplishes this by allowing the user to view captured objects in the Quick View and the Detailed View. At the same time, most of the data is accessible via high density table in the Quick View. Lastly, and most importantly, the entire Zurbo interface was designed to reduce viewer fatigue. By limiting the main navigation to just 3 buttons, the user concentrates their attention on the data rather than the overall interface.

HCI Design Principles

The work of Don Norman\(^7\) was also highly influential in our design. Don Norman’s emphasis on natural mappings and making things visible can be seen in the Zurbo navigation icons. Not only are the View, Organize, and Find buttons clearly labeled, but they are also represented by familiar icons that serve as a metaphor for the functionality (an open box, a file container, and a pair of binoculars). Zurbo also provides the user with a substantial amount of feedback (especially during the capturing prompts) and uses natural language as much as possible.

Design Team

The design of Zurbo was also heavily influenced by members of the extended design team. First and foremost, the LDT class of 2000 provided invaluable support and reflection throughout the design process. They were especially helpful at brainstorming features and providing tangible ideas for the needs assessment. Similarly, LDT advisors Decker Walker, Deb Kim, Jim Greeno, and Brigid Barron played an ongoing role in the development of the project, especially with regard to the learning goals.

A number of experts were also called upon throughout the process. David Fetterman, a social science research expert, provided a tremendous amount of insight on how researchers think and organize their information. Michael Kamil, an expert on reading on the Web, was extremely helpful at narrowing the learning goals of the project, and he had valuable insights on how web users use the web to gather information. Nina Kim, a master’s student in HCI, participated in the user testing phase of Zurbo, and she had tremendous insights on the usability and navigation of the final Zurbo interface. Laura Tebbe, a K-12 technology curriculum expert, also participated in the user testing, and she offered very practical ways that Zurbo could be utilized in a K-12 environment.

**Major Milestones**

- Fall, 1999: Preliminary Design
- March, 2000: Brainstorming
- April 1, 2000: Learning Goals & Setting Established
- April 10, 2000: Initial Features & Central Personas Created
- April 10-15, 2000: Scenario Designed
- May 1, 2000: Feature Set Finalized
- May 1-6: Backend Architecture and Prototype Designed
- May 7-11: User Testing
- May 12, 2000: Project Presentation
- June 5, 2000: Final Documentation Completed

**X. Testing and Iteration**

The initial needs assessment for ZURBO was done based on our personal experience with web-based research and gathering information from multiple sources. Informal discussion and brainstorming sessions with graduate students and mentors helped us identify the problem with greater detail. They confirmed our initial assumptions and helped us identify the critical components that were missing from existing products.

We did cursory investigation into the existing products that addressed this market. There was a plethora of tools that helped people organize information, but the method of capturing was not convenient. The tools would leave the task of capturing to the user. There was no tool that streamlined the entire process from capturing to organization. Analysis of existing web and desktop programs failed to offer powerful data-mining tools that would allow users to look at their research habits. From our talks with students, this feature seemed important to students who wanted help becoming more cognizant of their habits.

Analysis of current research on self-regulated learning, research methods, planning, and organization confirmed that ZURBO addressed a real learning problem that had been investigated and researched. The information that we read supported many of our assumptions.

Using an iterative design approach, we created an early feature tour of ZURBO in PowerPoint that was shown to users and experts to get feedback on potential uses and features. Feedback was gathered in the form of an interview and a formal survey. In the end, we interviewed 20 users from a variety of backgrounds that represented three potential user groups: personal researchers, higher education researchers, and corporate researchers. This provided us with more “needs assessment” data that helped us identify which features were critical and which were ancillary. Besides gaining feedback on the interactive features, we also asked a series of questions on research habits. Below is a list of the questions we used in this part of our survey.
Sample Survey Questions

1. I usually have a specific reason for gathering information/resources on the Web.
2. I usually print text I find on the Web.
3. I usually read everything on a web page before deciding what’s useful/important.
4. I can easily find all the downloaded items I get off the Internet.
5. I usually browse the web from the same computer.
6. I frequently find something I like, bookmark it, and plan to return later.
7. I often forget why I bookmarked a website or saved a resource.
8. I often cut and paste text from a website into a word processor.
9. I usually keep track of the time, date, and URL of an item I got off the web.
10. I frequently share web pages, text, images, or other Internet items with others.

After the prototype was complete, we conducted a few short think aloud observations with users that matched our user base. In this phase of testing we focused mostly on the icons, layout, and navigation of our web interface. Users were asked to perform a series of basic tasks with our tool and verbalize their thoughts as they went. Once done, we conducted a brief exit interview with each user.

All phases of testing proved to be invaluable to the design of Zurbo. The original needs assessment clearly proved that gathering information fragments on the Web was a much bigger problem than we anticipated. Every user we talked to expressed extreme frustration with some part of the research process, and all were extremely excited by the features we were suggesting. In fact, ¾ths of these users asked if the tool already existed and wanted to know if they could start using it immediately. This overwhelming enthusiasm was partially responsible for our decision to actually implement a working prototype rather than a demo.

Although our testing of the prototype was not as complete as we would have liked, it was extremely beneficial. Based on some expert HCI advice and the suggestions from our users, it became very clear that a number of items needed to be rethought. In particular, the entire navigation system during the capture process had to be redesigned and a much cleaner login/logout had to be created. With more time, we would have also entirely redesigned the “Create a Folder” sequence to make it simpler to use and navigate.

XI. Future Directions

Based on the amazing response to Zurbo so far, we believe that there is tremendous potential for this project to continue. In the immediate future, we plan to implement a few more basic features and release the product as version 1. Although anyone will be able to get a free account, we plan to target 3 specific organizations or groups (SLL, SRI, and LDT) to begin using Zurbo during the summer of 2000. It is our hope that an expanded user base will provide insights in two important areas: 1) the technical constraints and 2) the learning benefits of our design.

In the short term, it is easy to identify our successful implementation of our stated learning goals; however, we will need to gather data on how researchers utilize Zurbo over the course of months and compare those practices to their original researching habits. Although some of this data can be gathered via server-side statistics, most will have to come from in depth interviews, field observations, and user surveys.

Based on this feedback, it is hoped that Zurbo can be developed into a scalable web-based tool that can find its way into the commercial marketplace. There’s a lot of information out there, and Zurbo looks like a viable way to acquire, organize, and mine that information.