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MITRE TECHNICAL REPORT

Improving the Usability of A Corporate Intranet

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ABSTRACT

A redesign of MITRE's corporate intranet, the MITRE Information Infrastructure (MII), was undertaken to improve its usability. Requirements for the redesign were gathered from a corporate-wide employee survey, MITRE management, the project team, and a heuristic user interface evaluation of the existing system. Goals of the redesign included assessing whether new web capabilities, such as frames and Java, could improve the usability of the MII, updating the visual look and propogating the look to the subsite level, improving the organization of the information, improving the navigation, increasing the technical content to support information reuse within the company, adding job-oriented navigation aids, and adding a live announcements banner. This paper discusses the requirements gathering process, the redesign process, the user evaluations performed throughout the redesign process, and the lessons learned in this redesign of a large scale web site.

ACKNOWLEDGMENTS

The redesign of the MII navigation layer was a team effort. The team consisted of Carsten Oertel, Dennis Violett, Karim Khan, Don Whittemore, Joe Sain, Doug Phair, Linda Rodi, B.J. Fisher, Donna Cuomo, and Linda Borghesani.

We would like to express our thanks to Dolores Derrington and Edward Goodnight, the MII project managers for this effort, first for asking us to participate on such a fun task, and, second, for empowering the team to do this work and then leaving us alone to do it! We thank Carsten Oertel for being our fearless leader and keeping us on track. We want to acknowledge the creative visual work produced by Dennis Violett. We were totally impressed with his ability to create visually pleasing designs that met the team's objectives. And finally, we want to thank Karim Khan. Karim implemented all the web pages for the new system. He worked like a fiend to make the rollout date and exhibited the patience of a saint when we asked him to make "just this one more change...."

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INTRODUCTION

The presentation layer of MITRE's corporate intranet was recently redesigned. This paper documents the redesign process used, capturing results and lessons learned. This process and the lessons learned will be of value to anyone new designing or wishing to improve the usability of their intranet or any large-scale web site.

An intranet is a corporate resource which uses web technology and allows users to search and view information via a browser from their desktops. Intranets are extremely useful for disseminating and sharing both corporate administrative information and technical information. The ability to immediately update content, the distributed storage, and the cross-platform access to the information makes the intranet an attractive corporate asset.

An intranet is a collection of web pages and there is commonly a homepage, a presentation or navigation layer, and subsites. Often, a search capability is present and there may be other capabilities, such as publishing as well. Pages are usually comprised of three basic elements -- static text, graphics, and hyperlinks. Hyperlinks are graphic or text elements which, when selected, take the user to another web page or cause another action to occur.

The homepage is the first page a user sees upon entering the intranet or web site. It is important as it usually explains the purpose of the web site and offers high-level options so users may begin browsing a site for the information of interest. For very large sites, there may be several layers of hierarchical menu-type pages which need to be traversed before any given page is actually reached. This is called the navigation or presentation layer. It usually has a consistent look and feel and contains links that are pointers to content pages residing on all servers that comprise the corporate intranet. Content pages may be either pages devoted to a single topic (e.g., a policy and procedures manual) or they may be simple or complex subsites containing their own homepage, navigation mechanisms, and search engine. Each content page or subsite is typically created by different individuals within the company, often without corporate standards to guide them. This results in a diverse, rich information base but it may be difficult for users to navigate or search it successfully.

MITRE's intranet, the MITRE Information Infrastructure (MII), was originally rolled out in May, 1995. While the basic infrastructure was sound, the navigation layer had been added to over the years as the number of content pages grew, and the homepage and navigation layers were in need of an overhaul. The general mission of the MII redesign team was to identify what improvements were needed to better meet the needs of the corporation, to improve the usability of retrieving and adding information to the intranet, and to update the look and feel of the MII. A multi-disciplinary team was formed and usability engineering methods were applied in the redesign process. Methodologies recommended by Sano (1996) for designing large-scale web sites were also applied. The result was an improved MII both in terms of navigation and content, with an updated look.

In this paper, we will describe the process used to redesign the MITRE intranet, and the lessons learned. In section 2, we present the original intranet. In section 3, we describe the sources and methods used to derive requirements for the new MII. In section 4, the redesign process is described and the design iterations leading to the final product are shown. The evaluation stages are presented in section 5, and we conclude in section 6 with insights gained and lessons learned.

SECTION 2

EXISTING INTRANET

The MII as it existed at the time the redesign effort began is explained below.

2.1 MII HOMEPAGE

2.1.1 Category Hyperlinks/Navigation Pages

The MII homepage before the redesign is shown in figure 1. It contained 12 major category hyperlinks (e.g., About MITRE, Announcement and News, etc.). Selecting a major category hyperlink (by clicking on it with the mouse) would bring the user to the corresponding second level navigation page. An example of a second level navigation page is shown for About MITRE in figure 2. As stated previously, navigation pages are pages containing links related to the major category selected to get there. Some links on the second level navigation pages led to another page of links called third level navigation pages (figure 3).

2.1.2 Shortcuts

Also on the homepage, under each major category link, were "shortcuts." Shortcuts (e.g., Maps, Dept. Listings, WWW server for About MITRE) are hyperlinks which take the user directly to a content page in that category, skipping the traversal through any intermediary navigation pages. The page accessed from the Dept. Listings shortcut is shown in figure 4. The purpose of the shortcuts is twofold. First, they provide examples of the kind of content a particular category contains, providing context for interpreting the major category correctly. Second, they provide a quick way of accessing frequently used pages for a category. Unfortunately, only 2 to 4 shortcuts can be displayed without increasing the length of and risking overcrowding the homepage.

2.1.3 Phonebook Search

Another major element of the homepage is the phonebook search interface. The phonebook interface consists of a menu with four items: Phonebook, Best-match phonebook, Organization Information, and Project Information; a Find button; and a text input field. The phonebook allows users to access pages about employees, organizations, and projects. These pages are "dynamically generated" with information from MITRE's financial and human resources databases. Thus, the information they contain is administrative information as opposed to technical. For instance, project data consists of the project leader, the staff who charge time against a project and the percentages, lists of documents published under that project number, etc. Employee and phonebook project pages are shown in figures 5 and 6, respectively. Technical information about a project (e.g., project goals, acquisition strategies, etc.), an organization, or an employee is not automatically provided. There are links available on the phonebook pages, however, which can point to this type of technical information if published on the MII. At the time of the redesign effort, fewer than 5 projects had created project homepages, approximately 10 organization pages existed, and some employees had published employee homepages.

Figure 1. MII Homepage Before the Redesign

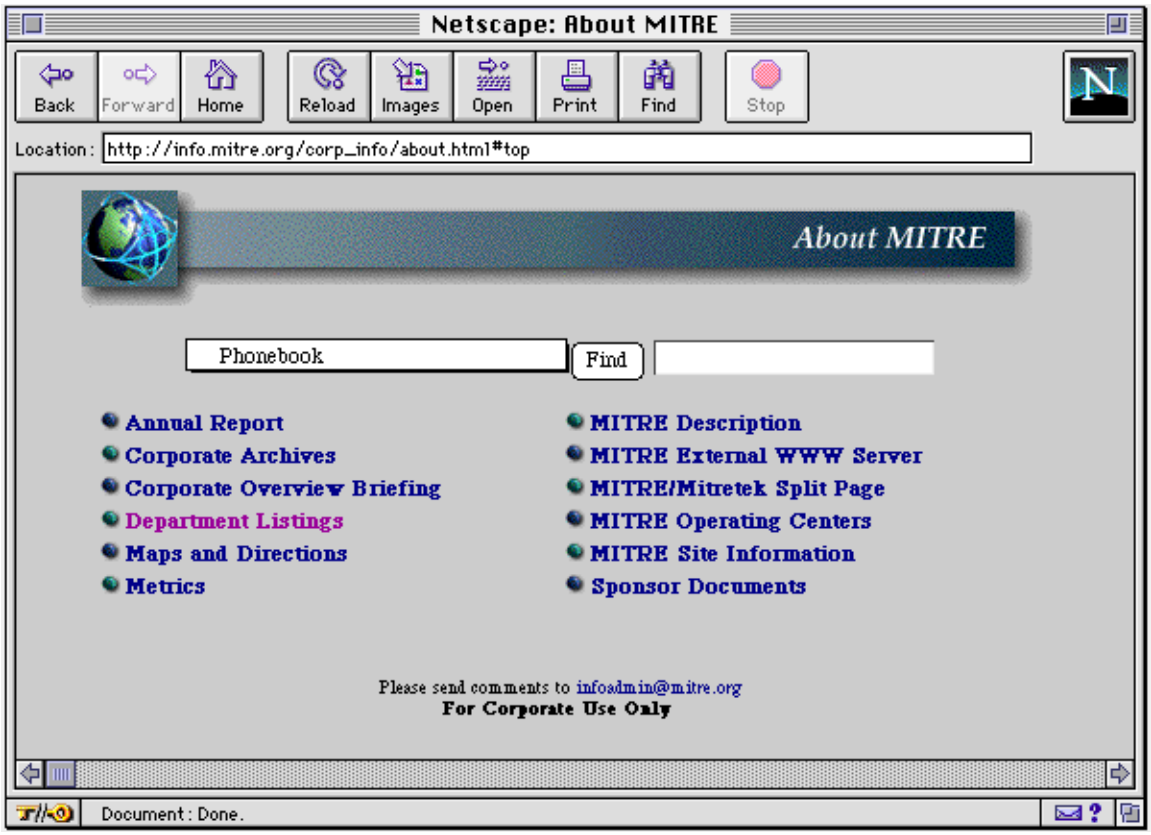


Figure 2. About MITRE Second Level Navigation Page

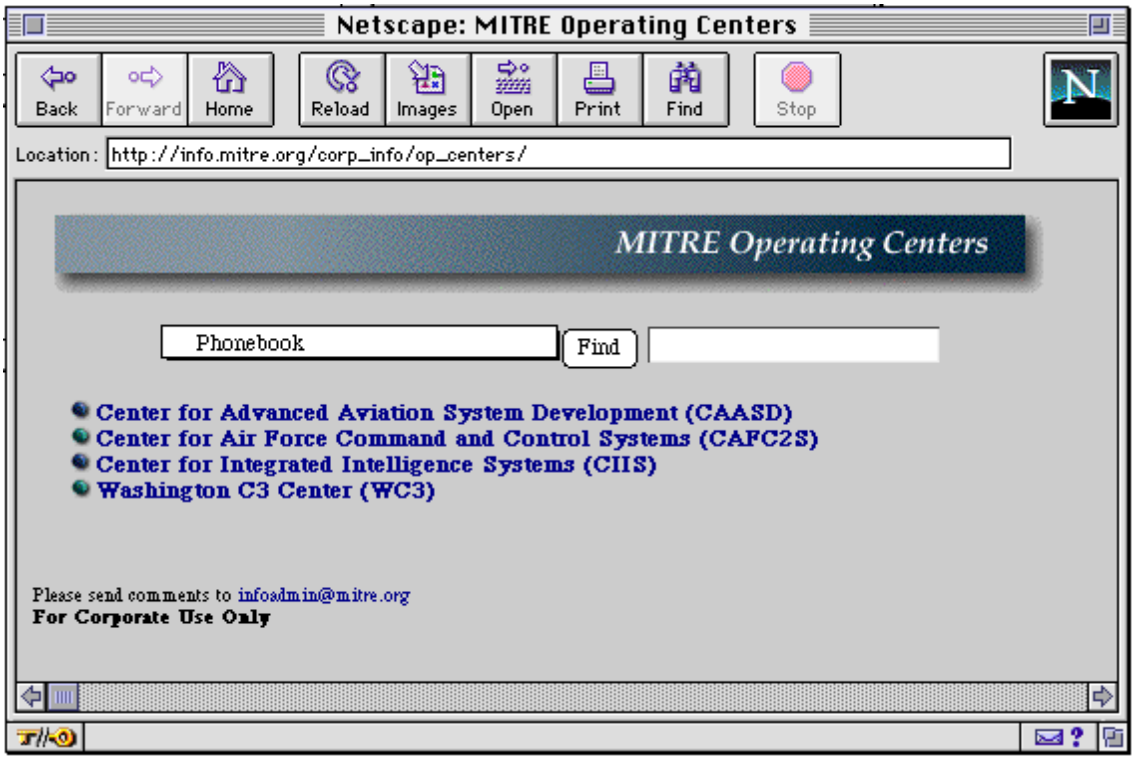


Figure 3. Third Level Navigation Page

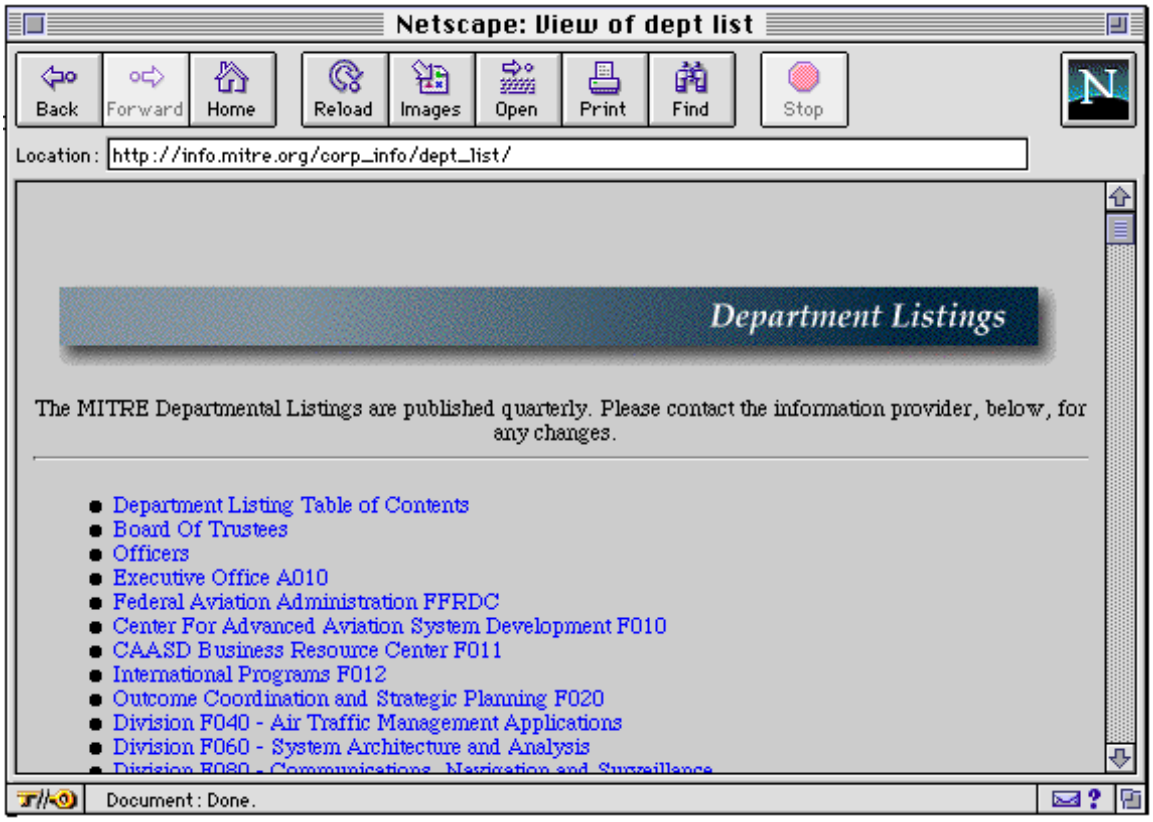


Figure 4. Content Page Directly Accessible Via A Shortcut

Figure 5. Employee First Level Phonebook Page

Figure 6. Project Phonebook Page

2.1.4 Toolbar

A third major element of the MII homepage was the toolbar. The MII toolbar was located at the bottom of the homepage and all of the second and third level navigation pages. It was also located on most of the phonebook pages. It contained icons for accessing the help system, the search pages, the tools pages, and the alphabetical index. The help system homepage contains links to major topics about the MII. The help is not context sensitive.

The search pages are divided into a simple search page (figure 7) and an advanced search page. The simple search page only allows selection of a single search space option with "All" as the default and AND, OR or phrase queries. The advanced search form is more complex and supports full text searches, metadata field searches, complex queries,

and selection of multiple search spaces. One of the search space options is the MII menu pages. This allows users to search for a particular link name on the MII navigation pages. Users may also choose to search "Staff-published Documents on the MII." MITRE employees can publish documents on the MII in their personal publish space or in their project or organization spaces. Word, PowerPoint, Excel and html documents can be published and then retrieved by others with this search tool.

Figure 7. Simple Search Page

The tools page contains links to a variety of MII and web-based tools for creating web pages, internet search engines, and information for posting information on the MII.

The final toolbar icon on the homepage was for the A-Z index. This index is an alphabetical index of many of the links that exist at all levels on the MII. This allows users who know the exact topic they are looking for to navigate directly to that page without having to guess which major category it is in and traversing the navigation pages.

Note that when the toolbar was presented on other navigation pages or the phonebook pages, it also contained a Home icon. The Home icon returned the user to the

MII homepage. No other navigation mechanisms were provided on the MII navigation pages. The user either used the MII Home icon or used the browser navigation buttons, such as Home, Back, History, Go, location, etc.

2.1.5 Announcement Area

Another element of the homepage was the announcement/banner area. MITRE management or the MII team frequently needs to send a corporate-wide message of general interest. These types of messages are often posted on the MII homepage in the announcement area (e.g., a reminder to employees to fill out their time cards daily). From one to as many as four messages could be posted on any given day.

2.1.6 Text-Only Link

Finally, the MII homepage contained a "text-only" link which allowed the user to display an equivalent MII homepage which only contained text links and no graphical elements. This was to support users who were using text-only browsers or who were using connections whose speed made downloading graphics too slow.

2.2 PAGE DESIGN SYSTEM

Most large-scale web sites have comprehensive page design systems which define the site's look and feel. A page design system describes and provides the page design elements, both graphical and navigational, as well as guidelines for using the elements appropriately. It is typically created by a visual interface design team and then passed along to page developers so all page creators create pages which look and behave consistently. This saves design time during page development since each page is not custom developed and it adds to a user's perception of quality associated with the publisher of the web site (Sano, 1996).

It is recommended that page design elements visually reflect the hierarchical scheme of the web site (Sano, 1996). So a homepage will typically have the web site "look" presented very strongly while second and third levels of the site should carry over the same look for consistency and to assure a user that they are in the same web site but the impact of the look should be lessened at each level. There is debate on how closely subsites within the site need to visually mimic the look of the parent site. Some provide only a minor visual representation that shows they are part of the parent site while others prefer a consistent look and feel throughout the entire site.

The MII at the time of the redesign had a fairly comprehensive visual page design system for the navigation layers and phonebook pages. The homepage had a large globe graphic and a grey title banner with drop shadows (see figure 1). The background color of all the pages was the default grey. The grey and green color scheme used in the globe was also used in the graphical bullets before each major category links, and the color scheme was carried over into the tool bar. As recommended, the MII "look" was carried through-out the navigation and phonebook layers, with lessening degrees of visual impact as you traversed down the hierarchy (see again figures 2, 3, 5, and 6). A smaller globe was used on some pages with the grey title banner, and pages farther down in the hierarchy did not

use the globe and only contained the grey title banners. However, there was not an MII style guide, some MII content pages, such as the travel content page, used the grey title banner, but all content pages did not, and the toolbar was used inconsistently throughout the MII.

The MII pages were 480 pixels wide so they fit within the default Netscape window.

Once the user reached a content page or subsite, there usually was no longer a visual indicator that they were on MITRE's intranet except for the "location" field on most browsers. Since hyperlinks on MITRE pages could lead to pages outside of the intranet, there was some user confusion as to when they were on the intranet versus the internet.

2.3 CONTENT COLLECTIONS

The number of collections (either individual topic collections or sub-sites) available from the MII at the time the redesign began was around 150. It is important to note that some of these collections reside on the MII server, a server maintained by the MII Operations team, while some of the collections reside on servers owned and maintained by individual departments or divisions. Some links even go to external web sites which we do not count as MII collections. There was also a lot of information on department or division servers which was never accessible from the MII via a hyperlink (that is, the information was not "posted") but was accessible to users through their browser only if the URL was known. Most of the technical content which was available from the MII via hyperlinks was accessible from the WWW Servers navigation page. This page (figure 8) contained a mix of topics which did not neatly fit into the other MII major categories and had grown to be 5 pages long.

Figure 8. WWW Servers Page

2.4 MII USE STATISTICS

Statistics are kept on the number of "hits" per month on the various MII pages and elements. Usage statistics for the various MII homepage elements for a typical month are shown in figure 9. This allows page use frequency and procedural frequency to be assessed. Frequently used pages as well as those not frequently used can be readily identified.

Summary Statistics for MII Pages (November, 1996)

Total Requests: ~2.4 million
Total Bytes Served: ~ 10.0 gigabytes
Total Unique URLs (excluding .gifs and .jpgs): 35,639
Number or pages served once: 25,814 (72.4%)
Number of pages served <10 times: 33,526 (94.1%)
Number of pages served >100 times: 272 (0.1%)
Number of pages served >1000 times: 49 (0.0%)
Total staff-published documents served: 21,557
8,593 Unique staff-published documents browsed
Total proj./org. published documents served: 22,954
Total number of errors: 25,984 (1.1%)

Figure 9. Usage Statistics

2.5 BROWSERS AND PLATFORMS

The MII was designed to be accessed by the corporate-supported browser which was Netscape 1.0 and then 2.0. Some users do, however, use Microsoft Internet Explorer as well as text-only browsers, particularly from sites. Both Macintosh, PCs, and UNIX workstations are used throughout MITRE with a large variety of monitor types.

2.6 USE HISTORY

While the MII had started as a "proof-of-concept" prototype, it had grown into a mandatory-use corporate tool by the time the redesign effort started. Many corporate administrative functions were now administered solely through the MII. The corporate Policies and Procedures manual was only being updated and maintained on the MII, for example. The paper copy of the MITRE phonebook was no longer updated and distributed. To get a phone number or mail stop, users had to use the MII. The Annual Report, the Time Report handbook, travel and per diem information, corporate initiative updates, MITRE Institute course listings, many desktop software upgrades and corporate document templates were only available via the MII. The intranet had passed the point of being an optional tool and was now mandatory for staying current and, for some employees, for getting their job done.

The MII was originally rolled out in a low-key fashion. Its use by employees in the beginning was ad hoc and there was not a great deal of publicity accompanying its roll out or even an employee training course being offered on its use. There was an on-line training course but it was not widely used. Courses on specific features, such as personal publishing, were offered when these features became available, but they were offered only a few times, and not regularly available through the MITRE Institute. The functionality offered was often so new that many employees did not realize the need to attend the courses at the time they were offered.

The corporate culture, knowledge, and enthusiasm about the MII and the internet in general were mixed. Upper management viewed this tool as the wave of the future, an efficient information dissemination and sharing mechanism to replace paper documents. Many administrative users, such as secretaries, viewed this as a new tool they had to learn but they did not really understand how to use many of its features or even have the desire to learn them. They learned to use the phonebook, download software and templates, and look up necessary travel information. The rest of the functionality was often largely ignored. The technical community was mixed. Some did not need this tool to do their everyday jobs and so ignored it. Others caught on to its benefits rather quickly and rejoiced in the capabilities it offered, whether it be to share information, retrieve technical knowledge or advertise skills. But, a critical point was being reached where so much of MITRE's corporate information and applications were on the web that users could no longer ignore it and use was increasing.

It was time to take another look at the MII, which had grown from a proof-of-concept prototype to a mandatory corporate way of doing business to ensure it was as usable and useful as it could be, so the potential of this technology could start to be fully realized.

SECTION 3

GOALS FOR THE REDESIGN EFFORT

While the existing MII's information organization was good, it was apparent that improvements and updates were needed. The MII Project Management team, for instance, felt the underlying file structure and architecture were sound but felt the usability and look of the presentation layer needed to be improved and updated. We also had inputs and requirements from corporate management and users to improve the MII in certain areas. The redesign requirements from each of these sources are discussed below.

3.1 MII DEVELOPMENT/MANAGEMENT TEAM

The MII had grown continuously since its rollout (an average of 4 to 5 new collections per week). Content links were continuously being added to existing navigation pages and new major category links, such as Corporate Initiatives, had been added. The MII team felt an organizational redesign could improve the usability of the MII. The number of messages appearing in the message area of the MII homepage was large and was starting to crowd the page and push the navigation links further and further down the page, off the screen for many users. The MII team wanted to explore a live announcement/ banner area to replace the static text messages that took up so much screen real estate. Web and browser technology had also moved forward in the interim and the MII team was interested in exploring how this could be used to improve the MII.

3.2 USER REQUIREMENTS FOR THE REDESIGN

Another major source of requirements for the redesign was the user community. Users provide continuous feedback on the MII through the comments they send and questions they ask via the "infoadmin" mail link located on the MII homepage and navigation pages. In addition to this daily feedback, between September, 1995 and March, 1996, a user-oriented evaluation of the MII was conducted in order to determine how well the MII was meeting user needs and its own goals. The evaluation consisted of two parts: user interviews to collect user's subjective feedback followed by a corporate-wide on-line survey.

3.2.1 Interviews

Thirty-two interviews across MITRE-Bedford and MITRE-Washington were conducted to collect subjective information in order to understand user opinions of the MII at an early phase of MII usage. The interviews were only conducted with people who used the MII on a regular basis and sampled the technical, administrative, support, and management populations.

We began the interviews by stating that our job was to collect some preliminary information to assess how well the MII is meeting the goals that were established for it. In order to orient the interview participant to that task, we read the following MII goal state-

ment (which was taken from an early MII requirements document, and was the basis of the questions we asked):

> "The MII shall enable employees to: Utilize an expanded information base. To improve the quality of their products. See increased job satisfaction by reducing frustration levels in information gathering. Reduce time spent on processing superfluous information (from paper and electronic media). Benefit from cooperative efforts by reducing organizational and geographic constraints. Eliminate repetitive efforts by using and contributing to the corporation's knowledge base."

We asked the participants to tell us about their initial reactions to those goals and the MII. We then asked a series of specific questions written to assess each component of the goal statement and asked each participant to identify the three things for which they use the MII the most.

A detailed account of the interview results is available upon request. Briefly, there were feelings of positive enthusiasm regarding the MII. People reported that they can access more information using the MII, the MII makes it easier to access information, and the information is more up to date than it was before the MII. However, some criticisms were raised. We were told that it is too difficult to find information on the MII and that the information it provided is often too superficial.

In order to obtain feedback from a much larger group of MII users, we used the information we obtained in the interviews in order to create a corporate-wide survey. The survey was distributed using the MII.

3.2.2 Survey

The survey consisted of 13 questions such as "Has the MII enabled you to use an expanded information base compared to what you had before the MII?" with a discrete set of answers. We then asked the respondents to indicate how frequently they access a series of MII options (which were identified as the most frequently used options in the interviews), we asked people to identify their job classification (e.g., technical staff, administrative, managerial, etc.), and finally, we asked people if they would like to provide any additional feedback, suggestions, or comments concerning the MII. A copy of the survey is provided in appendix A.

The survey was available on the MII for several weeks. One company-wide e-mail was also sent out to prompt users to fill out the survey. Over 500 users responded. Placing the survey on the MII had many advantages. It allowed for quick and easy data collection and analysis of the responses, for all data was written to a file which we imported into Excel, eliminating the need to manually enter or scan responses.

Overall, the feeling about the MII seemed to be that it currently had limited usefulness but people expected its usefulness to increase in the future. This is what would be expected at this early stage in its development. While all the user comments are very important, many are being addressed by other MII efforts. Only those comments and results which directly relate to the redesign analysis effort are discussed here.

The last question on the survey asked for additional free-text feedback regarding new information/capabilities that might be added to the MII, what people did not like about the MII, how they felt about the organization of the information, and any additional comments. These comments were read and categorized into 13 categories. The largest number of comments, 68, were in the user-system interface category and most of these were relevant to the redesign effort.

3.2.2.1 User-System Interface (USI) Comments

The USI comments included comments on organization of the information and functionality, navigation through the information, difficulty finding information/ functionality, and missing information and functionality. For each specific comment, we tried to identify whether the specific comment was the result of a general underlying user interface problem. Thus, a heuristic evaluation (evaluation of the user interface by a user interface expert) was part of the analysis.

When performing the heuristic evaluation to explore the potential root of the user comment, we made several assumptions. First, we assumed the MII desires a "walk up and use" interface. This implies that a user could access and use most of the functionality without user training. Through exploration, users can "guess" how to perform the desired function or find a piece of information. Although this may not be possible in all cases, we assumed it was a goal. When a user commented that a particular piece of information was difficult to find, we performed a quick analysis of the likelihood that the information could be found without prior knowledge of the MII. This type of analysis is called a cognitive walkthrough (Lewis et al., 1990).

Some user comments addressed the utility of the MII. Utility involves whether the system can do what is needed or provide the information desired. Other comments addressed the usability of the system. Usability involves how well users can use the system functionality/information that does exist (or whether they can find it at all). Comments were subdivided into the areas of: utility/content; functionality and information that exists but the users could not identify or find; information users identified as difficult to find; and organization and navigation. The latter three areas address usability. The area of "functionality that exists but the users could not find or identify it" is interesting because it implies the user interface to this functionality needs to be improved. Many of the comments concerned the phonebook. The phonebook functionality was not part of the redesign effort, however, and these comments will be addressed in a future phonebook redesign. Only the look of the phonebook was to be affected as part of this redesign effort.

Examples of comments concerning utility/content were: comments on the lack of technical information, information needs to be updated quickly and kept up to date, provide corporate guidelines for making official MII pages to improve coherency of the interface, a "headlines" to highlight corporate news.

Examples of comments concerning functionality and information that exists but users cannot find included users asking for a "What’s New" on the main page, MII accessibility when at home or on travel, ability to search documents published on the MII by keyword, a complete listing of what you are looking for. These capabilities or information were all available but users could not locate them.

Examples of comments concerning information that was difficult to find were department homepages (have to use search to find them), my own department and division servers, travel information, computer store hardware listing, conference room schedules, a document even if you know it is in, say, the System Engineering Process Library (SEPO), etc.

Examples of comments concerning the organization of information and navigation on the MII included headings and search paths are not intuitive, would like a clear directory tree, would like to browse in a way similar to the subject and author catalogues in libraries, cannot find the same things twice, the organization of the MII pages is its major failing, layout is not awfully intuitive, information is not sorted logically by subject, fewer categories at the top level since they are related, top-level headings not intuitive, etc.

3.2.2.2 Analysis of User Comments

Lack of technical information was a real drawback of the MII at the time of the redesign. Since administrative information was more readily available (it already existed in paper form) and administrative groups were more willing to put their information on line, this was accomplished rather quickly. Technical information, on the other hand, had to come from individual employees throughout the company and there were not any incentives in place to cause this to readily occur. Thus, the MII had a much greater administrative then technical focus at the time. Technical users, however, were interested in accessing technical information. Information on technical expertise available throughout MITRE was also sketchy. There was not a page where users could go to see the types of technical organizations and groups at MITRE. Some technical departments and groups had links to their pages on the MII while others did not.

So one serious goal of the redesign effort was to increase the visibility and amount of technical information on the MII. Another was to pull together in one place all the technical groups and organizations in MITRE.

The comment on the lack of the corporate user interface guidelines for the MII was another serious problem with the current MII. While the current MII had visual page design elements, there was no accompanying style guide on how to apply the elements consistently so they were applied inconsistently in places, even on the MII navigation and system pages. At the content level, some page developers applied some of the MII elements such as the toolbar to their pages and others did not. Most content pages or subsites had no visual indicators that a user was still in the MII. And once you were on a content page, there was no mechanism other than Netscape navigation controls to access other MII pages. An MII style guide was needed.

The “headlines” to highlight corporate news was a good comment, in line with the MII team’s recognition of the need for a live announcement/banner capability. Corporate news tended to be distributed in various formats.

Users noted functionality they thought was not available. Some of the functions were indeed available, but only from the toolbar. This included document searching by keyword and a complete listing of what you are looking for (we assumed this meant an

index). Comments and questions sent to the MII help desk team also made it apparent that the toolbar functionality was frequently overlooked. The inverse problem also existed. Users would browse the interface looking for documents, for instance, and there were hyperlinks on the navigation layer which appeared to be a match, e.g., "MITRE Documents On-line (HTML)." This link, in fact, only accesses a select number of MITRE documents. It does not access the staff-published documents on the MII. This lead to several redesign goals. First, we needed to increase the visibility of the toolbar. Second, we needed to pull all the document collections together on one page and explain their overlap and differences so users could be confident they had exhausted all the MII document collections while browsing or searching.

Other functionality not apparent to users was functionality available from the phonebook pages, such as the detail phonebook page, employee homepages and the user-created organization and project homepages. To have access to these pages, a phonebook search must first be performed and then links which are not descriptive of their purpose must be selected. To access the detailed phonebook page or an employees homepage, for instance, requires a user to click on the employees name link. These name links look like the titles for the page you are currently on. The user also does not know until after they select the link whether additional information is actually available or not. Providing a different mechanism for accessing some of the information, such as project and organization information by browsing from the MII homepage, was another goal.

For each of the items of information that the user had difficulty in finding, we assessed whether the information was readily searchable, navigable, or browsable. Some of the hard to find items reflected the fact that the major category link names on the homepage no longer adequately reflected the content beneath them. For example, the Software and Templates category contained items, such as the Computer Store hardware listings, how to dial into MITRE's modem pool, and other non-software related items. Another goal, therefore, was to revisit the category names and the content under them and change the names and reorganize the content, if necessary.

Other hard to find items reflected the depth of the navigation hierarchy under some of the categories, particularly the Technical Expertise category. Some items were three to four levels deep in the hierarchy. The lower down in a hierarchy an item is, the more abstract the category name is for it at the higher levels, making it potentially difficult to find. A goal was to flatten this hierarchy.

Many of the organization comments were general, reflecting many of the comments mentioned above. One addressed the fact that there were so many high-level administrative categories that it was hard to select the correct one. Of the twelve top level category links on the homepage, nine were for administrative topics. We interpreted the comment on needing a clear directory tree as a need for a map or table of contents (TOC) for the site. Goals included consolidating the administrative major categories and adding a TOC or site map to aid navigation.

3.3 MITRE MANAGEMENT REQUIREMENTS FOR THE REDESIGN EFFORT

MITRE management also had some requirements for the redesign effort. They also were eager to improve the visibility and amount of technical information available on the MII. So two redesign goals were to increase the visibility of the technical information that did exist on the MII (which as noted above tended to be buried) and to make it easier for users to add new content to the MII. There was also strong interest from upper management in the live announcement/banner concept.

3.4 SUMMARY OF MAJOR REQUIREMENTS FOR THE REDESIGN EFFORT

To summarize across the various sources of requirements for the redesign effort, the major requirements were:

- Assess whether new web capabilities, such as frames and Java, could improve the usability of the MII
- An updated look and feel
    - Include style guide for consistent use of graphical elements.
    - Propagate MII logo down to the content or subsite level.
- Improve organization of the information
    - Decrease the number of major administrative categories on the homepage.
    - Increase the number of major technical categories on the homepage.
    - Assess the resulting major category names and ensure they reflect their current contents.
- Improve navigation within the MII
    - Decrease the depth of the navigation layer pages by increasing the breadth.
    - Make some of the content currently accessible only by a phonebook search browsable via the navigation layer.
    - Currently navigation only provided downward and back to MII homepage. Add horizontal navigation across navigation pages.
    - Add a TOC or site map navigation aid.
    - Improve the visibility of the MII toolbar.
- Consider job-oriented and user-customizable navigation aids
- Consider methods for rapidly increasing the amount of technical content
    - What could the MII team do to populate the MII with technical content?
    - What could we do to encourage users to add content to the MII?
    - Try to remove the barrier between information on the MII server and information on the department- and division-controlled servers.
- Create a live announcement/banner area usable by all users to broadcast live messages in a compact area
- Pull together the document spaces and make the existence of each and their relationships to each other more obvious
- Build the new navigation layer and roll it out to the corporation with the minimum amount of disruption to users

The following sections detail the process used to meet these objectives.

SECTION 4

REDESIGNING MITRE'S INTRANET

To kick off the redesign effort, the MII management team formed a multi-disciplinary redesign team. Interestingly, the skills represented on the team almost exactly mirrored those proposed by Sano (1996). Sano recommends that the disciplines represented on a large scale web project include:

- project management -- project plan, business requirements, budget, schedule, management,
- usability engineering -- user requirements, functional specifications, user profiles and surveys, interface design, testing,
- visual communication -- art, screen design, style guide, prototyping,
- content management -- hypertext editing, writing, documentation,
- engineering -- hardware, software, maintenance, Java, upgrades.

Our redesign team included:

Discipline	Team Member
Redesign Project Management	Carsten Oertel Ed Goodnight
Usability Engineering/Human Factors	Donna Cuomo Linda Borghesani
Visual Design	Dennis Violett
Content Management	Karim Khan Don Whittemore Jean Tatalias
Engineering/Operations	Joe Sain Doug Phair and team
Training	Linda Rodi Chaya Rosen Ellen Cohn
Library Services	B. J. Fisher and team

The team members were distributed across the MITRE-Bedford and MITRE-Washington locations. Weekly VTC meetings were held and much of the communication occurred via e-mail. This allowed all team members to have a record of discussions even if they were not physically present for them. MII transfer folders were used extensively for file sharing, particularly of gif images and html documents. The redesign effort began around June, 1996 and the product rolled out on 16 December, 1996. Although this was

lengthy timewise, most of the team members were not full time on this effort and many participated just long enough to perform their specific function. For example, the training team was involved near the end to create a training course on the new MII.

4.1 GROUND RULES

Some initial ground rules were decided upon which influenced many of the later design decisions. For instance, the effort was scoped to include the MII homepage and navigation layers but the phonebook functionality, and the existing functionality accessible from the toolbar were not to be included other than how these pages looked. It was decided that we would assume all users were using the corporate-supported browser, Netscape 3.0. This meant that Netscape-specific capabilities could be used. We decided that the Netscape 3.0 implementation of frames was sufficiently improved over the previous versions that frames could be used when a usability benefit would result. For people using text-only browsers or users who have the "load images" option turned off, a link to the text-only version of the homepage is available. Those users with the "load images" option turned on would not have this as a choice. When in the text-only mode, frames pages are replaced with non-framed pages.

4.2 HOMEPAGE METAPHOR

The initial strategy for defining the overall concept or metaphor for the new MII user interface was to explore a variety concepts independently among team members and to review and discuss these ideas for potential inclusion in the final product. For example, one concept proposed was for a "magazine" style homepage with emphasis on links to announcements and news items, along with a live announcement/banner. To get to a page similar to the current homepage with the major category links required a user selection. This concept also included a user-customization feature which supported two different ways for customizing the homepage -- "cafeteria style" or by user job type. It was eventually decided not to include this customization concept in the final design but to consider it for the future.

An alternative proposal for the homepage was to keep the current homepage elements (the major category links and the shortcuts) and style since users were familiar with this design and there were advantages to it, and to just update categories and the graphical elements. This concept included predefined navigation pages tailored to a particular job category (e.g., an administrative user page). The concept eventually adopted for the homepage was a combination of the two. A live announcement area was added to a page similar in design to the current and new graphical elements were added. Many other changes were made as well to meet the other redesign objectives and the process and rationale for each of these is described below.

4.3 IMPROVE ORGANIZATION OF THE INFORMATION

One of the goals was to improve the overall organization of the information on the MII. The current homepage had 12 major category links with 9 category links related to administrative information and only 3, Technical Expertise, WWW Servers, and Library

and Reference, related to technical information. Users had voiced their concerns with finding information with this structure. We wanted to add technical categories without increasing the overall number of categories so we decided to combine some of the administrative categories so the homepage would represent both types of information equally. Categories were combined based on the number of links on the second level pages for a category (Education and Training had few links at the second level, as did Policies) and the potential confusability between some categories. For instance, it was not usually clear whether an item would be under About MITRE (contained corporate information), Employee Resources (contained corporate information of interest to employees) or Facilities and Services (a listing of most corporate services and facilities). In fact, a single link was often replicated across these topics because there was so much overlap in them. The best set of categories for a given domain will minimize the psychological distance within groups while maximizing the distances between groups (Paap & Roske-Hofstrand, 1986). Thus, the categories Policies, Employee Resources, and Education and Training were subsumed by other Administrative categories.

The technical categories to be added were chosen by looking at what was currently available on lower levels of the current navigation layer, thinking about the corporate structure and what MITRE does, and the user's comments from the survey.

4.3.1 Technical Groups and Organizations

MITRE is composed of technical expertise organized into four customer-based centers, divisions within centers, and departments within divisions. Some departments are also in technical centers and other employees are members of informal groups called specialty groups or cluster groups which support sharing of information by skill type. As noted previously, accessing technical organization information was an ad hoc affair on the current MII. Organization information could be accessed from a link on a phonebook page if the user knew the name of the organization or its number and did a phonebook search. Users could not determine, however, which organizations had published technical organization pages other than by trial and error. This method also does not support browsing. Some departments or divisions had links to their organization technical pages from the WWW Servers page but this was only a few organizations. Some technical center, specialty group, and cluster group links were available from one of the Technical Expertise navigation pages. Center-level pages were accessible from the About MITRE page. Creating a "Group and Organization Homepages" major category link from the homepage would definitely improve users ability to identify all the technical groups within MITRE. All centers and divisions within each center are listed and if they do not have homepages, they are static text as opposed to hyperlinks. This allows users to see the entire organizational structure and know at a glance which organizations published homepages and which did not. The page also contains links to technical center and specialty and cluster group homepages. The new Group and Organization Homepage is shown in figure 10.

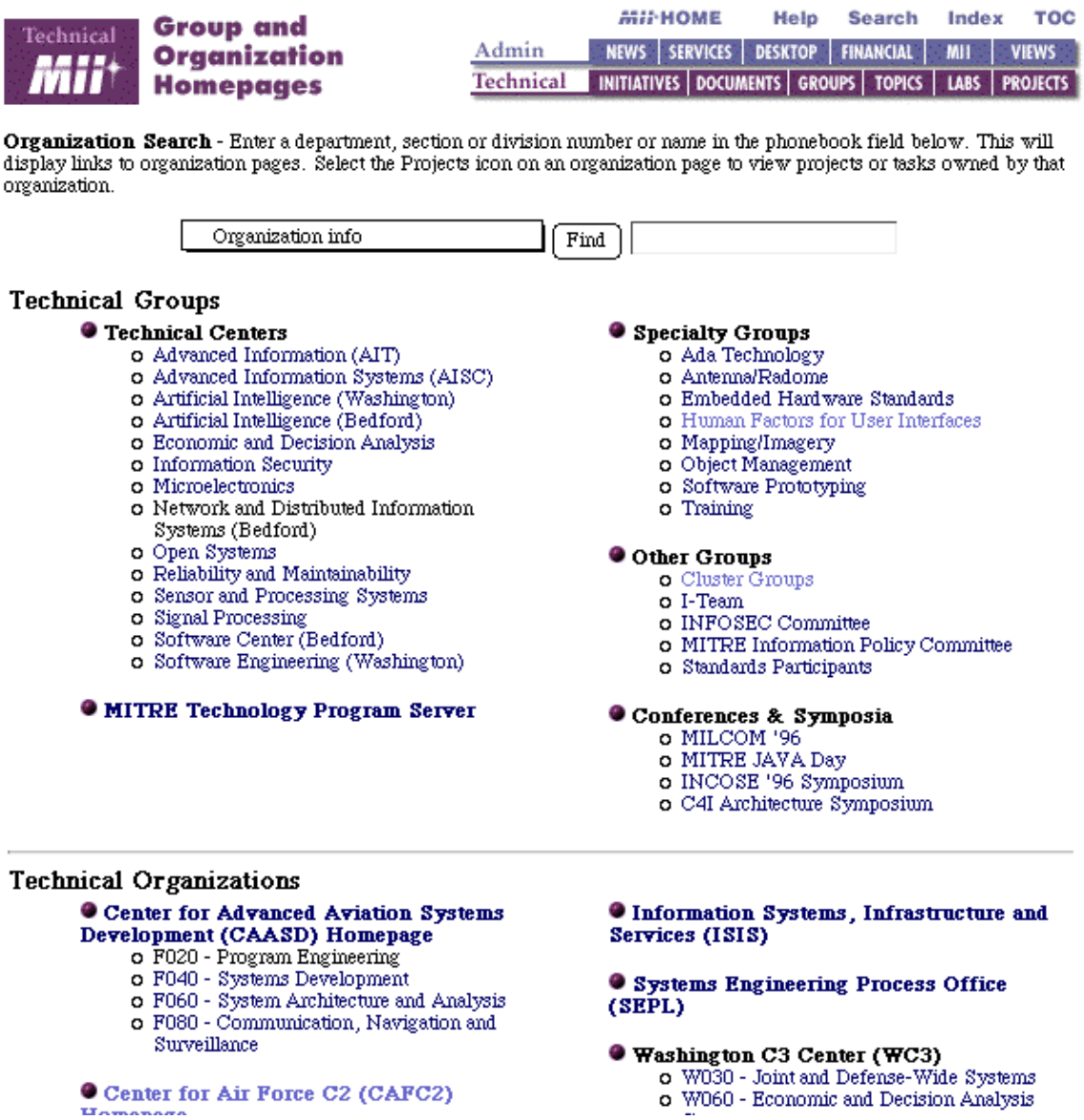


Figure 10. Group and Organization Homepage

4.3.2 Projects

All staff at MITRE support projects funded either by a customer, overhead, or MITRE sponsored research (MSR) or Mission-Oriented Investigation and Experimentation Projects (MOIE). Very few links to technical project pages existed on the current MII. A project phonebook search could be conducted and again, in a hit or miss fashion, users could click on the project name to see if a technical project page existed for a particular project or task. We decided to add a major category link called Projects to the homepage. The Project navigation page would contain a list of projects for which technical project pages existed, grouped by Center or MSR/MOIE.

This is a slightly different concept than that adopted for organizations above where all centers and divisions were shown whether they had homepages or not. The difference

is that hundreds or even thousands of projects and tasks can exist at any point in time. To list all of these, when most do not have homepages currently, was thought to be counterproductive. Additionally, tasks are often created which no one really supports so to do an encompassing list would not be usable. Instead, projects and their associated tasks will be added to the page under the appropriate center as homepages are developed for them. A separate MII effort is creating project page templates which will allow project leaders to quickly develop these project and task pages.

4.3.3 Information by Technical Topic

Another area that was difficult (or impossible) to browse for information on the current MII was information grouped by technical topic. What technical information does MITRE know about? What is available on-line about each topic? Currently, the only way to retrieve technical information was to perform a search using the search page accessible from the toolbar. If users knew exactly what they were looking for, and knew the search functionality existed, and were able to formulate a suitable query, this is an acceptable and also a necessary form of navigation. But, this type of navigation does not support serendipitous location of information or show a user all that is available on-line at MITRE for a particular topic . Having links to information grouped by technical topic held great appeal yet the redesign team was aware that most of the technical information on MITRE servers was not currently linked to the MII. To populate such a scheme with a reasonable amount of information would require all technical users to tell us what existed on their servers, which was not too likely given past history, or for the MII team to survey all servers and put links on the MII to useful-looking technical information, which would be a rather large undertaking. We chose to do the latter, assisted by a special sub-team from the Corporate Information Services department.

The five members of the Information Services team surveyed every server at MITRE and noted technical documents, homepages and other content of interest. Some of their concerns were what to do with collections that were out of date or had dead links in them, and who would ensure the content collections were kept up to date once they were available from the MII.

They then reviewed several potential categorization schemes starting with the Library of Congress Subject Headings (LCSH). They decided that this particular one was not appropriate and much too detailed. They then switched to the Defense Technical Information Center (DTIC) Subject Categorization Guide for Defense Science and Technology which seemed appropriate because of the areas of MITRE's work programs. The 25 basic, broad DTIC headings were eventually expanded to 37 main headings based on MITRE's work program and current technical collections of the MII.

This resulted in the new Information by Technical Topic navigation page shown in figure 11. This effort greatly increased the amount of technical information on the MII and provides it in a usable format.

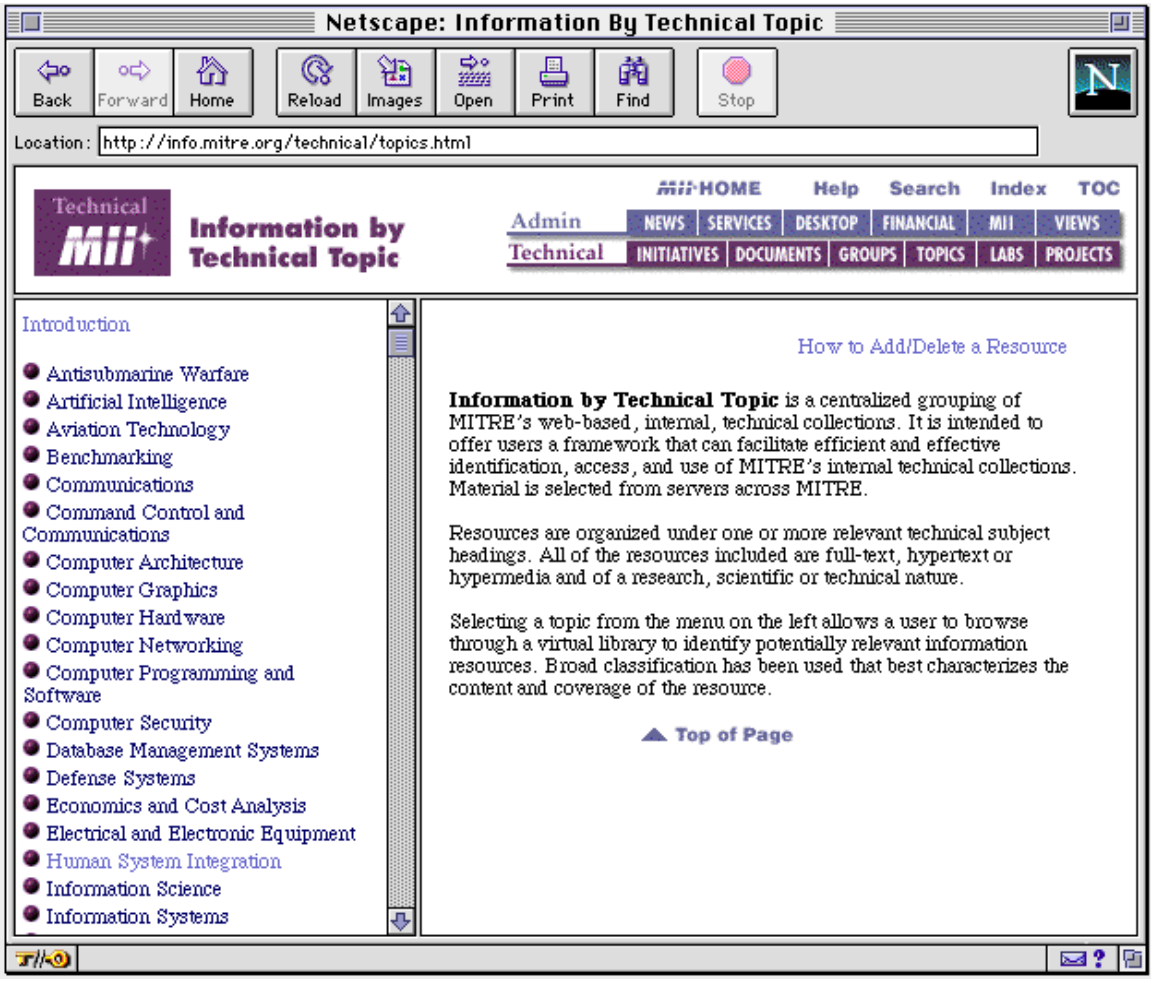


Figure 11. Information by Technical Topic Navigation Page

4.3.4 Technical Documents

Another redesign goal was to pull together all the document spaces currently on the MII and make the existence of each and their relationships to each other more obvious. From the current homepage, the only document space which was readily represented was the Library via the Library and References major category link. This link led the user to various collections, some which are only searchable (the corporate library collection) and some which were browsable such as Selected MITRE reports. Several document spaces were searchable via the Search icon on the toolbar such as staff-published documents on the MII. Finally, there were several technical document collections located in the bowels of the Technical Expertise navigation pages such as the COTS Collection, the System Engineering Process Library, the Risk Management and Assessment Program, and the Software Experience Factory. Some of these were browsable, and some had their own separate search engines and were not searched by the toolbar search tool. To a user, it would be difficult to locate all these collections, to know when you had searched or browsed them all, or to know whether some collections were subsets of others. Our solution was to expand the focus of the Library and Reference category to include all

technical document collections and a brief description of each. This page is shown in figure 12.

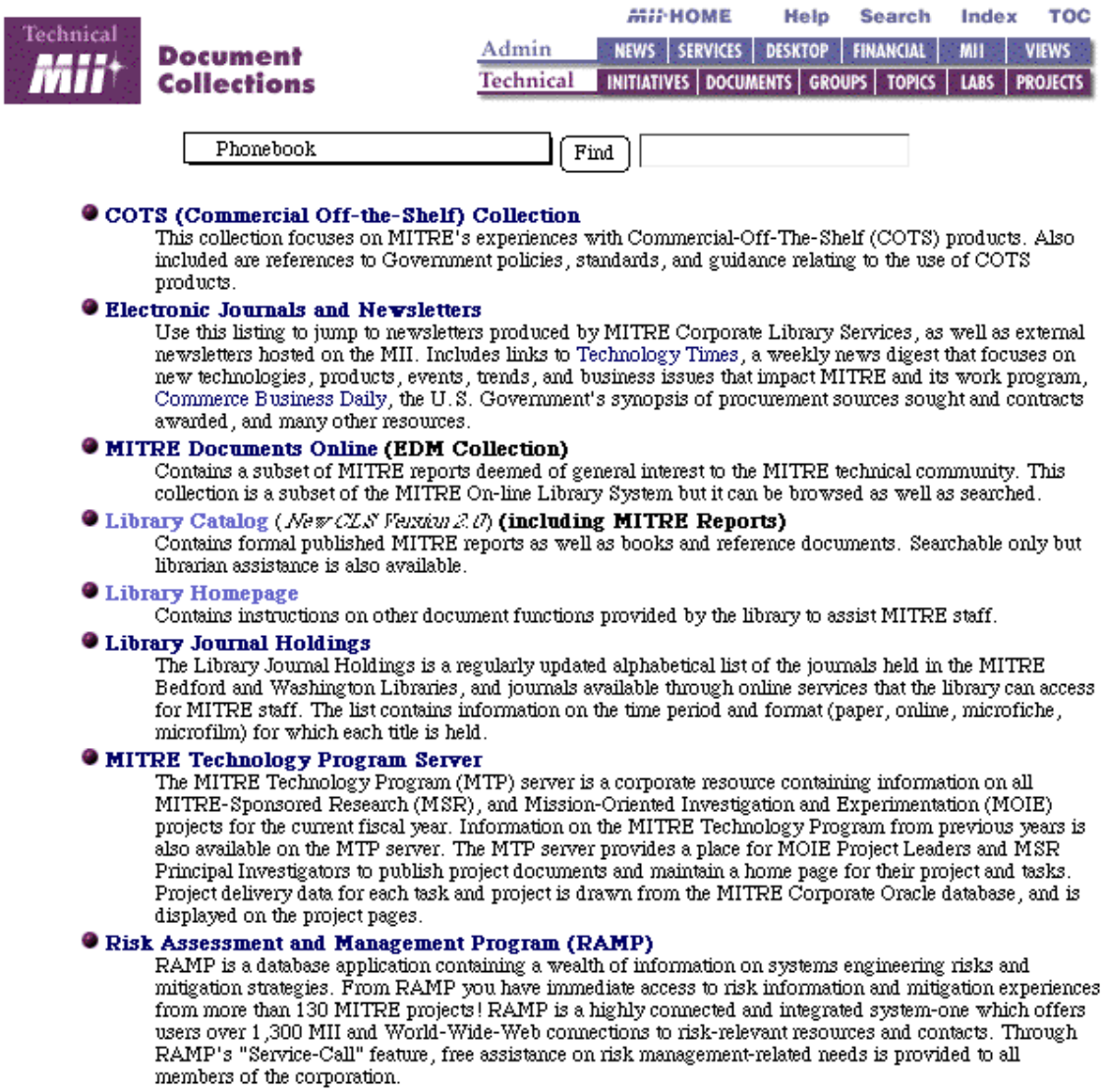


Figure 12. Document Collections Page

4.3.5 Labs and Engineering Tools

Finally, there had been a major effort in 1995 to collect and put on the MII descriptions of all of MITRE's laboratories and engineering tools. Engineering tools were defined to be software or hardware tools employee's owned and used or had knowledge of. This was to help other employees determine who in the company had a lab that might meet a current need and who had a tool or knowledge of one that they were interested in borrowing or knowing about. For instance, if a user wanted to know if anyone at MITRE knew about Microsoft Access, they could go to the labs and tools page and perform a search on that term. Or, they could browse lab and tool descriptions which were grouped by division. The collection also contained forms which allowed users to submit or update

lab or tool information. Once submitted, the pages were automatically published in the collection. The collection was developed by the Software Center. This was a major technical collection but it did not get high usage, partly because of its lack of visibility in the current homepage structure. We felt this deserved to be a major category link. The Labs and Engineering Tools page is shown in figure 13.

Figure 13. Labs and Tools Page

This seemed to round out the technical topics on the MII homepage. Instead of Library and References, WWW Servers, and Technical Expertise, the homepage now had five major category links representing the technical organizations, the technical document collections, labs and engineering tools, projects, and information grouped by technical topics. This seemed to be a much more logical organization for the technical information.

4.4 ORGANIZING THE ELEMENTS ON THE HOMEPAGE

Several iterations of the layout of the elements on the homepage occurred before reaching the final. Initially, the twelve major category links were listed in two columns in alphabetical order, similar to the current homepage. To improve navigation (see below) we had decided to add a menu bar to the top of every navigation page and the homepage to offer users horizontal navigation -- the ability to navigate between second level navigation pages directly. We had also decided to locate the toolbar at the top and bottom of the homepage and navigation pages to improve its visibility. On smaller monitors, it was often not visible on the page without scrolling. A preliminary version of the homepage with some of these concepts is shown in figure 14.

Figure 14. Preliminary Homepage with Single Menu Bar

This design used a single menu bar for all the major link categories and included a placeholder for the new live announcement area. It had a new MII logo and the toolbar had text labels for the items as opposed to the icon/text combination in the former design. The color scheme was burgundy. This early prototype was demonstrated to two technical content providers to get their feedback on whether they felt the visibility of their technical collections was improved with this new concept. They both liked the new technical links but one user commented that the mixing of technical and administrative information was confusing. This comment was a critical turning point in the design. Separating the major category links into Administrative and Technical would accomplish several purposes. First, it would highlight the new technical categories. Second, by having two groups of six links, it would reduce users search time to locate a category. Only seven items possibly needed to be searched with two groups while up to 12 might need to be searched with the one large group concept.

This design decision affected the look that had already been developed and required a change because we now needed two menu bars as opposed to a single menu bar. Two iterations occurred with the new two-column concept. The first design concept is shown in figure 15. It color coded the Administrative elements purple and the Technical elements teal. Several users and the larger MII team viewed this design. The meaning of the graphics in the Administrative and Technical labels was lost on users and they found them confusing. One user thought the paper clip in the Administrative label was a safety pin, for instance. We also thought the design was visually flat. The visual designer performed a second iteration and produced what was essentially the final graphical design, shown in figure 16. This was not the final homepage, however. The category names and shortcuts still required finetuning.

Figure 15. First Administrative/Technical Split Design

The new design had a vertical logo bar with a 3-D look graphic in shades of burgundy. This was actually a background as opposed to a page graphic. The Administrative elements were color-coded blue and the Technical elements were burgundy. The second level navigation pages originally also had a plain color-coded vertical bar down the side of the page with a reduced MII logo at the top of the vertical bar. This, however, was rejected as it consumed too much screen space. The final graphical design of the second level navigation pages was shown in figures 10 thru 13.

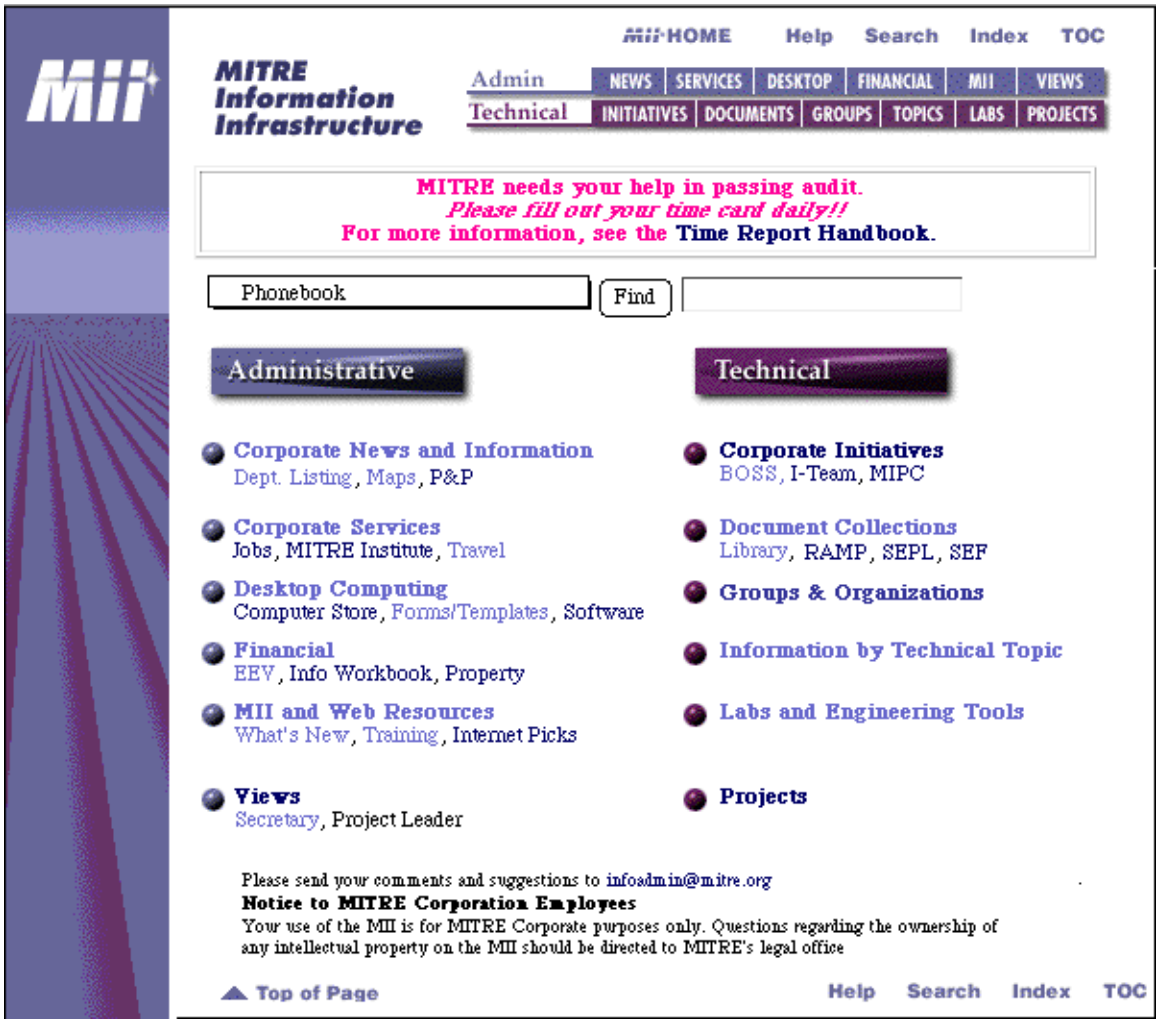


Figure 16. Final Graphical Look for the New Homepage

The new homepage design introduced a few troublesome issues. While the redesign team would have preferred to use the default Netscape link colors, bright blue for untraversed links and purple for traversed links, it was thought that this could cause confusion with the blue/burgundy color scheme used to indicate administrative and technical. Therefore, untraversed links are presented in a medium blue and traversed links in a light blue. While bolded text links are legible in the light blue color, unbolded text links have weak contrast with the white background when in the light blue color. On some monitors, these links are a little difficult to see. However, no one could decide on a more acceptable color scheme and so it was left as is. Users do have the option to override the page link colors and use the defaults, or colors of their choice, if they wish.

Another controversial issue was the window width. The current MII had a page width of 480 pixels which fit in the default Netscape window size. The new MII page width is about 570 pixels which means users have to resize their window horizontally to view the entire page. The page then fills the screen on some monitors or takes up a large percentage of the screen. Also, when printing these pages with the default print parameters, the contents do not fit on the page. Since Netscape 3.0 “remembers” the last window

width, it was argued that users would not have to constantly resize the window so this was acceptable. The advantage of the wider page was that options on second level navigation pages could be presented in a dual-column format, utilizing screen space more effectively. In the end, it was left at the wider width. Second level navigation pages with a lot of text on them were designed to wrap with the window width so users who do not like having their Netscape window so wide can still see most of the page contents.

The final controversial design issue was the loading time for the homepage graphics. The new MII logo graphic is rather large at 21 KB. Dial-in users had already registered complaints about the size and loading time of the graphics on the current MII and the new page had more and larger graphic elements. We expected this might generate complaints, but it was left as is.

4.5 FINE-TUNING THE CATEGORY NAMES AND DEFINING SHORTCUTS

The team now had a concept for the homepage, a new "look", and most of the major category topics that were to go on the homepage had been identified. What was still needed to complete the homepage design were finalized titles for the categories and shortcuts to go under each of the categories. By this point, we felt the need for a user test to validate the design changes we had made so far and to get feedback for finalizing the category titles and shortcuts. A paper-based test was designed using a color printout of the current homepage. It involved meeting with unscheduled potential users in their offices and asking them to pick the major category they would select to try to locate approximately 57 target items. This test is described fully in the next section on user testing. Based on the results, the homepage was modified and the final homepage was frozen (figure 17). The only element still missing was the live announcement/banner area.

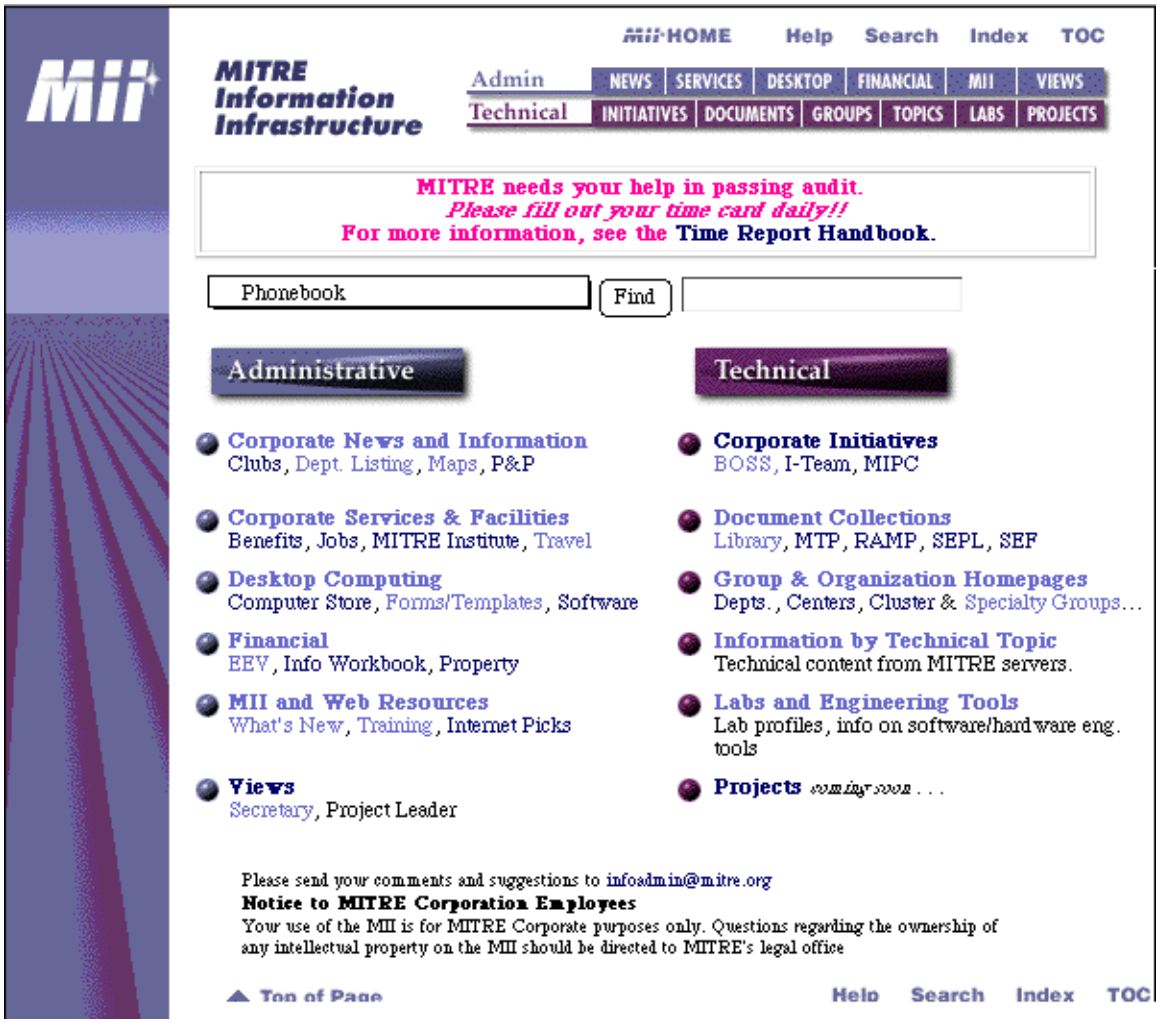


Figure 17. Final MII Homepage

4.6 DESIGNING THE SECOND LEVEL NAVIGATION PAGES

There were many considerations in designing the second level navigation pages. As noted previously, the current MII had an unevenness in the number of layers that needed to be traversed before a content page was reached. Some major categories had only a second level navigation page, with all options leading to a content page. Some major categories had three navigation levels before a content page was reached. Some navigation pages had only a few options in a single list while some, such as WWW Servers, had approximately 5 pages of options. The menu design research shows that there is usually improved performance and user preference for menu structures that have more breadth than depth (more options per page as opposed to more levels of pages). Users tend to get less lost, and it is easier to search more items on a single menu or page than to guess what topic an item might reside under and navigate down to it. Increasing the number of items on a page increases the search time to find a single item, however. This raises the question of what is the optimal number of options per page.

One group of researchers (Lee and MacGregor, 1985) quantified the trade-off between funneling (adding depth) and total search time as a function of breadth, processing time per option, human response time, computer response time, and the size of the database. They found that the optimal breadth was between three and eight alternatives per menu panel. They did not, however, assume that error rates would go up as depth increases, which studies have shown is an artifact of depth. They also did not look at other conditions under which search time on a single panel could be reduced, such as by arranging items in order of descending frequency, or grouping the options into meaningful categories (Paap and Roske-Hofstrand, 1986). By combining information on the optimal number of groups for a menu panel (the square root of the total number of items) with the previous formula, Paap, et al., calculated the optimal number of total menu options and groups per menu panel as a function of human key-press time, human processing time per item, and computer response time. As keypress time and computer response time increase and human processing time per item decreases, the optimal number of menu items increases. Performing calculations with values of .5 to 1.35 sec.s, .25 -2 secs/item, and either .5 or 1 sec, respectively, they created a table of optimal number of total options and groups for the various conditions. They show the optimal breadth per page can vary from 16 to 36 items and sometimes be as high as 78 items with the optimal number of groups being the square root of that number.

Applying these results to our system, we estimated human processing time per item would be toward the high end of the range since the item names are sometimes long and that our computer response time is toward the slow end. We, therefore, estimated we might want to target about 22-26 items per page with five groupings. Of course this is based on an assumption that equal numbers of items can exist for every group and that every page has an equal number of options. In real life, this is not the case. The authors of this study point out that it would be a mistake to force an unnatural organization and that simulations of non-optimal conditions show that grouping still decreases search times. Without grouping, and under conditions of self-terminating search, optimal menu size (number of items per page) is between 4 to 8 items.

Our goal for improving navigation, therefore, was to work within these navigation page design guidelines and to have all of the navigation paths be no more than two deep. Therefore, most content pages would be accessible with just two mouse clicks. Deviations for natural groupings would, of course, be made as necessary.

More of the second level navigation pages are shown below. The options on the new Corporate News and Information page (figure 18) were close to the desired structure. The page has seven groups of items, with groups containing from 3 to 12 items. The Desktop Computing page (figure 19) has 8 groups of items, with groups containing from 0 to 11 items.

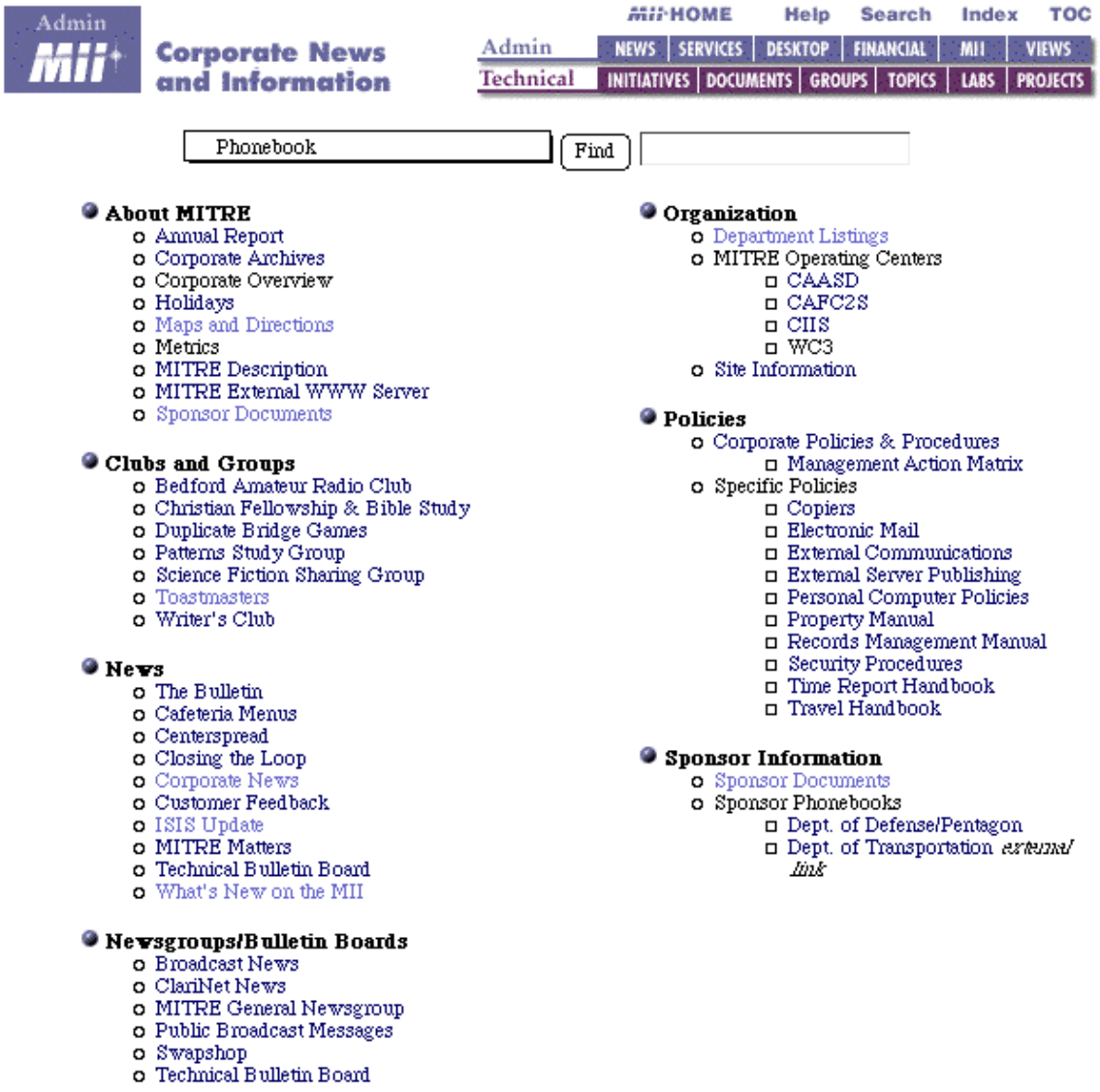


Figure 18. Corporate News and Information Navigation Page

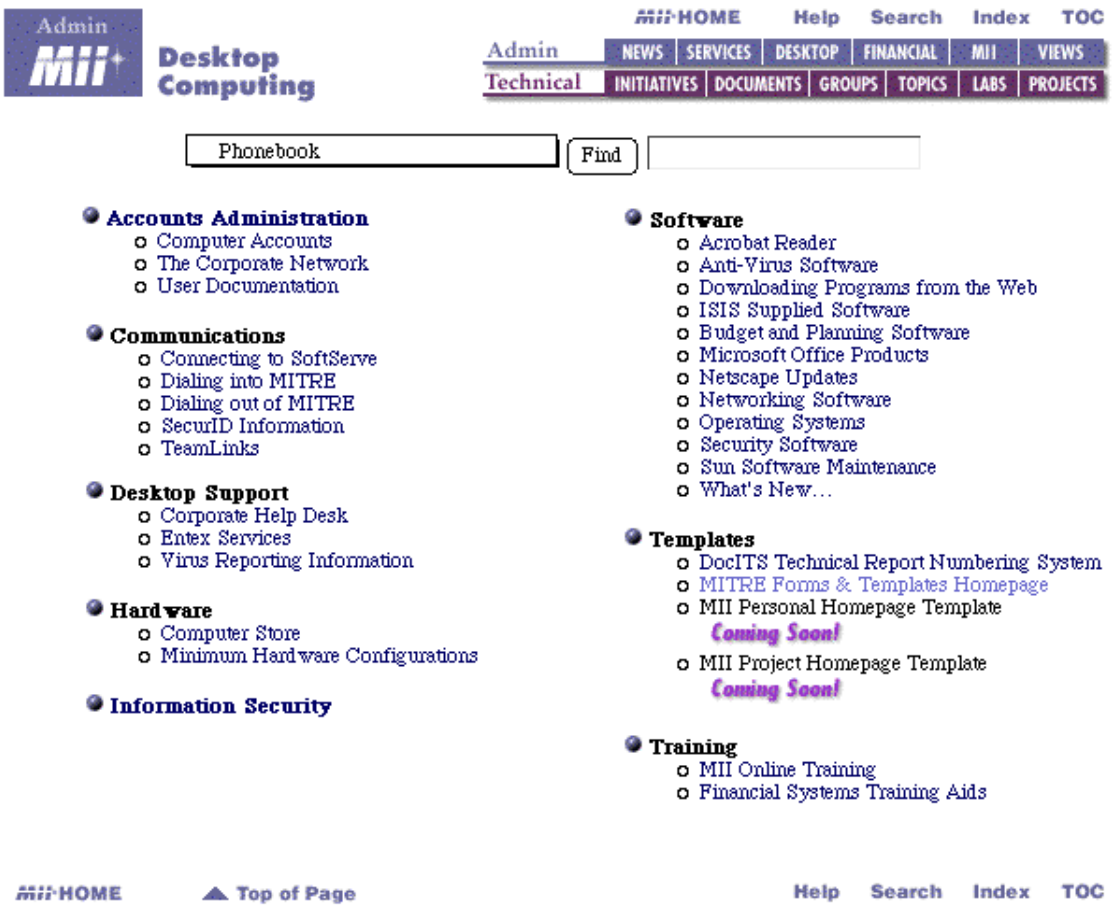


Figure 19. Desktop Computing Page

On navigation pages where there were many more than the recommended number of items and a natural higher-level breakout was apparent, we split the page into two sections and then provided grouped items within the sections. On the Group and Organizations navigation page, for instance, which was shown in figure 10, the top half of the page is devoted to Groups and the bottom half of the page to Organizations. Each half of the page roughly meets the guidelines for number of groups and items per group. The alternative to this concept would have been to break this page into two separate pages. However, the information is related and we did not want to increase the number of high-level categories on the homepage so we decided to user test this concept. A similar concept was used on the MII and Web Resources page.

The third major type of structure for the navigation pages was illustrated on the Information by Technical Topic (figure 11), and Lab and Engineering Tools pages (figure 13). These pages are more like index pages to content and will continue to grow over time, unlike the Groups and Organizations page which has a fairly static number of items. To accommodate potential growth, we used a frames-based design where the high-level categories or grouping headings are displayed in a scrolling frame on the left side of the page and the underlying options for a particular category are displayed in the right-side frame when a category is selected. Figure 20 shows the Information by Technical Topic

page when a category is selected. When the user first accesses the page and no categories are selected, the right side contains a description of the page, a link for adding or deleting resources, and a search capability, if one is available, as was shown in figure 11.

Figure 20. Technical Topics Page with a Category Selected

As noted previously, at the top of every second level navigation page, a menu bar was added (previously, only the toolbar was available) which allows users to navigate horizontally to a different second level navigation page, allowing quick scanning of multiple pages without having to navigate up and down the hierarchy.

4.7 ADDING RESOURCES

Another goal of the new MII was to enable users to quickly add information content to the MII. On the current MII, it was not easy to find instructions on how to post

your information collection. One of the features of the new MII navigation pages was the addition of a link on "How to Add/Delete a Resource." This link was placed on the Projects, Information by Technical Topic, and Lab and Engineering Tools pages. This link either leads the user to an instruction page on how to add a content collection or to a form page if the information is collected via an on-line template or form. This will make it easy for users to add their technical content to the MII.

4.8 SEARCHING

Some of the second level navigation pages also provide context-sensitive search tools. The Lab and Engineering Tools collection, for instance, had its own search engine since it was not developed by the MII team. This search capability was placed right on the main navigation page. The Groups and Organizations page has links to technical collections. However, the phonebook offers a search of organization administrative information so the phonebook search was displayed at the top of the Organization navigation page and instructions on its use provided. This will help increase the visibility of this phonebook search option and remind users that this related information also exists. The search mechanisms for the MII still need to be improved and made more seamless but that is being worked as a separate MII effort.

4.9 VIEWS

As mentioned previously, we wanted to add job-centered "views" to the new MII homepage. The goals of these view pages were to group links thought to be useful to a particular job type or user group and have them available on a single page. The MII Training team had already created a secretary page as part of their training materials and were in the process of developing a new employees page. They also had an out-of-date project leaders page. We used these as starting points for our view page concept. The plan was to develop draft pages based on our knowledge of these user types and what content was available on the MII and to hold focus groups with the various user types to refine the content of the pages. The first group we did was the secretaries. Using the secretary page developed by the training group, we held multiple focus group sessions with secretaries in our usability lab. The links on the page were refined, new graphics added and the resulting page is shown in figure 21. The focus group process and results are provided section 5. The project leader and new employees view pages are still in progress, but we plan to use a similar process to define and refine them.

Figure 21. Secretary View Page

4.10 TABLE OF CONTENTS

While the current MII had an alphabetical index, it did not have a TOC. A TOC is different than an index in that it shows groupings by topic and allows the user to learn which navigation page contains a particular link. The index is alphabetical and even if a user finds the link and selects it to navigate to that page, they still are not sure which MII navigation page this link resided on. Hoffman (1996) is a strong advocate of the TOC and feels that the hierarchical, indented, detailed, text-based outline is so powerful for finding information fast or for identifying the scope of a document or web site, that every author should create one. A TOC also serves as a "quick reference sheet" for users when printed out (and is searchable by the browser's built-in search).

We envisioned the TOC being used when a user was unsure of which category a link resided under. Typically, however, they should know whether it was a Technical or Administrative link and would, therefore, be searching across categories within the Technical or Administrative areas. Therefore, it would have been ideal to have a TOC which was laid out horizontally with the Administrative category headings across the top and the links each heading contained listed vertically underneath. Under this would have

been the Technical headings laid out in a similar fashion. This would have supported easy comparison across categories.

Unfortunately, our TOC proved to be too large to use this scheme. There would have been six categories laid out horizontally across the page with long link names beneath them and the user could only see all six categories by horizontally scrolling so an easy comparison of links across headings was not possible. Because some of the categories have many links under them, a lot of vertical scrolling was needed to access the Technical TOC area. So while this format would have been preferred, we ended up using a dual column format with Administrative and Technical category headings laid out side-by-side instead. This is shown in figure 22.

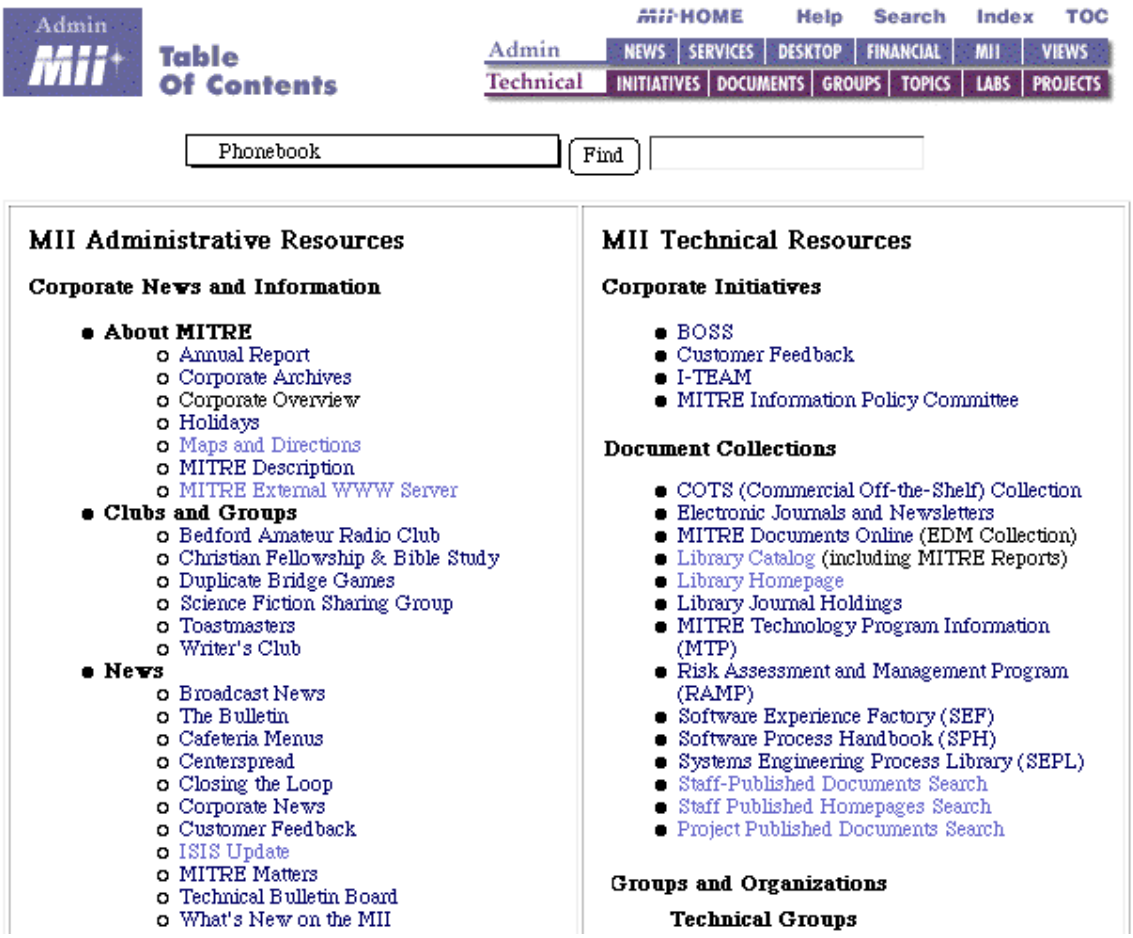


Figure 22. Table of Contents

4.11 LIVE ANNOUNCEMENT/BANNER AREA

The need for a live announcement area on the MII was a result of the number of messages being posted at the top of the MII homepage. The MII is a good way to communicate daily corporate messages to employees but displaying them as static text boxes was taking up too much screen space on the homepage. The original concept was to

display the messages one at a time with a ticker tape approach, so each message would slowly scroll from left to right across the page. The usability engineers on the team felt a constantly moving item on the homepage over which the user had no control was unacceptable and added further requirements. These requirements were that the user be able to stop the moving display and restart it at will and that an alternative display method be available. This method was a slide show method where each message appeared fully displayed then the next message appeared, etc., as opposed to the text scrolling across the display. We also requested that the total number of messages be displayed so the user would know when they had read them all. Other requirements from the MII team included a speed control button, a way of displaying all the messages in a separate window, a periodic refresh capability to poll for new messages, and an easy way to update the messages.

The software engineers on the team developed a Java-based announcements system with an alternative link to a text page for users who could not support Java. The new announcements interface is shown in figure 23. It contains start and stop controls, previous/next buttons, faster/slower speed controls, the option of scrolling messages or slide show messages, a button to access all the messages at one time on a page in a separate window, and a message counter. This design is not yet finalized and we are currently debating moving some of the controls to a secondary window as opposed to having them always be displayed.

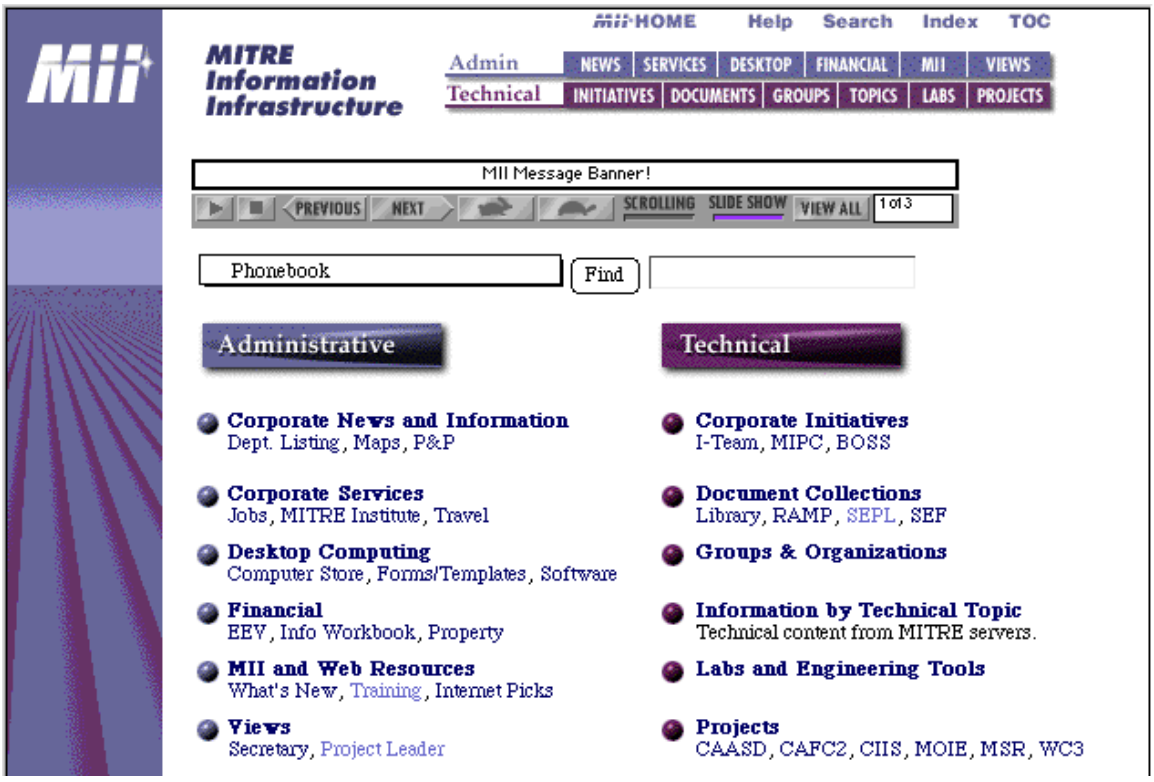


Figure 23. Live Announcement/Banner Area on Homepage

The new navigation pages were then built and it was time for another user test. This time we wanted to have users actually use the new navigation layer to locate target items. We wanted to test many of the new features of the second level navigation pages including the use of frames, the required scrolling to locate items on some of the pages, the add resources link, the search capabilities, and the new menu bar. The usability test and the results are described in the following section.

4.12 MII STYLE GUIDE

To record the design decisions being made and the new look for the navigation pages and content collection pages, a style guide effort was undertaken. Two style guides are needed -- one for the MII development team to record the style and page layout system for the MII navigation and system pages, and a user style guide for content developers to record how the MII elements should be used on the homepages of content subsites. More attention was given to the latter style guide. The goals of the user style guide were to "aid MII page developers in applying the tool kit elements to their collection pages to ensure a consistent look and feel for all users." This would provide MII users with a visual reference to identify the MII pages from external WWW pages and to know where they are in web space.

The only elements we recommended be used on content pages were a small MII logo in blue or burgundy for administrative and technical collections, respectively, an MII Home button, and an optional Top of Page button. The style guide described and explained these elements and provided instructions on how to include them on pages. We recommended against putting the MII phonebook, toolbar, or menubar on content pages. Putting too many of the MII elements on content pages could give the users the mistaken impression that these were MII system pages. Also many of the elements in the MII tool bar such as Help and Search, are commonly on content homepages and having two could confuse the user as to which one to use. As long as the MII Home button is available, users are just one click away from accessing these items. A content page with the MII technical logo and home button are shown in figure 24. There was quite a bit of discussion on whether we really needed both the logo and the home button. We were hesitant to make the logo also act as the home button because it is not a button on the MII navigation pages, and there is not an obvious indication that it is, in fact, a button. So we decided to include both even though it is somewhat repetitive having the MII twice in a row.

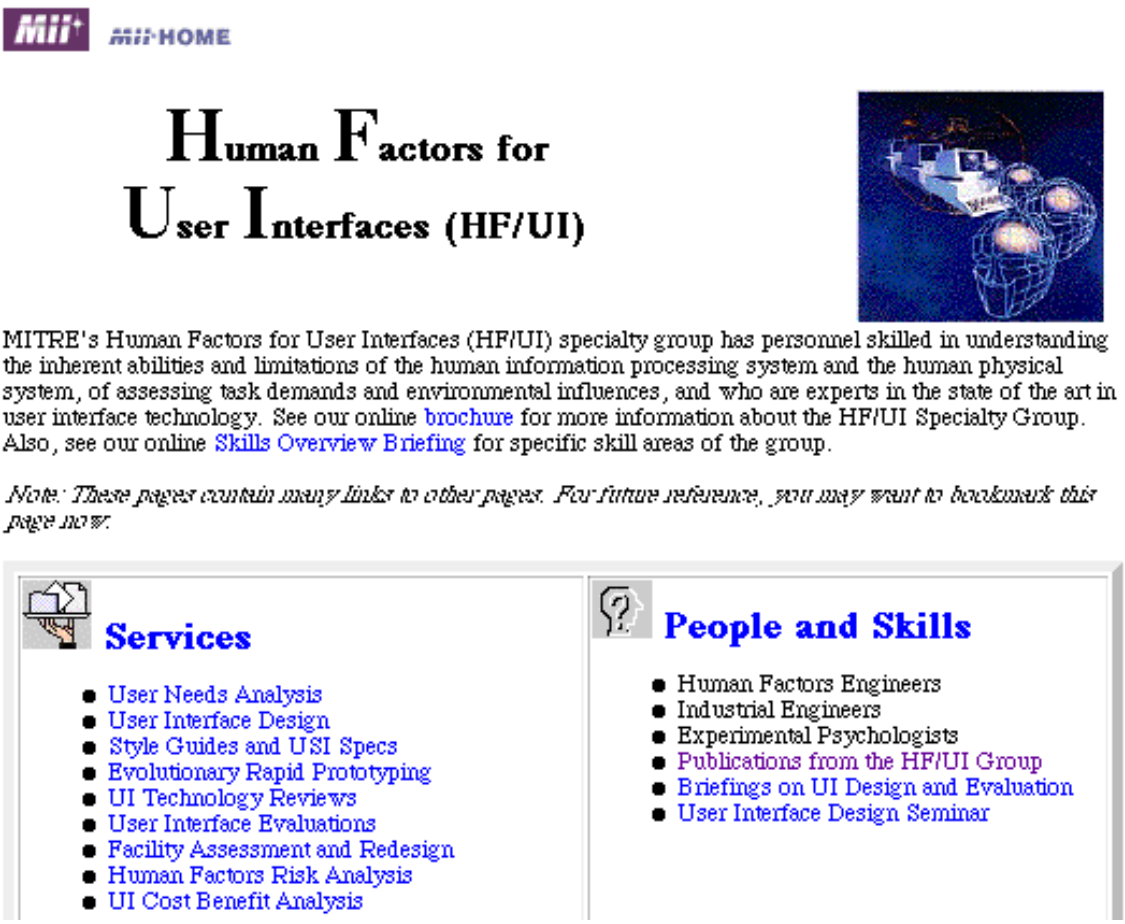


Figure 24. Technical Content Subsite with the MII Style Guide Elements

The following section summarizes the user testing performed throughout the redesign process.

SECTION 5

USABILITY TESTING FOR THE MII REDESIGN

When designing and developing or redesigning any major software or hardware product, it is always recommended that user testing or usability testing be inserted at various points in the process. Early user testing allows feedback on the "goodness" of the design before implementation. Later user testing allows the actual functionality and concepts of the system to be tried in a hands-on way to determine any design or implementation features that cause users difficulty in using a system. There is always a trade-off on when, what kind, and how many user tests to run throughout the design and development process.

In our redesign process, one natural test opportunity was after the new categories for the homepage were defined. Getting feedback at this point was beneficial because we did not want to design second level navigation pages that we would later determine were not needed or that had to be changed because the top-level categories had changed. We also felt feedback would help us finalize the category titles and the shortcuts and would feed the design process. A second test point was after the second level navigation pages were implemented. Finally, testing for the pages available under the View category are ongoing and a user feedback session to help us evaluate one of these page designs is described.

5.1 HOMEPAGE CATEGORY NAMES AND SHORTCUTS USER TEST

Twelve secretaries, 13 technical staff and 5 managers in Bedford and Washington participated in our user evaluation of the new MII Homepage. They were asked a few general questions on their expertise with, level of usage, and satisfaction with the current MII. Overall, they rated the MII as very useful. They were then shown a color picture of the new MII homepage (figure 16) and asked to tell the evaluator which category or categories they would select to locate 57 target items. The target item list was created to include items under new categories, items that had changed location, items we were trying to increase the visibility of, and items users previously had identified as hard to find.

Each user response was recorded. In some cases users thought the item would be located in two of the categories. In reality, some items were available from several categories. The results were scored and a table created showing the percentage of time each item was correctly "binned," that is, the correct category was chosen. Because no training was provided and users were seeing this new homepage for the first time, we selected a cut-off percentage of 75% correct as a reasonable performance score. Items that were correctly binned more than 75% of the time were considered usable and those that did not achieve that level of performance were closely examined to determine what user interface design change could be made to improve that items usability.

Below is a summary of the results for items in the Administrative and Technical categories. The items may have overlapping correct answers between the Administrative and Technical categories or within the two categories. For instance, only 17 of the items

were only available via the Technical side. Others were available from categories on each side. In general, Corporate News & Information was a "catch-all" response for the Administrative items and Information by Technical Topic was the equivalent Technical "catch-all" response.

5.1.1 Administrative Categories

Overall, across all users, people did not achieve at least a 75% correctness rate on 20/40 of the administrative items (50%).

Administrative Item	**% of time correctly binned**	**Incorrect categorizations**	**USI/ link change needed**
Annual Report	74%	16% - Financial	
Nurse's Schedule	70%	40% - Corp. News & Info	
Time Reporting Handbook	70%	21% - Financial	
Conference Room Information	63%	31% - Corp. News & Info	**X**
Space Planning	61%	36% - Corp. News & Info.	**X**
Benefits	56%	32% - Corp. News & Info.	**X**
Commerce Business Daily	53%	40% - Mix of Corp. News, **MII, and Resources**	
Retirement Program	50%	35% - Corp. News & Info.	**X**
Corporate Diner's Club Update	48%	36% - Financial	
CAFC2S Home Page	39%	55% - Projects	**X**
Instructions for dialing into MITRE's Modem Pool	36%	22% - **MII & Web Rsrcs**, 19% - Info by Tech Topic	**X**
Cafeteria Menus	34%	62% - Corporate Services	**X**
PRISM Update	33%	33% - Desktop Computing	**X**
MITRE Newsgroups	32%	32% - Grps. & Orgs.	**X**
Center for Integrated Intelligence Systems (CIIS) Home Page	30%	55% - Projects.	**X**
MITRE Public Server	25%	46% - **MII & Web Rsrcs**.	**X**
Corporate Research Computer Facility (CRCF) Server	24%	30% - Info by Tech Topic, 21% - Labs & Tools	
Toastmasters	10%	80% - Grps. & Orgs.	**X**
Clip Art and Photography Resource Collection	9%	34% - Document Collections 31% - Desktop Computing	**X**
MITRE Manual for Documentation	9%	31% - Corp. News & Info., 28% - Desktop Computing	**X?**

Overall, across all users, people achieved at least a 75% correctness rate on the following 20/40 administrative items (50%).

Administrative Item	% of time correctly binned
Employee Expense Voucher Form	100%
1996 MITRE Holidays	100 %
Corporate News	93%
Policy and Procedure (P&P)	93%
Security Procedures	93%
Memo Template	90%
PRISM Supported Software	90%
Travel Services Home Page	90%
Corporate Library System	87%
MII Online Training	87%
Help Desk	86%
Job Postings	84%
Minimum Hardware Configurations	83%
Secretary Home Page	81%
MITRE Institute	80%
MITRE Matters	80%
Computing and Networking Services	77%
Property Reuse	75%
Anti-Virus Software	75%
Department Listings	75%

Similar analysis was performed on the items in the the technical categories.

5.1.2 Technical Categories

The following items did not get binned correctly at least 75% of the time.

Technical Item	% of time correctly binned	Incorrect categorizations	USI/ link change needed
MITRE Reports	68%	18% - Info. by Tech. Topics	
Artificial Intelligence Technical Center	68%	19% - Projects	
D070 Home Page	58%	16% - Corp. News & Info. 16% - Projects	**X**
Software Center Home Page	56%	28% - Desktop Computing (mainly Admin staff, tech staff/mgrs. did much better)	
MSR/MOIE Technology Program at MITRE	55%	15% - Corporate Init. 15% - Tech. Topic (mainly Admin staff, tech staff/mgrs. did much better)	
Commerce Business Daily	53%	See admin above	
Year 2000 Homepage	45%	14% - Corp. News and Info. (mainly Admin staff, tech staff/mgrs. did much better)	
CAFC2S (Center for Air Force Command and Control Systems)	39%	See admin above	
Information about SuperCard	32%	35% - Info by Tech Topic	**X**
CIIS Home Page	30%	See admin above	
Information about Sybase	27%	50% - Info by Tech Topic	**X**
Corporate Research Computer Facility (CRCF) Server	24%	See admin above	

Users did achieve at least a 75% correctness rating on the following items.

Technical Item	% of time correctly binned
Microelectronics Lab	97%
Systems Engineering Process Library	97%
Specialty Groups	94%
CIIS Projects	91%
Corporate Library System	88%
I-Team	87%
Economic & Decision Analysis Center Lab	79%
Speech Processing Laboratory	79%
Risk Assessment and Management Program (RAMP)	75%

5.1.3 Analysis

Looking at items that performed the most poorly, we tried to identify what incorrect categories were chosen and why. For instance, Toastmasters was incorrectly classified 90% of the time. A large majority of users (24/30) thought it would be under Groups and Organizations on the technical side. Therefore, we recommended adding "Clubs" as a shortcut under Corporate News and Information. We do not recommend adding this link to the Groups and Organizations page because it will violate our conceptual model and would increase confusion in the long run. We do, however, recommend adding shortcuts to the Groups and Organizations major category link and to slightly change this category name to clarify what kind of content it contains (see below).

Some items did not perform well but it may be because users did not know what the item was. CRCF was an example of such an item. It was only classified correctly 24% of the time but we believe it is in logical categories and did not recommend a change. Some items performed well under technical staff and managers but not administrative users. The administrative users may not have understand what the items were. Examples include the Year 2000 Homepage and the MSR/MOIE program. Again, we do not recommend a change for these items. A summary of recommended changes for each category is presented below.

5.1.4 Recommended Homepage and Navigation Page Changes

5.1.4.1 Corporate News and Information

- Add a "Clubs" shortcut

5.1.4.2 Corporate Services

- Add a "Cafeteria" or "Food Services" link on this second level page (also keep on Corp News and Info.)
- Add the shortcut "Benefits". This will make it clear where the Benefit and Retirement information is.
- Users had trouble finding Conference Rooms and Space Planning, and were looking under Corp. News and Information. We probably can't fit anymore shortcuts (like

Facilities). We should change the category title to "Corporate Services and Facilities," since there is space.

5.1.4.3 Desktop Computing

- Add an "ISIS Update" link to Desktop Computing
- Add a "Clip Art and Photography Resources" link on the second level page. We do not recommend adding this to Document Collections, since this is a technical collection.

5.1.4.4 MII and Web Resources

- Add a link on the second level page to the MITRE Public Server
- Add a link on the second level page to Dialing into MITRE Modem's pool

5.1.4.5 Groups and Organizations

- This needs to be more descriptive. Many administrative items were thought to go here, such as MITRE Newsgroups. Recommend retitling to "Group & Organization Homepages" and add the following shortcut links "Depts., spec/cluster grps., centers..."

5.1.4.6 Labs and Engineering Tools

- Users did not know software tool knowledge was contained under this category. The term Engineering Tools needs to be more descriptive or explanatory text included. We recommend leaving the title the same but adding the following link text as a shortcut "Labs, Software/Hardware Eng. Tools".

These changes were incorporated into the homepage design to produce the final design shown in figure 17.

5.2 USABILITY TESTING OF THE NEW NAVIGATION LAYER

Once the homepage was finalized based on the above results and all the second level navigation pages were designed and implemented, a usability test was performed to test the new system. The final usability test was conducted to evaluate whether the changes made to the homepage as a result of the first usability test were effective and to assess the navigational and interactive aspects of the new MII navigation layers. The development version of the MII navigation layer was used in the testing. Since users would actually be interacting with the software in this test, we designed some task-based scenarios in addition to repeating some of the item retrieval tasks from the first test. Items that changed location as a result of the first test or did poorly were used.

5.2.1 Test Participants

Another MII team had been working to identify MII division points of contacts (POCs). These were people identified to liaison between the staff in their technical divisions and the MII team. Seven division POCs participated in our usability test. They included four administrative users, two technical users, and one manager. Each session lasted approximately 30 minutes.

5.2.2 Procedure

All test sessions took place in the Usability Lab in the basement of M-building. Each test session was videotaped for future observations with the screen display being directly recorded to the videotape via a scan converter. Members of the MII team were invited to attend the test sessions and sit behind the one-way glass. Test participants were told the purpose of the usability test and were informed that the session would be videotaped. They were encouraged to speak aloud during the test session. During each session, the usability engineer sat with the test participants in the evaluation room. The tasks were read one at a time and the participants responded when they were done with the current task. Additionally, the participants were prompted for feedback.

Test participants were shown the homepage for the new MII on the computer screen. They were asked to perform the tasks listed below and then were asked to find some of the 38 items listed below by going to the link for the item (not necessarily to the page containing the item). Note that not all participants were asked to find all items due to time limitations. The order of the tasks varied for each participant.

5.2.3 Tasks

1. What information exists at MITRE on Military Intelligence?
2. View the labs owned by W150. How many are there?
3. What software tools does D086 have knowledge/expertise in? How many are there?
4. Go to the page where you would enter your knowledge of the software tool SuperCard, so others at MITRE would know you know about this tool.
5. Look for information on the MicroElectronics lab
6. Find the home page for the Fort Monmouth site
7. How would you add your web page on Artificial Intelligence to the Information by Technical Topic collection?
8. Find a list of electronic journals which MITRE subscribes to.
9. Search for a document published on the MII about user system interfaces (just set it up)
10. Find the TOC entry for the Retirement Program
11. MITRE Java Day

5.2.3.1 Target Item List

Administrative Items	Technical Items
Annual Report	MITRE Reports
Nurses Schedule	Artificial Intelligence Tech. Center
Time Reporting Handbook	D070 Home Page
Conference Room Information	Software Center Home Page
Space Planning	Commerce Business Daily
Benefits	Year 2000 Homepage
CAFC2S Home Page	CAFC2S (Center for Air Force Command and Control Systems)
Instructions for dialing into MITRE's Modem Pool	Information about Sybase (database tool)
Cafeteria Menus	MII FAQ
ISIS Update	MIPC
MITRE Newsgroups(Broadcast News)	Corporate Research Computer Facility (CRCF) Server
MITRE Public Server	
Toastmasters	
Clip Art & Photo Resource Collection	

5.2.4 Usability Test Results

We again identified items that performed poorly, defined as binned correctly less than 50% of the time on the first try. These items included:

1. What software tools does D086 have knowledge/expertise in? How many are there?
2. Find the home page for the Fort Monmouth site
3. How would you add your web page on Artificial Intelligence to the Information by Technical Topic collection?
4. MITRE Java Day
5. Instructions for dialing into MITRE's Modem Pool
6. MITRE Public Server
7. Toastmasters
8. Clip Art and Photo Resource Collection
9. D070 Home Page
10. Year 2000 Homepage

We also recorded areas where participants had trouble using each second level navigation page.

5.2.4.1 Comments or places that participants had trouble using the Labs & Tools page

- Test participants tried to search by topic not organization.
- When performing a search, change to "Your search on 'xxx' matched 'x' Labs/Tools" instead of "Your search on 'xxx' matched 'x' Documents."
- Test participants commented that they wanted general tools (i.e., web maintenance tools) included in the Labs and Tools list.

- The help link is too long and confusing.
- The search engine does not find partial words. One test participant typed "micro" and did not find the microelectronics topic.
- Some test participants did not see the Labs and Tools button and did not know they needed to switch to perform a tools search. They would perform the search and wonder why the results did not match what they were looking for.
- Expects to see labs listed by topics not by owning departments.
- Two test participants commented that they were unsure what "tools" contained.

5.2.4.2 Other usability concerns

- During the usability test sessions it became apparent that users need more help/instructions on using the pull-down menus for performing "Finds."
- Few test participants used the menubar and the majority of the time, the participants returned to the MII Home page between each tasks.
- Test participants seemed confused that sub-links sometimes brought them to the topic on the MII navigation page and other times took them directly to the content page.
- Two test participants commented that they missed the Desktop Computing category when looking for which category to select (they eventually found it after selecting one or more wrong categories).
- Test participants interchanged document collections and the library links. When they wanted information on the Documents Collection navigation page, participants went to the Home Page for the Library.
- Test participants did not know where to look for site home pages.
- Test participants commented that they wanted to search on a Technical topic and constrain the search by organization.
- One test participant commented that they wanted an easy way to search corporate-sanctioned information.

The results which directly affected the new MII navigation layer redesign were provided in draft form to the MII team immediately after testing and some changes were made as a result. Some of the problems were related to user job position (they just were not familiar with the meaning of the item they were searching for) and some were general MII concerns, outside the scope of the redesign effort.

5.3 SECRETARY FOCUS GROUPS

Data collection for the evaluation of the Secretary View page included distributing a questionnaire and holding three focus group sessions for secretaries in three MITRE divisions. Questionnaires were given to all secretaries in these divisions; however, only secretaries in Bedford were invited to the focus group sessions. Eighteen secretaries participated in the focus group sessions. A total of 24 questionnaires were returned.

The focus groups were performed to achieve the following:

- Discuss the most frequently used functions/pages
- Gather opinions about the MII
- Gather opinions about Secretarial Resources Page

- Identify recommendations for improvement
- Collect success stories

All focus groups were moderated by a single usability engineer. Each focus group took approximately one hour. Sessions were held in the Usability Lab in the basement of M-building and were video taped for analysis purposes. At the beginning of each session, participants were asked to fill out a questionnaire. The questionnaire contained general questions on the secretaries background, and their use and knowledge of the MII.

The information that secretaries reported using includes: phonebook information, templates, travel, travel per diems, Policies & Procedures, department listings, accessing published documents, data retrieval, computer store, software price list, technical documents, personal interests, information needed for school (Northeastern), information about MITRE, Washington information, Search, Index, retirement, project numbers, new software, Secretarial Resources page, medical information, purchasing, security, library research, site information, and PRISM information.

Twenty-one out of 22 secretaries reported creating bookmarks and 13 reported saving bookmarks for locations within the MII. Some job-related pages both within the MII and outside MITRE that secretaries reported bookmarking include:

Sites Inside MITRE	**Sites Outside MITRE**
Telephone directory	Flight information
Templates	Airline Home Pages
MII Resources for Secretaries	Yahoo
Administrative Information	DoD sites
Travel home page	Fed Ex
Per diems	Weather
Bedford Software Center	Internet search
Division home pages	

When asked what they like least about the MII secretaries reported:

- Having to go through too many layers of information
- Reading about a site and navigating to it only to find out that it is under construction.
- There is so much information I often forget what I am looking for
- Difficulty downloading forms (move, purchasing), applications (Virex)
- Not aware of everything available
- Taking a long time to load pages
- Poor naming conventions when using transfer and publishing
- Confused about publishing and transferring documents (only used by four (17%) of the secretaries)

The level of expertise of secretaries with using the MII varied greatly and it became obvious that many were not aware of much of the functionality the MII provided. For example, many secretaries did not know about the index and many did not know about the publishing and search capabilities.

Eight out of 11 secretaries responded that it is easier to access information from the Secretarial Resources page than from the MII Home Page. The remaining three secretaries responded that accessing information is about the same from both pages. Some comments that the secretaries made regarding the Secretarial Resources page include:

- It is easy to read and find what I am looking for.
- All secretarial-related sites are at my fingertips.
- Easier to find things that secretaries would do.
- Everything I need is available in one area.
- Forms and Templates are much easier to find.

5.3.1 Recommendations for Secretary View Page

Overall, the secretaries reacted positively toward both the MII and the Secretarial Resources Page. Some of the suggestions made were out of the scope of this study but are included for future redesign efforts. Based on the feedback obtained, the following changes were recommended to the Secretarial Resources Page and dissemination of information for the secretaries:

- Add the phonebook search to the top of the page.
- Include the toolbar.
- Provide a direct link to this page from the MII Home Page.
- Add a link to property.
- Add a link to HR information.
- Heavily advertise new features and hold training classes tailored for secretaries.
- Identify MII point-of-contacts in each division for fielding questions and spreading MII information.

Although the secretaries rated the MII and Secretarial Resources page as beneficial, it became apparent during the focus group sessions that they were unaware of a lot of functionality within the MII and Netscape and are, therefore, not using the MII to its full potential. It is important to advertise existing functionality and new features and information as they become available. It was also of interest that there was some ambiguity in terms of the secretary's role in online publishing. Some had the opinion that they did not need to know about it because staff can publish their own documents. But others noted that they were asked by managers to retrieve documents from transfer folders and had to find out how to do it quickly.

SECTION 6

CONCLUSIONS AND LESSONS LEARNED

Below are some reflections on the process we used for redesigning our intranet.

6.1 TEAM COMPOSITION

While the team we had appeared to be large, the skills that were represented were each critical at some stage of the design process and there was not a skill that turned out to be of no value. We feel that the end product would not have been as good with just a subset of the team. Therefore, we recommend that on any major intranet development or redesign project, a multi-disciplinary team similar in composition to the one we used be utilized.

6.2 DESIGN PROCESS

The design process we used was satisfactory although somewhat unstructured. While this encouraged much free-flowing thinking and a lot of ideas, there may have also been a little bit of inefficiency in the process. For instance, the first graphical designs were done very early in the process before all the information groupings were identified and the navigation structures finalized. This meant that when these concepts were iterated, new graphics had to be generated. On the other hand, early involvement of the graphical designer meant he could contribute his insights and ideas early on and he had a good understanding of what the team was trying to accomplish each step of the way.

One thing this team did which the usability/human factors engineers were gratified about is we did not roll out new technology just for the sake of it. All too often in designing new systems, new technology is utilized just because it exists or to show we as a corporation have knowledge of it. While we do have knowledge of most of the new web and Java technologies, we did not come across a single instance of it being used without careful consideration of how it would impact the users. For instance, providing users with the ability to customize their homepage was briefly explored. While this was a “neat” feature, it was not rolled out at this time because it was felt that the usability of it, and the need for it were not adequately explored, and it was saved as a potential future enhancement.

Similarly, the new live announcement/banner concept had the potential to become a major user annoyance. The first cuts at exploring this concept included a javascript version in which the text scrolled jerkily across the display area and was difficult to read. This was thankfully excluded from further consideration. Going with a Java implementation provided much better text scrolling and the slide show option as well. The usability engineers concern about users being able to turn off and control anything on their display was listened to and the requirements for the off button and display options were added. What could have been a major user annoyance (jerky moving text that they could not control) instead became an easy to read banner display fully under the control of each user.

6.3 THOUGHTS ON THE ROLL-OUT PROCESS

The process somewhat broke down at the end in that planning for roll-out did not occur early enough. Roll-out implementation began about two days before product rollout. Therefore, users were not provided with advanced publicity that this major change would be occurring. From a human factors point of view, to have 5,000 users walk in one morning and have a new intranet appear on their computers without warning was not an acceptable roll-out strategy. Users need time to familiarize themselves with new concepts and to explore new applications. Once we realized that the roll-out process had gotten away from us, the team quickly hustled some publicity material which was e-mailed to the entire corporation the day before the roll-out. This at least provided them with a warning of what was to come . Part of the publicity material was two graphical images. The first showed the current MII and how the categories and shortcuts on the home page mapped to the new MII homepage. The second was a graphic of the new MII homepage which showed how the categories from the current MII mapped to the new MII homepage categories. The materials also pointed out the new menu bar and TOC, and explained the new categories that had been added (e.g., Technical Information by Topic). It was hoped that a user searching for a particular item could use these materials to aid them.

Finally, it was decided at the last minute to put a link on the new MII homepage to the old MII so users could continue to access the old version for some period of time. This was a major factor, we believe, in minimizing any damage that could have occurred from the short roll-out notice. If users did not have time to familiarize themselves with the new MII immediately, in one click they were able to access the old MII and do their time-critical tasks.

Overall, the roll-out was pretty positive. Mostly positive feedback was generated and the lack of any response from most users was taken as a good sign. Some of the issues mentioned by users did address some of the issues we were concerned about when making design decisions. For instance, e-mail was received that stated the traversed link color was difficult to read and there was an unexpected comment that the untraversed link color (the dark blue) was difficult to distinguish from the black static text. We, also, as we had feared, received e-mail that the new homepage took too long to load, particularly for dial-in users. We are currently readdressing the speed issue and looking at how to better optimize the usability of the MII for this type of user. One user commented that it was now much easier to find things, that everything seems to be right there. We believe that although this user could not articulate what the improvement was, he was noticing the effects of the flatter two-layer design.

If we had to do it all again, we would certainly start the roll-out procedure at least 2 to 3 weeks before rollout.

6.4 POSTING PROCESS

A corporate issue that needs to be resolved is how to decide what gets posted on the MII, what constitutes a message important enough to be broadcast to the entire corporation, and who decides what is important enough that it needs to be a link on the homepage.

Many people feel that for one reason or another (security, compliance with guidelines, etc.,) that their link has to go on the homepage or their message needs to be green and blink and be posted every day. This can quickly ruin a well-designed homepage and a corporate process needs to be in place so sensible decisions can be made which do not negatively influence the usability of the rest of the intranet.

6.5 GROWING PAINS

One of the difficulties with intranets is they continue to grow over time, sometimes rapidly and they need to be constantly evaluated for usability. There is no doubt in our minds that not too far in the future, some of the second level navigation pages will become too dense and need to be broken out. This will require either more top-level categories or increasing the depth of the navigation to three levels in some places; neither of these is an attractive option. The other possibility will be to find items that are obsolete and try to remove items at the same rate they are added. This may or may not be possible. Already new links have been added to the second level navigation page that have not been grouped in with the existing groups, increasing the number of top level categories on the second level pages beyond the theoretically recommended optimums. Each of these new links will need to be evaluated to determine whether they could sensibly fit under one of the existing category groupings or whether a new category grouping which could encompass several of these could be added.

6.6 EXPLORING OTHER NAVIGATION AIDS

Trying to improve the user's ability to quickly locate information in a large web site will be a continuing goal. In this effort, we explored and implemented the TOC and job-customized views but we did not look at all possible navigation aids as part of this effort. As a follow-on to this redesign, we need to spend more time fully exploring navigation aids. We need to look in greater depth at how the navigation ideas we do have could be improved (e.g., should our index be indented by topic like the standard book index to improve its usability) and examine the more advanced navigation aids, such as user-tailorable home and navigation pages that we only started to explore here. User navigation aids can range from user-controlled options where users choose from a discrete set of options the pages and categories on pages they want to be visible to system-tailored pages based on user profiles or user use information. As the web site continues to grow, these "optional" navigation methods and system tailoring methods may become necessities.

6.7 MONITORING USAGE

The MII team currently collects a lot of data on usage. We had ample data on page-use statistics for web pages residing on the MII server. We do not feel, however, that we had adequate time to explore how this data could or should be used. It is intuitively obvious that frequency of page use should be a factor in the design process, but we did not come up with a way to use this data in this design. We, of course, took into account some of the high use pages when deciding what should be a shortcut, but we think there are other and more innovative ways this data could be used as well. One way, for tailoring web sites

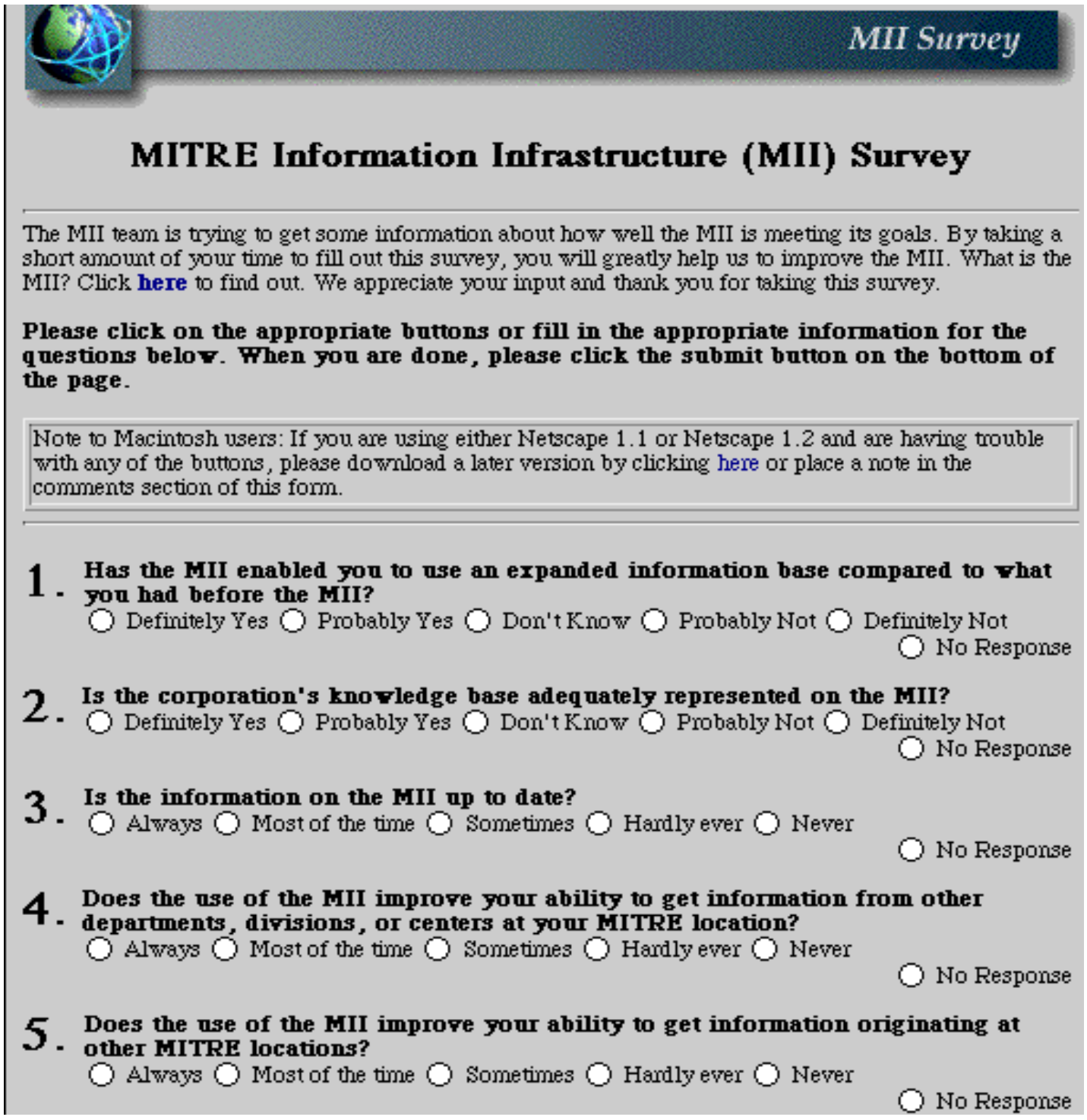
or navigation pages, was mentioned above in exploring other navigation aids. We would like to revisit this area at a future date and put this information to use effectively.

6.8 USER INVOLVEMENT/EVALUATION

We feel we conducted the right number of evaluations for the time frame of this effort. One lesson we learned from the evaluation was that the MII and probably most sophisticated intranets are not yet "walk up and use." Some percentage of the MITRE population is still in the novice web user category and even for web savvy users it is not easy to figure out how to use some of the MII advanced functionality, such as profiles and publishing. MITRE needs to continue offering a variety of training courses for all user sectors and continue a dialog with users via mechanisms, such as usability tests, focus groups, and on-line surveys.

Our final lesson learned is that when it comes to intranets, you are never finished!

APPENDIX A - SURVEY



MII Survey

MITRE Information Infrastructure (MII) Survey

The MII team is trying to get some information about how well the MII is meeting its goals. By taking a short amount of your time to fill out this survey, you will greatly help us to improve the MII. What is the MII? Click **here** to find out. We appreciate your input and thank you for taking this survey.

Please click on the appropriate buttons or fill in the appropriate information for the questions below. When you are done, please click the submit button on the bottom of the page.

Note to Macintosh users: If you are using either Netscape 1.1 or Netscape 1.2 and are having trouble with any of the buttons, please download a later version by clicking here or place a note in the comments section of this form.

1. **Has the MII enabled you to use an expanded information base compared to what you had before the MII?**
   ◯ Definitely Yes ◯ Probably Yes ◯ Don't Know ◯ Probably Not ◯ Definitely Not
   ◯ No Response

2. **Is the corporation's knowledge base adequately represented on the MII?**
   ◯ Definitely Yes ◯ Probably Yes ◯ Don't Know ◯ Probably Not ◯ Definitely Not
   ◯ No Response

3. **Is the information on the MII up to date?**
   ◯ Always ◯ Most of the time ◯ Sometimes ◯ Hardly ever ◯ Never
   ◯ No Response

4. **Does the use of the MII improve your ability to get information from other departments, divisions, or centers at your MITRE location?**
   ◯ Always ◯ Most of the time ◯ Sometimes ◯ Hardly ever ◯ Never
   ◯ No Response

5. **Does the use of the MII improve your ability to get information originating at other MITRE locations?**
   ◯ Always ◯ Most of the time ◯ Sometimes ◯ Hardly ever ◯ Never
   ◯ No Response

6. **Are the feedback messages you receive when you use the MII (e.g. "Server not found") informative?**
○ Always ○ Most of the time ○ Sometimes ○ Hardly ever ○ Never
○ No Respons

7. **Do you use the MII search tool located at the bottom of the MII pages (not to be confused with the phonebook)?**
○ Yes ○ No
○ No Respons

If yes, can you find information using the search tool based on the criteria you specify?
○ Always ○ Most of the time ○ Sometimes ○ Hardly ever ○ Never
○ No Respons

8. **Can you return reliably to information you've found on the MII at an earlier time**
○ Always ○ Most of the time ○ Sometimes ○ Hardly ever ○ Never
○ No Respons

9. **Do you use bookmarks?**
○ Always ○ Most of the time ○ Sometimes ○ Hardly ever ○ Never
○ No Respons

10. **Has the quality of your MITRE products improved due to the use of the MII?**
○ Definitely Yes ○ Probably Yes ○ Don't Know ○ Probably Not ○ Definitely Not
○ No Respons

11. **Does the MII provide information you need to do your job?**
○ Always ○ Most of the time ○ Sometimes ○ Hardly ever ○ Never
○ No Respons

12. **Overall, has the MII improved your ability to communicate with others in the organization?**
○ Definitely Yes ○ Probably Yes ○ Don't Know ○ Probably Not ○ Definitely Not
○ No Respons

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