IS E.N.O.F. ENOUGH?
DESIGN AND EVALUATION OF
AN ELECTRONIC NEWSPAPER OF THE FUTURE

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Abstract: A working prototype Electronic Newspaper Of the Future (ENOF) was designed and implemented. The ENOF system allows subscribers to define custom newspapers containing personalized sections. ENOF uses a coarse filtering technique to select articles for inclusion in each subscriber's newspaper. The system was designed to filter news precisely enough that subscribers find the service useful, but not so precisely that subscribers miss important stories or are not able to browse. Subscriber preferences were assessed through qualitative user evaluations. An analysis of user diaries, logs, and interviews revealed that ENOF's coarse filter is appropriate for most members of the target audience. Additional conclusions about user preferences may serve as a guide for future research.

1 INTRODUCTION

Electronic newspaper development once focussed on delivering the contents of a printed newspaper electronically. Now, electronic newspaper researchers seek to develop news products with capabilities and features beyond those available from printed newspapers. These new electronic newspapers allow subscribers to perform keyword searches, specify criteria by which news stories are automatically selected for reading, and view photographs and video clips. Further technological advances may allow the development of an electronic newspaper far superior to printed newspapers in the near future.

This paper describes research to determine the preferences of potential electronic newspaper users through the design and evaluation of a working prototype Electronic Newspaper Of the Future (ENOF). This knowledge of user preferences is intended to serve as a guide for future research.

This research was conducted in three phases: literature review and user survey, ENOF development, and ENOF evaluation. The literature review led to the formulation of three main assumptions:

- Interests are dynamic, difficult to specify, and best judged by each individual.
- People can quickly filter information to eliminate that which they find least interesting.
- The traditional printed newspaper format is not the ideal format for an electronic newspaper.

2 BACKGROUND

2.1 READING HABITS

Most people spend about 24 minutes each day reading a newspaper [15]. People usually read newspapers to obtain information; however, their motivation for obtaining information varies. People seek information for both tangible and intangible reasons [5]. Some seek information to help make decisions, to have something to discuss in social settings, or for the sheer pleasure of increasing their knowledge [2].

The gathering of information can be thought of as a combination of three methods: grazing, browsing, and hunting [24]. Grazing is a passive activity, in which a person absorbs information with little discrimination. In browsing, readers scan large amounts of information without a particular purpose. In hunting, people search for specific information.

Television and novels lend themselves well to grazing, while newspapers lend themselves to browsing. Hunting is most easily achieved using information sources with keyword indexes or search facilities. Unlike books, newspapers are seldom read in order from cover to cover. People tend to browse when reading newspapers, reading articles that catch their eyes and sometimes ignoring whole sections that they know from experience are usually not interesting. Sometimes, however, people hunt through newspapers for specific information [8, 24].

In a study conducted by Graber [8] participants ignored on average 67 percent of all stories in a daily newspaper. Of the stories that were noticed, 18 percent were read completely. Graber attributes this partial reading to the inverted pyramid style of news stories, in which the most important information is presented in the first few paragraphs. "Readers know they can glean the essence of a story without going to the trouble of reading all of it," Graber explains. Graber also notes that participants were more likely to notice stories that were cued by large headlines, a prominent position, or frequent mention; contained keywords of interest to them; or were on topics that "had become the focus of attention for conversation among friends or associates."

2.2 ELECTRONIC NEWSPAPERS

The first paperless electronic newspapers were developed in the late seventies. Early commercial electronic newspapers, including Times Mirror's Gateway and Knight-Ridder's Viewtron, were marketed towards home consumers [24]. These electronic newspapers, which simply scrolled selected news stories across subscribers' computer monitors or television screens, introduced a new method for text delivery but did not expand on printed newspapers' functions. They were not commercially successful.

The participants in a 1988 American Press Institute seminar imagined electronic newspapers published in parallel with printed newspapers [15]. Some envisioned newspapers delivered to home fax machines, while others imagined news outlets for plugging in portable newspaper computers. Most predicted electronic newspaper formats with the look of printed newspapers. As with the early electronic newspapers, these hypothetical newspapers focussed on changing the delivery method rather than changing the contents or function of the daily newspaper.

Currently, there are several commercial and experimental electronic newspapers in existence. Most of these electronic newspapers are available to computer users over phone lines or through computer networks and consist mostly of news stories gathered from other media. Some allow users to preselect the type of news they want delivered. Compuserve, Prodigy, ClariNet, and Individual, are among the companies currently selling electronic newspaper products.

Three advantages of electronic newspapers over printed newspapers are: they can be delivered continuously as news is reported, they can be customized, and they can incorporate a wide variety of media formats. These advantages are discussed below.

2.2.1 CONTINUOUS DELIVERY

Printed newspapers are economical only if mass produced; it is not financially feasible to print "extra" editions with late-breaking news. By eliminating the necessity of physically reproducing a printed document, electronic newspapers, like broadcast media, are able to provide news as it is reported. However, unlike media which must deliver news according to a schedule, electronic newspapers can deliver specific news stories whenever consumers request them.

2.2.2 CUSTOMIZATION

Perhaps the most unique aspect of electronic newspapers is their ability to be customized. Because they need not be mass produced, electronic newspapers can be personalized. Researchers are exploring a variety of information filtering methods that can be used to automatically generate personalized newspapers and journals that contain only news of interest to each subscriber [7]. Commercial electronic newspapers currently use imperfect filtering methods. These methods involve searching for keywords, keyphrases, or combinations of weighted keywords [23]; and searching for articles similar to those the user has requested in the past [6].

John [11] of Southwestern Bell Technology Resources is developing an electronic newspaper using adaptive neural networks. Articles are grouped by category based on the scripts (groups of adjacent words) they contain. Categories are selected for inclusion in a newspaper according to user preferences. The program learns individuals' preferences through a simple supervised learning procedure. Through informal user tests, John has observed that people's reading habits are inconsistent. However, he has found that the filter becomes stable in the long run. In addition, a test which compared the neural nets' filtering with human editors' filtering, demonstrated that the neural nets had about 80 percent accuracy.

2.2.3 FORMAT

One of the biggest problems with most commercial electronic newspapers is their user interfaces. Most require readers to access news in a manner that is complex, inconvenient, or unfamiliar. As a result, reading news online can often be too difficult or frustrating to be enjoyable.

Most electronic newspapers are accessed through a series of menus. However, research shows that menu-driven systems tend not to facilitate browsing [24]. Browsing is difficult when small quantities of text are displayed at a time and when the text displayed is a uniform size and typeface. An experiment conducted by Richardson et al. [14] found that readers clearly preferred large displays over small displays when searching for information in a text, although the display size did not affect their success in finding particular information.

Some hypertext information retrieval systems attempt to facilitate browsing by providing a well-defined and consistent hierarchical structure and short machine response time [14]. Experiments have shown this to be somewhat effective. Current technology limits the use of rapid hypertext systems over computer networks and "paying on-line time charges...lessens the likelihood of browsing through information which may seem superfluous to one's life" [24].

Some experimental electronic newspapers are designed to look like traditional newspapers. A European consortium is developing an Individualized Electronic Newspaper (IEN) [10], which is graphically composed for each subscriber based on his or her profile. The IEN is delivered in two forms, a hypermedia form and a printable form, both of which are laid out like a traditional printed newspaper. It includes articles, images, video, advertisements, and access to background material. The IEN is based on a publishing model that "combine[s] structured document manipulation tools and knowledge-based systems" [22]. It is designed to be delivered over a broadband network to users with personal computers running hypertext systems. However, the composition and delivery speed for IEN are unknown because the system has yet to be completely implemented [21].

A format similar to a traditional printed newspaper was chosen for IEN because it is familiar to users [21]. IEN researcher Weber explained, "We think the layout chosen can serve to remedy disorientation and lost in hyperspace problems of hypertext systems. Others have also proposed to learn from paper documents in order to improve the presentation and navigation in hyperdocuments."

The MIT Media Laboratory's Newspace project displays both traditional and non-traditional news sources using a traditional-looking broadsheet-sized front page metaphor [3, 13]. The Media Lab's Electronic Publishing Group chose this format because of its familiarity and standardization. In addition, citing the 1988 American Press Institute seminar, they note, "Without exception, industry predictions of the future of the newspaper include a front page." However, it is uncertain whether all seminar participants would have predicted a front page if they had not been specifically asked to bring a front page prediction to the seminar.

Newspace is among the experimental electronic newspapers that combine elements of traditional newspapers with short video clips typical of television news. The creators of these electronic newspapers think of an electronic newspaper as a medium for conveying news in the manner best suited for each story. However, the bandwidth of digital communications channels restricts the widespread use of video in electronic newspapers. As changes in network technology and the telecommunications infrastructure occur, the technological restrictions on electronic newspaper formats will disappear [9].

Another experimental electronic newspaper was developed by Apple Computer for the EDUCOM 1990 conference in Atlanta, Georgia [9]. The system combined news wire text, postscript graphics, and Cable News Network video footage in a Macintosh hypertext system. Each day's news was compiled at a production studio, assembled over night, and delivered between 5 and 7 a.m. via a T-1 line to a local area network (LAN) at the main conference hotel. About 35 Megabytes of news was compiled each day. It took about 10 minutes to deliver the news to each group of Macintosh computers on the LAN. Following the conference, the system's designers concluded, "Hypertext features were useful for giving more information than what appears on the surface; however, the ability to add a large number of hypertext links and cross-references on a tight production schedule should be perfected" [9].

3 ENOF DESIGN

The ENOF design is based, in part, on three assumptions formulated after a literature review. The preferences of a target audience and other considerations were also taken into account during the design process. This section describes the three assumptions, details the habits and preferences of the target audience, and explains the rationale behind the design decisions that were made in the course of the project.

3.1 ASSUMPTIONS

The following assumptions provide a partial basis for the ENOF design decisions. Furthermore, they allow many of the problems currently under investigation by other researchers to be ignored. These include issues such as developing the capabilities to conduct extremely precise searches, learning subscribers' changing interests, and automatically designing newspaper-like pages.

Assumption: Interests are dynamic, difficult to specify, and best judged by each individual. Each person is the best judge of whether something is personally interesting. Most people cannot precisely specify their interests in a way that makes sense to others. Even if they can precisely specify their interests, such a specification is likely to require frequent updating to remain accurate.

This assumption is particularly applicable to the assessment of general news interests. While interests in technical literature or business news are often static and easily specifiable, general news interests tend to vary greatly and depend on a variety of interacting and changing factors [1, 7]. Furthermore, people may want to browse through articles that do not perfectly match their interests.

This assumption indicates that a precise filtering technique may not be achievable or desirable for news selection. Therefore, the ENOF design includes only a coarse filter that uses a user-defined profile consisting of news category (specified by the news provider) and keywords. More precise filtering becomes the job of the user.

Assumption: People can quickly filter information to eliminate that which they find least interesting. People do not have time to read everything that they find interesting. Therefore they routinely prioritize reading material and select a subset of the information presented [4]. Most people quickly filter information by looking at titles, authors, formats, and other cues [8].

This assumption indicates that the user will be able do precise filtering. ENOF is designed to assist the user with this task by presenting users with headline menus for each section of their newspapers. The headline menus are designed to allow users to quickly select articles for reading.

Assumption: The traditional printed newspaper format is not the ideal format for an electronic newspaper. The printed newspaper has been designed based on a variety of factors, many of which are not related to making it easy to read. Printing technology, advertising, and tradition have dictated many elements of newspaper design. Furthermore, traditional newspapers have been designed to fit on a broadsheet or tabloid page, not a computer screen.

This assumption indicates that it may be better to design an electronic newspaper that takes advantage of the unique aspects of the electronic format rather that trying to copy the traditional print format. Therefore, ENOF is designed for readability and ease of use on a computer screen. While the newspaper metaphor is used for naming parts of the ENOF system, ENOF has not been designed to look like a printed newspaper.

3.2 HABITS AND PREFERENCES OF TARGET AUDIENCE

In order to narrow the scope of this project, a target audience for ENOF was selected. The target audience is composed of people who work full time in a university or research setting and have some familiarity with software applications that run in an X Window System environment. Members of the target audience are assumed to have sufficient computer skills to learn how to use an application program with a well-designed user interface quickly. In addition, they are assumed to be busy people who do not have time to experiment with software that does not appear to meet their needs.

This target audience was selected for several reasons. First, it was easy to find volunteers from this group who have access to the necessary computer equipment to run the ENOF software. Second, members of this group have enough computer knowledge that they should be able to learn to use an applications program with little training. Third, members of this group tend to have busy, but fairly regular schedules, and thus have somewhat consistent news media habits and limited time for media exposure.

A survey was conducted to determine the media habits and preferences of the target audience and to identify participants for the evaluation phase of this study. Surveys were delivered to 30 full time Washington University faculty and and staff members who have computers on their desk at work. Responses were received from three females and 15 males.

Survey participants were asked to list their favorite news sources and explain what they liked about each source. The most popular news source was the newspaper, with 15 out of 18 respondents listing it among their two favorite news sources. Radio and news magazines were favored by seven and five respondents respectively. No respondents said they preferred television or electronic news services. Reasons for preferring newspapers and news magazines included browsability, depth and breadth of news, portability, ability to be read any time, and lack of commercials. Those who said they preferred radio explained that they liked to listen to it while doing other things such as driving, and that it did not take up as much of their time as a newspaper. In addition, all respondents listed newspaper, news magazine, or radio as the most convenient form of news media for them.

The primary reason most respondents cited for using news media was to stay informed about events in the world, either to "feel up to date" or to satisfy their curiosity. Other popular reasons included gaining information needed to make decisions and entertainment. Most respondents cited more than one primary reason for using news media.

The majority of those who responded said they use two or more forms of news media every day. While five respondents reported rarely or never watching television and three reported rarely or never listening to the radio, all said they read a newspaper at least once a week. However 15 out of 18 respondents said they read less than half the text of each newspaper. About half the respondents said they usually do their daily newspaper reading in one sitting. Most of the respondent who said they listen to radio news reported listening mostly while driving to and from work. About half the respondents said they currently read on-line work-related news, and several others said they used to read news online.

The survey asked several general questions about how participants might use personalized electronic newspapers. Some questions were left purposely vague so as not to bias the answers and to generate a wide variety of responses. Most respondents said they would be likely to use a personalized electronic newspaper if it were available to them. However, they said it would probably not be a substitute for other news media. Respondents said they would be much more likely to use an electronic newspaper at home than at work. Furthermore, several said they would be more likely to use an electronic newspaper it it was portable and could read the news aloud. One respondent said he would like his electronic newspaper to be water proof so he could read it in the bathtub.

3.3 DESIGN OBJECTIVES

Information gained by examining the main assumptions and user preferences was synthesized to generate nine design objectives. These objectives were kept in mind throughout the development and evaluation phases of this project. ENOF has been designed to:

- allow subscribers to access news of professional interest in addition to general news.
- allow subscribers to browse comfortably.
- allow subscribers to search the archive for articles on a particular topic.
- allow subscribers to select the quantity of news to read.
- be easy to use.

- filter news precisely enough that subscribers find the service useful, but not so precisely that subscribers miss important stories or are not able to browse.
- present headlines and articles in a format that allows users to quickly select articles for reading.
- present headlines and articles in a format that is easy to read on most available X Window Systems displays.

4 IMPLEMENTATION

The ENOF system was written in C++ and designed to run in a Unix [1] environment. This project was implemented on a Sun SPARCsystem 400. ENOF was built on standard USENET software and includes an indexed archive, a filter, and an X Window System based user interface. Figure 1 shows how ENOF processes new articles. The filter and indexer are programs that automatically run at scheduled times to query the news server for new articles. The filter reads the users' .binx files, which contain specifications for the content of each user's newspaper. The filter then examines each story to determine which users' newspapers to include it in. The title of each story is written into the appropriate users' .bin files. The indexer creates index entries for the new stories so that they can be easily retrieved from the archive.

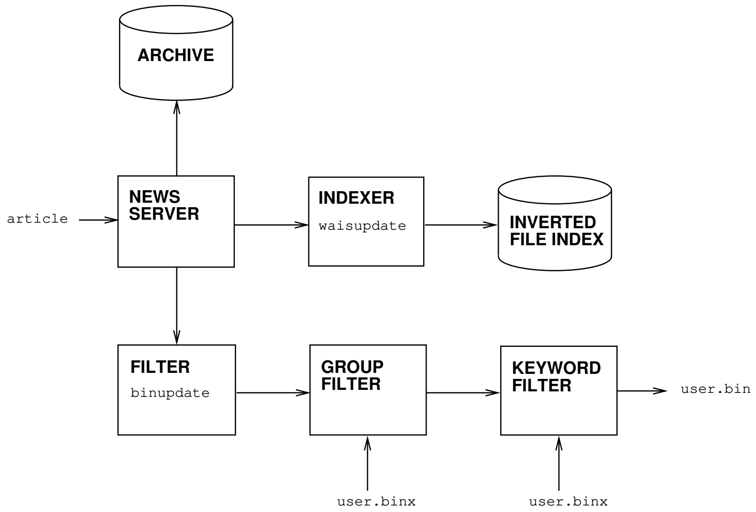


Figure 1: How an Article is Processed

This system was designed as a prototype electronic newspaper for 15 subscribers. Efficiency considerations, essential to the development of a large system, were ignored. The prototype system scales linearly in proportion to the number of subscribers and the number of articles received each day. As the quantity of news and the number of subscribers increase, the amount of time required to filter the articles received in a given time interval will approach (and eventually exceed) the time contained in that interval. For the ENOF system to run properly with a large number of subscribers, the system must be made more efficient, run on an extremely fast computer, or run on a distributed system in which the filtering is done by local workstations.

4.1 ARCHIVE

Stories are archived using Thinking Machines Corporation's Wide Area Information Server (WAIS) serial indexer program [12]. The program creates an inverted file index that can be used to perform searches quickly. The index can be continuously expanded, however, entries cannot be removed without rebuilding the entire index.

The WAIS search mechanism uses a weighted search technique which assigns numeric values (weights) to the articles in the database that contain one or more of the search terms. The weight of an article is determined by the

[1] Unix is a registered trademark of AT&T Bell Labs.

number of times the search terms appear in that article. All articles containing search terms proceeded by the word "not" have their weight reduced to zero. The articles assigned the highest weights are most likely to match the search request.

Four months of wire service news articles were archived in the course of this project. The articles were received and stored in USENET format (the format used by a large electronic bulletin board system accessible through international computer networks) from ClariNet Communications Corporation [20].

4.2 FILTER

ClariNet [2] classifies each of its articles into one or more "ClariNet groups." A set of "standard groups," each containing one or more ClariNet groups, has been defined for ENOF. ENOF subscribers can define "personal groups" which contain one or more standard groups. In addition, a personal group may be modified by key words which articles must contain in order to be a member of that group. Figure 2 shows how a user's newspaper may be structured.

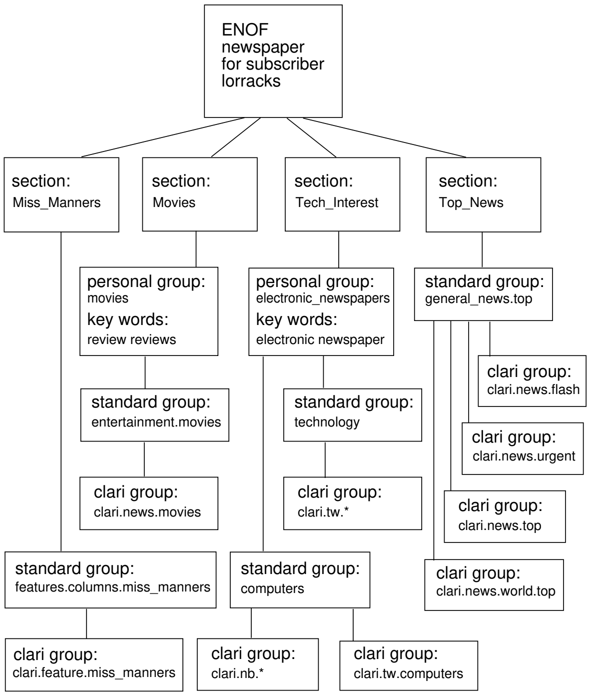


Figure 2: How a Newspaper is Structured

ENOF subscribers define newspaper sections, each containing one or more standard or personal groups. Section and personal group definitions for each user are saved into .bins files. These .bins files are then automatically converted into the .binx files read by the filter.

The filter is composed of two parts: a group filter and a keyword filter. The group filter checks each new article against the .binx files and determines which users have requested articles from one or more of the groups which the new article belongs to. The keyword filter then determines whether the new article contains the key words necessary to belong to users' personal groups. Pointers to articles which pass through both filters successfully are written into the appropriate users' .bin files.

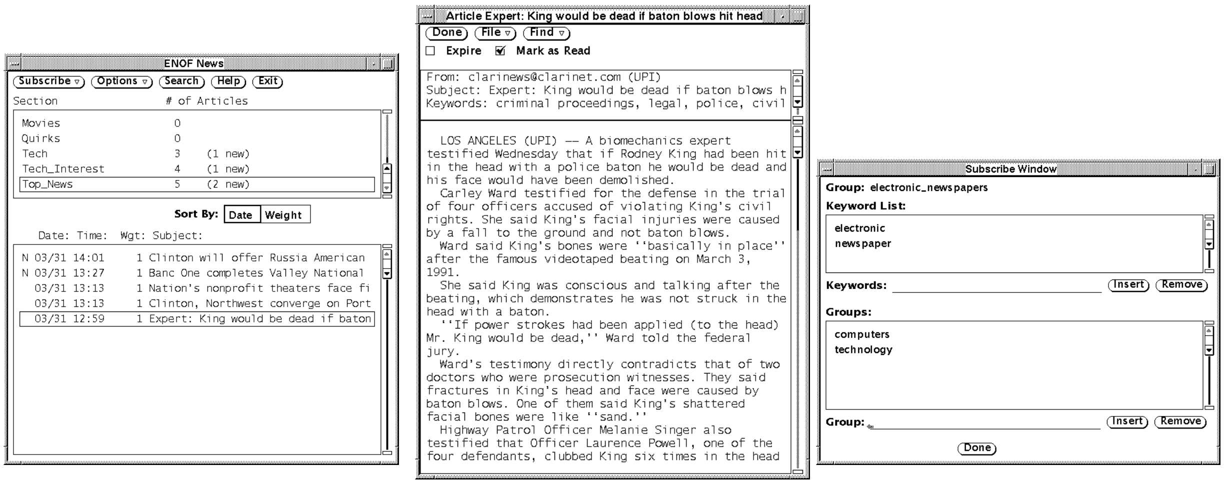
[2] ClariNet is a registered trademark of ClariNet Communications Corporation.

4.3 USER INTERFACE

The user interface was written using Devguide [19], a tool for developing XView [3] applications. It consists of a main window, an article window, a subscribe window, an all groups window, and several auxiliary windows. The windows can all be independently repositioned and resized.

The ENOF main window is shown in Figure 3. This window contains buttons, a scrollable list of sections, and a scrollable list of articles.

The left-most button is the Subscribe button. Clicking this button with a mouse opens a menu that allows subscribers to add, remove, and define sections. The Options button opens a menu which allows subscribers to change the article font, specify article expiration conditions, and expire groups of articles. The Search button, allows subscribers to search the archive for articles of interest. Clicking the Help button opens a window containing helpful information about using ENOF. The Exit button, asks the user for confirmation and then exits the program.



(a) Main window

(b) Article window

(c) Subscribe window

Figure 3: ENOF Windows

The top scrollable list contains the subscriber's section names. Next to each name is a number that indicates the number of articles currently in that section. Users can display the headline list for a particular section by clicking on that section name. The headline list appears in the bottom scrollable list. In addition to displaying each article's headline, the headline list also displays a status symbol, the time and date that the article was sent by the wire service (converted to local time), and the article's weight. The status symbol "r" indicates that an article has been read. The symbol "d" indicates that an article will be deleted. The symbol "N" indicates that an article is new and unread. A space in the status symbol column indicates that the article is not new, but it still has not been read. By clicking one of the Sort By buttons in the middle of the main window, users can select whether articles are sorted by date or weight.

Clicking on an article's headline selects that article for reading and opens an Article window, as shown in Figure 3. The article window contains three buttons, two check boxes, a headline, and the text of the article. The left-most button, the Done button, dismisses the article window. The middle button, the File button, opens a menu that allows subscribers to save, print, or mail articles. The right-most button was designed to search for words within the article being displayed, however it was never implemented. The check boxes indicate the status the article will have once it is dismissed.

Users subscribe to ENOF by first adding sections and then defining them. Selecting Subscribe... from the Subscribe menu opens the Subscribe window and the All Groups window. The Subscribe window, shown in Figure 3, is used to

[3] XView is a registered trademark of Sun Microsystems, Inc.

define both sections and groups. In Figure 3, it is shown defining the electronic_newspaper personal group. The All Groups window, allows subscribers to select standard and personal groups from scrollable lists.

The user interface also includes several auxiliary windows. These windows report user errors, request confirmation, or request information.

5 EVALUATION METHODOLOGY

While only a few guidelines exist for measuring the effectiveness of information retrieval systems, even less has been written specifically about how to evaluate information filtering systems. The evaluation methodology used in this project is based loosely on evaluation methods used in other information filtering studies as well as guidelines for evaluating information retrieval systems [16, 18]. Qualitative evaluation methods modeled after social science measurement were also used [17].

5.1 MEDIA DIARIES

Six volunteers participated in the evaluation phase of this project. These volunteers were selected from among the respondents to the media survey described in Chapter 3. The volunteers included three research associates, two professors, and a secretary.

Prior to evaluating ENOF, the volunteers were given blank diary forms and asked to record their media usage for two weeks. Each volunteer's forms were analyzed for media usage patterns. Volunteers were then given short tutorials on how to use the ENOF system. They were asked to continue their diaries for an additional two weeks, while periodically using ENOF. The diaries were analyzed for changes in the volunteers' media usage patterns.

5.2 INTERVIEWS

The six volunteers were interviewed at the conclusion of the evaluation period. Each volunteer was asked 15 standard questions, in addition to questions specific to his or her media usage patterns. The questions were not always asked in the same order and wording. Additional follow-up questions were asked where appropriate. Informal interviews were also conducted with several other Washington University students and staff members who tested ENOF.

5.3 USER LOGS

In order to monitor the way subscribers used the ENOF interface, the program recorded subscriber actions in a log file for each subscriber. The log file contained the date and time that each action took place. It also included the number of articles and sections present at the start and end of each ENOF session.

6 RESULTS AND CONCLUSIONS

The small sample size made any qualitative or quantitative assessment of trends impossible. However, after many months of reading, discussion with experimental subjects and members of the general population, and analysis of the limited data, a series of observations are suggested as hypotheses. These hypotheses, outlined below, should be tested in a larger study.

ENOF's coarse filter seems appropriate for most members of the target audience. Evaluators liked having the ability to customize their news, but they also liked receiving some articles that they had not specifically requested. Most said they could customize ENOF to deliver the quantity and type of news they wanted. In addition, they said they were able to quickly scan article headlines and decide what to read. Most evaluators said they would most likely use a service similar to ENOF as a substitute for a daily newspaper. Some said that if the service included audio and video they might use it as on demand radio or television.

It is unlikely that a single user interface will suit all electronic newspaper subscribers. Even the six volunteer ENOF evaluators had conflicting news reading preferences. Some said the single article presentation format allowed them to focus on their reading, while others said it inhibited browsing. Some felt that visual cues could best be provided by copying the types of cues used in printed newspapers; others felt new types of visual cues should be developed. Therefore, user interface development efforts should be aimed at developing a variety of compatible interfaces.

While it may not be necessary for an electronic newspaper to closely resemble a printed newspaper, an electronic newspaper should contain some visual cues similar to those found in printed newspapers. Some evaluators said the use of differing fonts, icons, and layout would make browsing easier. In addition, some evaluators said they would prefer multiple articles to be displayed at a time. However, others said they liked the fact that ENOF displays only one article at a time. Some said it would not be necessary for electronic newspapers to resemble printed newspapers once people get used to reading news electronically. More research is necessary to determine which aspects of a printed newspaper are most important to emulate in an electronic newspaper.

The more portable an electronic newspaper system is, the more subscribers it is likely to have. Most evaluators said they would be more likely to use an electronic newspaper at home than at work. Furthermore, some said they would be more likely to use an electronic newspaper if they could read it at the breakfast table, in a comfortable chair, while waiting in line, or wherever is most convenient.

The addition of still and moving images to electronic newspapers is likely to increase their popularity. Most evaluators said they like to see photographs and maps when reading news articles. In addition, some said reading the comics is an important part of their newspaper reading routine. Some said the addition of short video clips would also help sell them on using an electronic newspaper.

In order for an electronic newspaper to compete with printed newspapers, it must contain all the news contained in the printed newspapers it is competing with. Most evaluators said they would be hesitant to replace their daily printed newspapers with electronic newspapers unless they knew they could get local news, weather, and entertainment information, editorials, and indepth reports electronically.

More work should be done to simplify or better document the subscribe component of the ENOF user interface. Most of the evaluators said that subscribing to ENOF was confusing, but they were able to figure it out. However, a less computer-literate target audience might have more trouble.

The possibility of developing an audio electronic newspaper interface should be investigated. Many members of the target audience get most of their news by listening to the radio while driving. A portable electronic newspaper with an audio interface might serve as a form of on-demand radio.

Problems associated with reading text on a computer screen are likely to become less important as people use computers more. Most of the evaluators said they have no preference about reading newspaper text on paper or on a computer screen. Most said they used to prefer paper, but have gotten so used to reading on a screen that they no longer have a preference. In addition, evaluators said they liked the fact that there was no paper to throw away or recycle when they finished reading.

7 FUTURE RESEARCH

7.1 USER INTERFACE

This study has shown that a variety of user interface options may be necessary to satisfy all electronic newspaper subscribers. Some incremental improvements to the ENOF interface should be attempted. Future user interface research should investigate the following questions:

- What visual cues used in printed newspapers should be emulated in electronic newspapers?
- What visual cues can be developed specifically for electronic newspapers?
- What is the best way of displaying multiple stories on a screen much smaller than a standard broadsheet newspaper page?
- What is the best way to display a miniature image of an entire electronic newspaper?
- How can the subscribe process be simplified?

7.2 TEXT FORMATTING

During the design and implementation phase of this project it became clear that electronic news formatting standards would make electronic newspaper development easier. Currently, human writers write stories in formats suitable for human editors, human page designers, or human broadcasters to process. For example, a new paragraph is often marked by two end-of-line characters in a row. A single end-of-line character usually represents an arbitrary line break, and can generally be ignored. However, an article that contains tabular information might contain a single end-of-line character that represents the end of a line in the table. A human can quickly recognize a table, even if it is not explicitly labeled. Programming a computer to recognize every such text irregularity would be more difficult. To solve this problem, paragraph, table, date, keyword, and header formats should be standardized.

Furthermore, special formatting features that would facilitate electronic indexing, filtering, and layout could be added. For example, writers might include codes to indicate placement of hypertext links to previous articles. In addition, they might write the article in distinct sections that would allow a reader to request an article summary, background information, update information (news that did not appear in the last article on the topic), indepth news analysis, interesting quotes, or the entire article. Human editors might add article ratings that subscribers could use to help select which articles to read. As long as humans are involved in the reporting and editing process, it seems appropriate for them to continue to do tasks more easily done by humans then by computers.

7.3 STILL AND MOVING IMAGES

The ability to display still and moving images may be a major selling point of electronic newspapers in the future. Transmission speed, storage space, and the need for text tags [3] in order to index images are currently the main limiting factors to the use of images in electronic newspapers. In addition to continuing to work on the above problems, researchers should determine the best way to incorporate images with text in an electronic newspaper.

7.4 AUDIO INTERFACE

Portable electronic newspapers have the potential of becoming not only a visual medium, but also an audio medium. The addition of an audio interface would allow them to provide radio on demand. People who currently listen to radio news while driving to work might ask their electronic newspapers to "read" them the news in the car.

The idea of conversing with a computer about the day's news is somewhat foreign. The only experience most people have had talking to a computer involves voice mail and automated phone systems. However, many people have observed humans and computers conversing in science fiction movies and television shows. A variety of questions must be investigated before an audio interface of this type is developed. These questions include the following:

- Is current natural language processing technology sophisticated enough for humans to converse with a computer for this purpose?
- How can a menu of articles be represented in an audio format?
- Does current voice synthesis technology produce a voice that is pleasant to listen to for long periods of time?
- Do people like listening to newspaper articles read aloud, or must articles be written specifically for this purpose?
- Do people want to choose the stories they hear on the radio, or do they prefer listening to a packaged newscast?

7.5 ADVERTISING

Advertising may be important to the success of commercial electronic newspapers. In addition to reducing the costs to subscribers, the inclusion of advertising may also attract subscribers who want to read advertisements or use their computers to order products. Research should be done to determine the best way to format advertising to the satisfaction of the advertisers and the subscribers.

7.6 COMMERCIAL PRODUCT

An electronic news system similar to ENOF could potentially be commercially successful within a few years. The following is an outline of how ENOF could be implemented as a commercial electronic news service.

The ENOF company buys specially-formatted electronic news, images, and advertisements from several wire services. As new articles arrive, the company archives them in a permanent collection and distributes them over the Internet to subscribers' computers.

Subscribers' computers store and filter new articles as they are received. All filtering is done on subscribers' local computers using software provided by ENOF. The ENOF software also includes a news reader interface and an indexing program. Subscribers can save and index as much news as they have room for on their local computer systems. Subscribers normally read news directly on their local computers. However, when a subscriber requests an article that is no longer available on the local system, the ENOF program automatically connects to the ENOF archive and searches for the requested articles.

Subscribers are charged on a monthly basis according to how many wire services they wish to receive. They can pay an additional monthly fee for access to the ENOF archive, or they can be charged a small fee for each article they down load from the archive. Discounts are given to groups of subscribers who receive their news on the same computer.

The ENOF software includes a user interface similar to the current ENOF interface. It might also offer an alternative interface which more closely resembles a printed newspaper. Other electronic news providers might compete with ENOF by offering different interfaces, wire services, or payment structures.

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