

A STUDY OF USER EFFORT AS MEASURED USING QUERY CONSTRUCTION AND INTERFACE SELECTION

by
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This pilot study was designed to examine user beliefs and behaviors on the selection and use of search features and search interfaces. The study consisted of five weeks of user logs taken from an Ultraseek server and surveys administered immediately before and after this time period. The survey results indicated a strong correlation between a user's level of effort and their perceived benefit of that effort. Results from the log files were inconclusive but suggested a reluctance to use the advanced search interface. Reported feature use increased by more than 35% over the five weeks. This raises the question of how the behavior of an Internet user changes over time. Further study into the increased use of features and the best interface to provide them is recommended.

Headings:

Online Searching

World Wide Web Case Studies

End User Searching

End User Case Studies

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Introduction

The World Wide Web is a cacophony of sights, sounds and information. The resources are diverse and intended to satisfy numerous audiences. When attempting to estimate the current extent of the Web, the phenomenal growth rate prompts experts to agree simply that it's vast. (Hsieh-Yee, 1998, Lawrence & Giles, 1998) Most users spend at least some portion of their time on the Web looking for resources. They may simply browse following links from page to page and site to site, or utilize one of the many search services available.

How much effort is a searcher willing to expend creating a web based search? In this study we addressed this question by designing a measure of effort and collecting data through surveys and log analysis. Effort was measured using several factors. The number of terms used in each search and the number of search features selected were the primary two factors to determine effort. Features were defined as the use of Boolean operators, the number of text fields used and the number of non-default options selected from drop down or check boxes. In addition, selection of an interface other than the one initially displayed was considered another indication of effort.

We believe that by better understanding the effort searchers are willing to put into Web based searches, the interfaces and the information indexed can be refined to best match the way users search.

Literature Review

As search services became available they were tested, compared and rated based on a variety of criteria. (For a brief history of the World Wide Web and the rise of Search

Engines, please see Appendix A.) Schwartz (1998) provides an excellent survey of the research done through 1997. The performance evaluation research to that time tends to focus on features, precision and relevance – most often precision. Precision is defined as the proportion of retrieved documents that are relevant. (Korfhage, 1997) Examples of features include Boolean searches, exact phrase matches, specifying which terms must or must not be present, proximity searching, fielded searching and restricting searches by language or dates. Queries are posed to a number of search engines and the results are compared. Given the volume of “hits”, precision is often calculated by reviewing the first 10 or 20 documents. This is often referred to as first X precision, where X represents the number of documents reviewed for precision for a given search. (Schwartz, 1998, Leighton & Srivastava, 1999) An example of this sort of study is the article by Leighton and Srivastava (1999), which looks at first 20 precision among five major search engines. Other research detailed in Schwartz’s “Web Search Engines” (1998) looked at the amount of duplication within a search engine’s collection, link validity and relevance.

Of the two cornerstone measurements within systems based information retrieval theory, recall and precision, little work has been done in attempting to measure recall. To measure recall would require knowing the number of relevant documents within a collection. Precision on the other hand only requires determining the number of relevant documents that have been retrieved. While this can be measured for any query whose full list of matches is known, the return of thousands of hits to individual queries make impractical any measure of “true precision” in those cases, thus precision at X documents is often used.

Other studies involving Web based search engines have focused on the user. A study conducted at the State University of New York in 1995 (Wei He and Jacobson, 1996) surveyed the users of six Internet kiosks within the University Library. Part of the information they were looking for was demographic to determine who their user base was. Undergraduates accounted for 52% of their users and graduate students for another 36%. As one might expect, a large percent (79%) of the user population were of ages 18 to 34. Of those surveyed 97% found the Internet useful, and 66% reported using Web based search engines. Almost half (46%) had been using the Internet for 6 months or less.

The Graphics, Visualization & Usability (GVU) Center at Georgia Tech has done user surveys (Georgia Institute of Technology, 1999) of the Web since 1994. The first such survey included sections on general demographics, knowledge of and opinions on HTML, knowledge of HTTP, CGI scripting and related technical knowledge, a few questions on NCSA's Mosaic and a section on browser/internet usage in general. Ten surveys at the rate of two per year have been completed, though no surveys for 1999 have been conducted. The average age for users of the Web has tended towards roughly 35 years old. Looking at the results of the 3rd survey which was done only a few months after the SUNY study there is comparable amount of Internet experience with 31% having used the Internet for less than 6 months and another 29.9% having used it for less than 1 year. The level of experience has changed by the 10th GVU survey (1998) with the largest category of users reporting having been on the Web for between 4 – 6 years. They attribute this change to new users representing a smaller percentage of the overall Internet community than had been previously. This change in general experience levels

may help spur the use of advanced search engine interfaces and other web based applications that are considered more complicated as the average user becomes more comfortable with Web based interfaces in general.

Pollock and Hockley (1997) looked at the usability of web-based search engines by “Internet-naïve” users. They did two trials with the first consisting of participants with little computer experience and the second specifically targeting individuals who were comfortable with personal computers but who had little exposure to the Internet. Their study indicated that familiarity with PCs did not make the process of finding information on the Internet for the novice user any easier. Both groups had trouble generating good keywords, even when the researchers deemed they had all necessary information. Basic search interfaces usually limit users to terms and Boolean operators. It may be better to look at interfaces that have different select fields and check boxes not as more advanced but as more basic – training wheels for the novice Internet searcher.

Hsieh-Yee (1998) reviewed users search tactics, where “search tactics” is defined as responses for dealing with specific events during a search process. Targeted tactics include those utilized when too many items were retrieved. The most popular tactic for this situation was browsing through the search results. The next most popular response was to narrow the search by adding terms or in some other manner. Between the two of these they accounted for 84% of the responses. The reverse was also studied – what to do when no items were retrieved. The top three responses here included using another term, using a different search engine or utilizing additional resources such as a librarian or other library tool. The three of these accounted for 54% of the responses with seven other responses comprising the remaining 46%. The search tactics for selecting starting

points were reviewed as they applied to the two sites for the study. One was graphic intensive while the other was text based.

One area that has received almost no attention for web based searching is that of measuring user effort. Ultimately the user will decide which documents are relevant and whether a search has concluded successfully or unsuccessfully. In the case of systems based testing, how do researchers determine the queries they use as grounds for comparison? Will the number of terms submitted be consistent with the average user? Can the use of Boolean operators or other features be either expected or rejected? Are those search services recommended truly “best” for the typical searcher?

Search terms have been studied in different manners including their selection and their effectiveness (Siegfried, Wilde & Bates, 1993, Spink & Saracevic, 1993, Spink & Saracevic, 1997, Wildemuth & Moore, 1995) but the number of terms has not been studied as a direct measure of effort. Paris (1998) as part of her doctoral dissertation reviewed user effort as measured by their persistence in reviewing results and determined optimal cutoffs from the user’s perspective. The median number of documents reviewed was 100 and the mean was 116 documents. Her research looked at the maximum effort, not the amount of effort initially invested.

One way that the effort a user is willing to put into their search can be measured is through the query they construct. While it is certainly true that this does not directly take into account the preparation of a user prior to interacting with the search engine, it will show itself at least to a degree in the complexity of the search. A study by Berger and Hines (1994) asked what patrons of the library at Duke University wanted out of the library in the future. Among the results “sophisticated computer searching” was

considered critical. In another study, transaction logs were used by Tolle (1983) to determine the features used for an on-line catalogue.

The paper by Jansen, Spink, Bateman & Saracevic (1998) is the only study we have found which focuses on query formulation in a web-based environment. It also looks at the number of queries in a session and the number of search terms used. With search terms the focus is on how many per query and which ones are most frequently sought. From Excite they obtained the logs of all searches on a single day. The search interface has a single text entry field for terms and operators.

From the data they determined a mean number of queries per search (2.8), an average number of terms per query (2.35) and the mean number of pages examined per query (2.21). In addition they were able to determine other characteristics of user search behavior. According to their research, 67% of users had only one query in a session, and 57% never looked past the first results page of 10 hits. Of the features that Excite provides, neither the Boolean operators nor the relevance feedback were used much. When the Boolean operators were used they detected a high error rate (~32%), though they state that determining errors necessitated a judgement call on their part in some cases leaving a wider margin of error. The use of relevance feedback was determined by looking at the number of queries that had no search terms specified. The percentage of searches that could have used the provided relevance feedback mechanism was at most 5% of total queries. The reason for the uncertainty was because the 5% must also take into account the mistake of queries processed without search terms. This figure differs notably from the 11% presented by others (Spink and Saracevic, 1997) on the use of relevance feedback in more traditional IR systems.

Jansen et. al (1998) concludes that there is a low use of advanced search techniques. This finding is supported by Schwartz's survey where she discusses advanced features available from various search engines.

Many search engines do provide a full array of sophisticated search commands, but the casual user is usually protected from these by their being in a help file or only accessible under the guise of "power" or "advanced" search. (Schwartz, 1998)

Is the single entry field necessarily better than a one with more available fields and features? The single text entry field interface which is the normal layout for the "basic" search interface provides no real difference to a command line interface and in most cases offers less feature options than search engines that are specifically command line driven. It seems reasonable that to make best use of the medium of a graphical user interface, requires the use of fields and features that can be operated with a click of a button rather than typing and a dependence on memory for commands and syntax.

Advanced Search interfaces have as Schwartz says been removed from users. There is at least some extra effort to get to that interface, which almost invariably requires stepping through a page with the basic search interface. Yuan (1997) points out that for most users, searching is only an occasional task. If this is indeed the case then the terms "advanced" and "power" can be barriers to use.

Methodology

Participants for this study were drawn from two sections of INLS 181 "Internet Applications" at the University of North Carolina at Chapel Hill. Specific demographic data was not collected, however previous statistics indicate that 65% are graduate

students, 25% are undergraduate students and 10% are continuing education students. The course is described as providing an introduction to Internet applications, services and concepts, and is intended for those with limited knowledge of the Internet including the World Wide Web. Because of the various applications and services covered, experience for any given area varies.

Looking at the statistics for GVVU's 10th WWW User Survey places the majority of the students in these classes in the most frequent categories for users based on age, and educational experience. For age, individuals between the ages of 21 and 35 comprise the three highest reported categories and account for 42.2% of GVVU's surveyed population, with the largest bracket being the 26 – 30 category at 16.1%. With regard to educational attainment, individuals having completed a bachelor or a master's degree accounted for 52.1% of those surveyed of a total of 9 categories. "Some College" was the second largest category at 28.5%. While the students in the two sections of INLS 181 are not representative of the population of those using the Web as a whole, they do represent a significant subset of that population.

All of the students in INLS 181 were invited to participate and could select their level of participation. The study as a whole was comprised of two surveys and a search engine with a collection custom built as a resource to their class. Those wishing to participate fully would fill out the pre-survey, use the search engine over the course of four weeks and then fill out a post-survey. Both surveys were administered during class time. The instructors for those classes were not present at the time to help ensure that no pressure was brought to bear on the students. The students were given two copies of a consent form that contained a description of the project, the URL for the search engine,

contact information and the statement of consent. If they wished to participate they were asked to read, sign and return one copy. The other would be for them to keep in case they had questions. A copy of the consent form can be found in Appendix B.

Students were then given a copy of the pre-survey. Each student was requested to put their name on each page of the survey for the purpose of comparing their initial results to the second survey. Once the surveys had been matched, the space with their name would be removed. There would then be no way to associate the responses with any given individual. The survey was divided into two parts. The first part asked about their use of search engines and search features. The second part asked how frequently they found various search related conditions to be true, such as how often it is useful to be able to search for an exact phrase. A copy of the pre-survey can be found in Appendix C. After five weeks the students were given the follow up survey. All the questions in the first two sections of the pre-survey were duplicated in the corresponding sections of the post-survey. There was one question added to the second section that asked if they'd used the class search engine. There was then a third section on the use of the provided search engine if they had used it. The post survey can be found in Appendix D.

Search Engine

Two search engines were considered for use with this project, Ultraseek and [ht://Dig](http://Dig). Ultraseek is the commercial version of Infoseek's search engine. Both search engines shared a number of features including customization of the spider for depth and URL pattern matching, full text indexing of HTML and text documents, Boolean searching and robot exclusion while indexing. There were also a number of differences.

ht://Dig allowed for customization of the search algorithms used and provides the full source code under the GNU General Public License. It will index metadata keywords and weight on those keywords. The ht://Dig server will also provide email notification when pages change.

Ultraseek can do real-time updates and schedule indexing times. It also supports a number of additional document formats including Rich Text Format (RTF), the eXtensible Markup Language (XML), Microsoft Word, PDF and others. Re-indexing of sites can be customized and the spider can work through firewalls and use password access. In addition to HTTP, it can also index over FTP and NNTP, and there are a number of other server and indexing options available. In addition, there are a host of additional search options including searching by phrase, on title and on URL. It provides mechanisms for relevance feedback using the “Find Similar” option. XML fields can also be mapped and searched. Searches can also be limited to a specific date range.

As the goal of this study was to measure the effort the user is willing to expend in the initial interface selection and query formulation, the Ultraseek server was the better choice based on the advanced search interface and the features to which they mapped. Infoseek was also rated one of the top three search engines based on first 20 precision in a study of five popular search engines – Infoseek, Alta Vista, Excite, HotBot and Lycos. (Leighton & Srivastava, 1998) While the study did not use Ultraseek, the underlying search engine is the same in both and some measure of known quality can be inferred.

The participants were given a single URL to access the search engine. This was to test user preference and effort with regard to the selection and use of a search interface. This URL was in fact a CGI script that would alternate the initial page presented to

searchers. The first person would be sent to the basic search interface, the next to the advanced and back and forth. Once presented with a given interface they would use the same one through their session unless they specifically switched to the other. Links to the other interface were prominent and available.

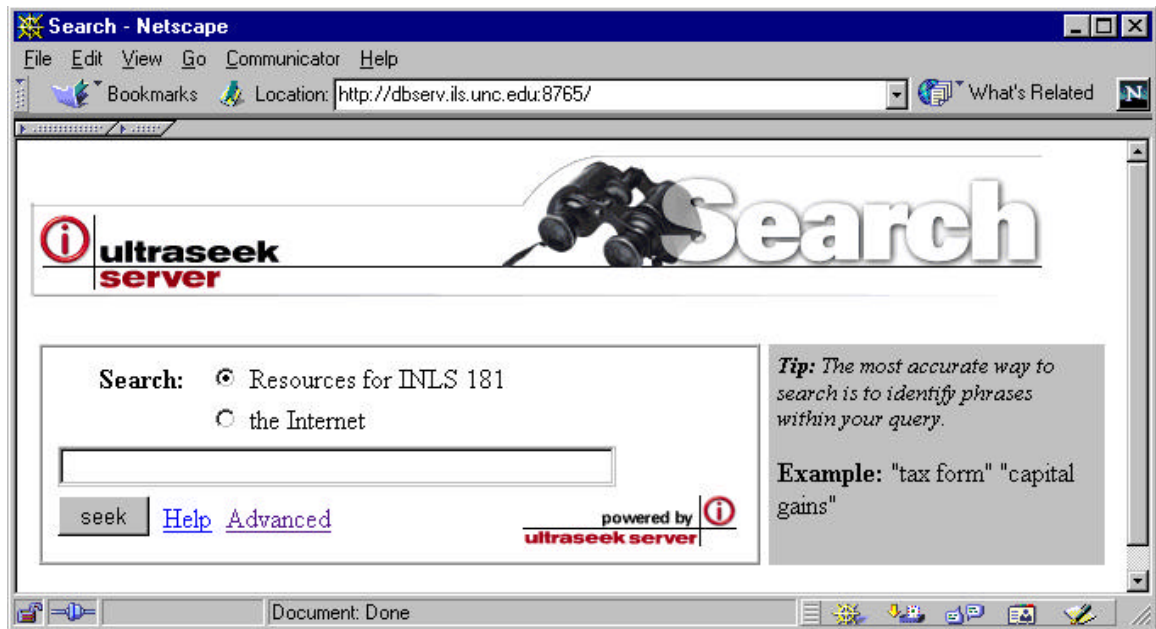


Figure 1. Basic Search Interface

Having the participants log into the search engine was considered as part of the process and discarded. While the information could have been associated with the surveys for a particular individual, we viewed the login process as a barrier to use. First it required the user to remember a name and password. Second, even if a password wasn't required and their login name easy to remember it still requires additional effort to make use of the search engine. With the required login there was no way to determine what impact the login had on search engine use. We therefore decided not to track searches by individual in this manner.

Search - Netscape

File Edit View Go Communicator Help

Bookmarks Location: qp=%qs=%qc=%pw=100%25&ws=0&la=&si=1&q=a&nh=10&lk=1&rf=0 What's Related

ultraseek server **Search**

Search: ☒ Resources for INLS 181
☐ the Internet

for documents that
 should contain in the body the words

and
 must contain in the body the words

and
 must not contain in the body the words

and were last updated
☒ Anytime
☐ in the last week
☐ on or after November 16, 1999
 and on or before November 23, 1999

and show
 10 hits sorted by relevance with summaries
☐ Show individual word scores

seek [Help](#) [Simple](#)

powered by **ultraseek server**

Document: Done

Figure 2. Advanced Search Interface

The Collection

The collection was created by indexing resources included on resource pages for INLS 181 and by adding one or two prominent repositories to that list. Our license allowed for 25,000 documents to be indexed. New sites were added until this capacity

was reached. A listing of the sites indexed and the parameters used for the spidering of those sites can be found in Appendix E.

Data Collected

As described earlier, data collection took the form of two surveys and the log files for the search engine. For the pre-survey, 54 surveys were returned. Of these two did not have accompanying waivers agreeing to participate in this process and were therefore removed from consideration. With the post-surveys, 50 were returned of which 47 matched by name pre-surveys. Two others had no name and therefore no associated waiver and were removed from consideration. The last post-survey was submitted with a waiver and included in the data. Overall a total of 53 participants supplied data used in this study. On a few surveys a question or two were skipped, however there was no overlap in the missing data, and all calculations were done without them. The search engine logs recorded 32 sessions over the five weeks set aside for that aspect of the study. Sessions were differentiated by the interface accessed, the time and the terms used.

Constructed Measures

Three composite measures were created as a way of analyzing the data. This includes two measures of effort and one for the perceived benefit of effort. The questions that were used for the two measures of effort were the following:

1. I have used a web search engine within the last:
 day week 2 weeks month or more never
2. I have used quotation marks (“ ”) to specify an exact phrase in a search within the
3. Besides quotation marks and just putting the terms next to each other, I have used another method to specify an exact phrase in a search within the last...
4. Have you ever used Boolean operator AND in a search?
5. Have you ever used Boolean operator OR in a search?
6. Have you ever used the Boolean operator NOT in a search?
7. I have used the “advanced” search page of any web search engine within the last...
9. How many terms do you typically enter before having the search engine run your search?

The numbers above correspond to the question number on both surveys. All of these questions except number nine, had answers that described the time frame in which the specified occurred. (See Appendices C and D for the two surveys.) Question one provided the base time of comparison for questions two through seven. Each question that matched the answer specified for question one was considered one point towards total effort, for a range of zero to six points for questions two through seven. This was then added to the average number of terms specified by question number nine. In the case of ranges such as 4-6, the lowest number in the range was selected. These ranges were developed from results reported in Jansen et. al (1998) and the lowest number in the range represented more than half the total number of queries specified by the range.

The reason that terms were given a higher weighting is that they are the most common search “feature” used. For those items that matched, it is unlikely that all of them were used each time for every query submitted, while the terms represents the average number used. This yielded a range of one to eleven for the terms and an overall range of one to seventeen for effort.

The second measure of effort provided a bit more leeway in the time frame in which the various features were used. Rather than needing to match the time specified in question one, one rank of time difference were permitted for questions two through seven. So, if the search engine had last been used in the past day, then day or week were considered matches for the purpose of effort. Likewise if a week had been specified, then a week or two weeks were acceptable and so on.

Actual effort scores ranged from one to ten on the pre-survey and one to nine on the post-survey. Table 1 shows the number of terms used on average, while Table 3 shows the combined terms and features for the pre-survey. This information is provided for the post-survey in Tables 2 and 4 respectively.

Number of Terms Used:	Frequency of Response
1	4
2	22
3	14
4-6	11
7-10	0
11+	0
Average	2.63

Table 1. Terms Used - Pre-survey

Number of Terms Used:	Frequency of Response
1	1
2	21
3	13
4-6	10
7-10	0
11+	0
Average	2.71

Table 2. Terms used - Post-survey

Comparing the average number of terms to the first measure of effort shows that on average 1.27 features are used within the given time frame. If the time is expanded by one step, the use of features grows to 2.31. This should not be interpreted to mean that every search that is done on average uses one or more features, however it does indicate that features are being explicitly used on a regular basis and within a reasonable amount of time.

Over the six week period between the two surveys the average number of terms increased only slightly from 2.63 to 2.71. The use of other features though increased more notably.

Number of Terms and Features Used	Frequency of Response – Same Time	Frequency of Response – Within 1 Time Step
1	1	1
2	12	6
3	8	8
4	15	6
5	4	5
6	6	13
7	3	8
8	0	1
9	1	1
10	0	1
Average	3.9	4.94

Table 3. Effort - Pre-survey

Number of Terms and Features Used	Frequency of Response – Same Time	Frequency of Response – Within 1 Time Step
1	1	0
2	8	2
3	5	1
4	9	10
5	8	6
6	9	7
7	3	10
8	1	4
9	1	5
10	0	0
Average	4.44	5.91

Table 4. Effort - Post-survey

In the post-survey the average total for terms and features was 4.44 for the first measure of effort, an increase of 0.46 features after adjusting for the change in average

number of terms used. For the second measure of effort, the average was 5.91 yielding an increase of 0.89. One explanation for these increases is due to regular use of search engines. Table 5 shows the differences in terms and features between the two surveys.

More than 60% of the participants indicated having used a search engine within the last day on the pre-survey and a like percentage indicated the same on the post-survey. All but two of the respondents on each survey had used a search engine within the last week.

	Pre-survey	Post-survey	Change
Terms used	2.63	2.71	0.08
Features used – 1st measure of effort	1.27	1.73	0.46
Features used – 2nd measure of effort	2.31	3.20	0.89

Table 5. Changes in Term and Feature Use

Other features comprise a significant part of the overall effort expended in the searches. This number also increased more rapidly than the average number of terms being used, suggesting that it is the additional features more than additional terms that help searchers find what they are looking for. But is this a valid assessment? Do the searchers really believe that the use of additional terms and features will improve their search? To help answer this question we created another measure that we termed “the perceived benefit of effort.” This included the following questions from the surveys:

11. Specifying more terms and options decreases the number of pages I have to look through...
12. Specifying more terms and options finds more of the pages I’m looking for...
13. Specifying more terms and options decreases the time I spend looking for information...

Again, the numbers above correspond to the questions in the two surveys. There were four answers “rarely”, “some”, “often” and “always.” These were given values of “1” to “4” respectively for a total range of “3” to “12”.

The mode of these questions in all cases but one was “some.” The exception being question 11 on the post-survey where “often” was the mode with “some” close behind. This may help explain the differences in the two measures of effort. While there is a perceived benefit of effort it is not sufficient to warrant the use of additional features on a more frequent basis. This seems to suggest that the user may be using a wider variety of features, but not using them within the same query. Determining a more definitive answer would require additional study.

We ran a comparison of each measure of effort vs. the perceived benefit of effort using the Pearson Correlation test. Table 6 shows the results of those correlations. There is a correlation between each measure of effort in the pre-survey and for the second measure of effort in the post-survey. These correlations indicate that the users actually behave as their belief dictates.

Perceived Benefit of Effort	Pre-survey: Effort – Same Time	Pre-survey: Within One Time Step	Post-survey: Effort – Same Time	Post-survey: Within One Time Step
Pearson Correlation	.421	.350	.280	.542
Significance (2-tailed)	.002	.013	.063	.000
N	50	50	45	45

Table 6. Correlation of Effort and it's Perceived Benefit

Search Engine Use Analysis

Using the survey responses we were able to calculate the terms and effort for those who reported using the provided search engine. Seven individuals reported having used the search engine, accounting for all 36 queries over 17 sessions. Tables 7 and 8 show the number of terms and the effort that this group reported on the post-survey.

Number of Terms Used:	Frequency of Response	Frequency of Use in actual searches
1	0	13
2	4	15
3	3	7
4-6	0	0
7-10	0	0
11+	0	1
Average	2.83	2.08

Table 7. Terms Used by Searchers (Post-survey and search engine)

Number of Terms and Features Used	Frequency of Response – Same Time	Frequency of Response – Within 1 Time Step	Actual Searches
1	0	0	13
2	1	1	8
3	1	0	13
4	1	2	0
5	2	0	1
6	1	1	0
7	0	2	0
8	1	1	0
12	0	0	1
Average	4.71	5.43	2.36

Table 8. Effort by Searchers (Post-survey)

The number of terms used was slightly higher than the overall average (2.83 vs. 2.71) and the first measure of effort increased by only 0.15 when the adjustment was

made for the number of terms used. The second measure of effort dropped by 0.60 to an average of 2.60 features used within one time step.

Comparing the reported results against those actually obtained showed notable differences. The average term frequency used in actual searches was 2.08 down 0.75 from the reported average. The number of features used was 2.36, which indicates only a 0.28 feature use compared to the 2.6 reported in the post-survey. Before attempting to make sense of these discrepancies, other information needs to be considered.

The provided search engine was only accessed 32 times over the course of the five weeks allocated for its data collection. Of these 32 sessions, only 17 resulted in actual searches. The breakdown of access can be seen in Table 9. The use of features seems to be spread out over a variety of searches and over the course of time. As seven people indicated that they used the search engine, this means that on average each individual performed less than 3 searches. More data would be determine whether the discrepancies indicated within the current data set are indicative of an actual disparity between the reported and observed.

	Accessed but not Used	Accessed and Used	Switched To
Basic Interface	5	11	2
Advanced Interface	10	6	1, but not used

Table 9. Search Engine Access

The measurement of effort as mentioned earlier is based on the selection of the search interface used and the number of terms and search features selected for each search. Most search engines provide a basic search interface and then provide for an “advanced” or “power” interface that may be selected. The user must then select the link

to that page unless it is already book-marked. Locating the link and selecting it are extra steps and therefore extra effort that a user has to exert in order to get to their desired search interface. The theoretical complexity of the advanced search interface is used as a reason to not make it the default.

All searches that can be accomplished using a basic search interface can be done using the advanced search interface. No loss of capabilities would be sustained by utilizing the advanced search interface over the basic. In addition, the ready availability of additional features may inspire their use and ideally improve the search results by increasing the precision. A preference for the advanced interface or an ambivalence to which search interface is used, would strengthen the argument for providing the advanced search interface as the default and encourage search engine creators to improve on the fields and manners of limiting searches such as through the use of metadata standards and tags.

During the 17 sessions, users switched interfaces only 3 times – twice from the advanced to the basic, and once from the basic to the advanced. In all cases, users submitted queries in the interface provided before switching to the alternative interface. The fact that the searchers attempted one or more queries using the advanced interface and even took advantage of the search features there suggests that being presented with an advanced interface first may be a reasonable approach. While this is encouraging it must be tempered by the fact that users were twice as likely to not submit a query when presented with the advanced search interface first. As the number of sessions is small, more data would need to be collected before any substantial conclusions could be drawn and any recommendations could be made.

It is worth comparing the results obtained from the search engine to those obtained by Jansen et. al (1998). Their analysis of 51, 473 queries produced an average term frequency of 2.35 as compared 2.08 for the use of the search engine and an average of 2.67 terms between the two surveys. While they do not have a strict measure of features, they do list that “about one in 12 queries contained a Boolean operator” and “about one in 11 queries incorporayed (sic) a ‘+’ or ‘-’ modifier.” Of the queries submitted to the search engine, 7 of the 36 queries or roughly one in 5 actually made use of a feature.

Other Questions

We considered a number of additional relationships as part of this study. They included:

- Ease of use vs. how often the advanced search interface was used
- Whether there were enough options provided by web search interfaces vs. how often the advanced search interface was used
- How often they reported finding the information they were looking for vs. the effort they put into their search
- How often they reported finding the information they were looking for vs. the perceived benefit of effort
- The effort they put into their search vs. how often they had to submit additional queries

The Pearson Correlation test was used to test each of the relationships described above.

No correlation was found between any of these proposed relationships.

Conclusion

This study was a pilot and intended to explore and perhaps lay the groundwork for further research. While little could be drawn conclusively from the use of the search engine, there were a couple of interesting and potentially promising results. The first is that being presented with the advanced search engine first was not necessarily a difficulty, or at least not one that warranted extra effort to correct. Those that switched from it to the more basic interface used the advanced search first. This should still be tempered by the fact that twice as many individuals did not use the advanced search engine when presented with it vs. those who did not use the basic search engine. A larger data set would be needed to examine and to clarify the results. The second thing of note was the increased use of features over the study by Jansen et. al (1998). Rather than the previously reported one in 11 or one in 12, the use of features was closer to one in 5. The nature of the features used was different. In the use of the provided search engine, no Boolean operators were used at all – though they were certainly available for use. The features used were additional fields, selections from drop down boxes and proximity operators, the last most closely resembling the features used in the Excite study. It is certainly possible that the ready availability of additional features is enough to bring them into occasional use. A more detailed study could also be done to determine exactly what search features are most desired and equally important – the manner in which they are presented to the user.

The change in reported term and feature use over a five-week period is notable as both measures of effort reported at least a 36% increase in feature use. This raises the

question of how the behavior of an Internet user changes over time. A longitudinal study would be needed to answer this question.

Part of the reluctance to use advanced search interfaces beyond the possible complexity issue is whether or not it really has much impact. The perceived benefit of effort as measured by the surveys indicated that while effort was seen to have some impact, the impact was not constant. The results also showed a correlation between effort and it's perceived benefit in most cases. Improving one will likely improve the other. The difficulty comes in making that improvement. The infrequent occasion of no returns on a Web based search has mitigated the need to extensively learn the interface. This has made searching accessible to a larger audience but at the potential cost of time spent.

Continued study of the effort that a user is willing to Web based search needs to be done. The crafting of queries based on information from actual use needs to be understood to allow for additional improvements in the interface and the mechanisms behind it. Ideally the results at the top of the list will meet the needs of the searcher. The question is how to maximize the content into the system and put it in context. That is what we hope to see in future studies.

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Appendix A: Brief History of the World Wide Web

The World Wide Web, commonly referred to as just the Web, began with a proposal from Tim Berners-Lee to the management at CERN for a system that would keep track of large projects.(Berners-Lee, 1989) The proposal called for the implementation of a hypertext system. Documents could be created that had links to other documents. The collection of linked documents could be accessed in a consistent and immediate fashion, regardless of where the actual documents resided. This allowed for distributed authoring and maintenance of the documents, which facilitated keeping the information up to date.

Tim Berners-Lee described the more general purpose of the World Wide Web model a few years later.

The WWW model gets over the frustrating incompatibilities of data format between suppliers and reader by allowing negotiation of format between a smart browser and a smart server. This should provide a basis for extension into multimedia, and allow those who share application standards to make full use of them across the web. (Berners-Lee, 1992)

The data format and protocols developed were the Hypertext Markup Language (HTML) and the Hypertext Transport Protocol (HTTP) respectively. HTTP was originally only intended for the transfer of HTML documents and could be described in just a few pages. In 1991 they decided they wanted to serve more than just HTML, and so revised the HTTP protocol. (World Wide Web Consortium, 1998)

Rise of Spiders and Search Engines

One of the goals for this project was to make information easy to find and to enable the automation of this process. Software programs called spiders were written to walk the web of documents by following links to additional pages and systems. The first spider was called the Wanderer and was launched at MIT in 1993. (Gray, 1995) Spiders were used to build indexes that could be used with search engines to help find documents on user specified topics. Early search engines created full text indexes of pages and provided a simple keyword search mechanism. This interface would continue in what would commonly be referred to as the basic search interface.

Later on, an effort was made to provide specific information about individual pages such as keywords, summaries and author. The META tag was introduced in HTML 2.0 in 1995 for just this function.(Berners-Lee & Connolly, 1995) Unfortunately widespread use of this tag didn't occur, likely due to a combination of required effort and lack of knowledge. Since then it has been utilized to some extent, most frequently to specify keywords and descriptions or to implement a redirection of the browser to another page entirely.

Growing Pains

The World Wide Web began to grow at an even faster pace than it had been, and spiders would eventually be unable to keep up. As the Web grew it became increasingly harder to find information. A number of commercial search services popped up which focused on assisting users find the information they were looking for. A list of some of the initial search services and their launch dates can be found below.

Webcrawler:	1994
Yahoo:	1994
Alta Vista:	1995
Excite:	1995
Lycos:	1995

Initially these search services provided a simple keyword interface to their collections.

As the collections grew, technologies expanded, and in an effort to distinguish themselves from other search services by making the information they had easier to find, more advanced interfaces were developed.

Today

The Web is vast, and any given search engine contains only a fraction of the total accessible pages. A number of pages are not accessible to search engines because they are behind firewalls, are password protected or contain files that indicate that they are not to be indexed. An estimate of the size of the Web was made in 1998 by comparing the results to 575 queries for pairs of search engines at a time, looking for unique documents. Based on the results the minimum size expected for the web at the end of 1997 was 320 million pages, and the most expansive collection of pages for a given search engine was Hot Bot at 34% of the total indexed pages. (Lawrence & Giles, 1998)

Currently Search engines boast document collections in the millions of pages. Alta Vista for example claims to have indexed more than 140 million pages. (AltaVista, 1999b) While it is certainly possible that given the sheer volume of pages and sites available that the information a user seeks is out there, the problem is now more one of finding that information. As with other information retrieval systems, it's possible to get too many returns that match the criteria specified. The volume of hits returned was one

of the problems cited in a study of users of the QUICKLAW system conducted over the course of a year's time from 1992 to 1993. (Yuan, 1997) It is not uncommon to specify a query that results in thousands of hits, and even should the number be merely in the hundreds it is still quite time consuming to review the returns for information that meets the need of the user. So how does the searcher find the answer to their information need? This is one of the fundamental questions of the Information Retrieval discipline.

Appendix B: Consent Form

User Effort in Initiating a Web-based Query Consent Form

As an individual enrolled in INLS 181, you are invited to participate in a study which will examine the amount of effort individuals are willing to put into a Web based search, given expected returns on their effort. Relevant information has become increasingly harder to find as the volume of materials contained within most search engine databases continues to grow. New and refined interfaces and methods need to be developed in order to improve upon the returns for these searches. One aspect that needs to be considered is the effort the individual user is willing to invest in their search. Measuring effort is the goal of this study and is being undertaken as the basis of Paul Gerwe's master's paper, under the guidance of Dr. Charles Viles.

Participants in this study will be given one survey now and another at the beginning of November which will ask you about your experiences and thoughts on searching using a Web interface. Each survey should take approximately 10 minutes to complete. In addition, whether or not you participate in the surveys, you will have access to a search engine with a custom database of resources. The sites indexed by this search engine have been tailored to INLS 181 but may be of use to you for other classes. Information will be gathered from the search engine logs to measure the effort involved in those searches. Data collection will be completed at the end of October, however the search engine will remain an available resource for the duration of the semester.

Your privacy is very important, and I wish to assure you that every effort will be made to protect your privacy. I request that you put your names on each surveys so that I can match your first survey to the follow-up one. Once I have made a match, your name will be removed from both copies so that there will be no means of associating those responses with you. The search engine will be accessed from:

<http://ils.unc.edu/~gerwp/search.cgi>

and will require no special log on. Use of the search engine will be completely anonymous.

You are free to decide whether or not you wish to participate in this study, and to what extent. The search engine is available for use, and does not require completing the surveys to use it. However, because of the anonymous nature of the search engine, I will be unable to remove any queries you have executed from the general body of data. While I encourage you to take advantage of the search engine and believe it will be useful to you in your class, there is no requirement to do so.

You have the right to withdraw from this study at any time. This means that you will not be required to complete either survey, and if you have completed the first one, it will be returned to you at your request. I will not be able to remove your survey answers

from the collection once the second survey has been processed, as I will have no means of identifying your responses from the others.

The Academic Affairs Institutional Review Board (AA-IRB) of the University of North Carolina at Chapel Hill has approved this study. If you have any concerns about your rights in this study you may contact the Chair of the AA-IRB, David A. Eckerman, at CB #4100, 300 Bynum Hall, UNC-CH, Chapel Hill, NC 27599-4100, (919) 962-7761 email aa-irb@unc.edu.

If you have any questions or concerns regarding the study itself, you may contact Paul Gerwe at gerwp@ils.unc.edu or by phone at (919) 929-9334. You may also contact Dr. Charles Viles at viles@ils.unc.edu or by phone at (919) 962-8366.

By signing this form, you agree to participate in the study with the understanding that you can leave the study at any time. You also agree that I may use the information gained in this study in any way I feel is best for publication or education. Signing this form indicates that a second copy of this form has been provided to you for your own records.

Printed Name: _____

Signature: _____

Date: _____

Appendix C: Pre-Survey

Part I

Instructions: All of the questions below are specific to the use of a search engine accessed through a Web browser. When selecting an answer, please select the one that best describes your experience. To make the selection, please put an “X” or a check mark within the [] immediately to the left of the option being selected.

1. I have used a web search engine within the last...
[] Day [] Week [] 2 Weeks [] Month or more [] Never
2. I have used quotation marks (“ ”) to specify an exact phrase in a search within the last...
[] Day [] Week [] 2 Weeks [] Month or more [] Never
3. Besides quotation marks and just putting the terms next to each other, I have used another method to specify an exact phrase in a search within the last...
[] Day [] Week [] 2 Weeks [] Month or more [] Never
4. Have you ever used Boolean operator AND in a search?
[] No
[] Yes → 4b. Within the last...
[] Day [] Week [] 2 Weeks [] Month or more
5. Have you ever used Boolean operator OR in a search?
[] No
[] Yes → 5b. Within the last...
[] Day [] Week [] 2 Weeks [] Month or more
6. Have you ever used the Boolean operator NOT in a search?
[] No
[] Yes → 6b. Within the last...
[] Day [] Week [] 2 Weeks [] Month or more
7. I have used the “advanced” search page of any web search engine within the last...
[] Day [] Week [] 2 Weeks [] Month or more [] Never
8. Which search engine(s) have you used in the last 2 weeks?
[] Altavista [] Hot Bot [] Lycos [] Yahoo
[] Excite [] Infoseek [] Northern Light [] Class Search Engine
[] Google [] Inktomi [] WebCrawler [] Other_____
9. How many terms do you typically enter before having the search engine run your search?
[] 1 [] 3 [] 7-10
[] 2 [] 4-6 [] 11+

Appendix D: Post-Survey

Part I

Instructions: All of the questions below are specific to the use of a search engine accessed through a Web browser. When selecting an answer, please select the one that best describes your experience. To make the selection, please put an “X” or a check mark within the [] immediately to the left of the option being selected.

1. I have used a web search engine within the last...
[] Day [] Week [] 2 Weeks [] Month or more [] Never
2. I have used quotation marks (“ ”) to specify an exact phrase in a search within the last...
[] Day [] Week [] 2 Weeks [] Month or more [] Never
3. Besides quotation marks and just putting the terms next to each other, I have used another method to specify an exact phrase in a search within the last...
[] Day [] Week [] 2 Weeks [] Month or more [] Never
4. Have you ever used Boolean operator AND in a search?
[] No
[] Yes → 4b. Within the last...
[] Day [] Week [] 2 Weeks [] Month or more
5. Have you ever used Boolean operator OR in a search?
[] No
[] Yes → 5b. Within the last...
[] Day [] Week [] 2 Weeks [] Month or more
6. Have you ever used the Boolean operator NOT in a search?
[] No
[] Yes → 6b. Within the last...
[] Day [] Week [] 2 Weeks [] Month or more
7. I have used the “advanced” search page of any web search engine within the last...
[] Day [] Week [] 2 Weeks [] Month or more [] Never
8. Which search engine(s) have you used in the last 2 weeks?
[] Altavista [] Hot Bot [] Lycos [] Yahoo
[] Excite [] Infoseek [] Northern Light [] Class Search Engine
[] Google [] Inktomi [] WebCrawler [] Other_____
9. How many terms do you typically enter before having the search engine run your search?
[] 1 [] 3 [] 7-10
[] 2 [] 4-6 [] 11+

Survey – Web Search Engine Use

Name: _____

Part III

Instructions: If you have used the class search engine (answered yes to question 21 above) please answer the following questions.

22. Did you use the Basic Search Interface?

☐ No

☐ Yes → 22 a. I had to submit additional search requests to find the information I was looking for...

☐ rarely ☐ some ☐ often ☐ always

22 b. When using the basic search interface I found what I was looking for...

☐ rarely ☐ some ☐ often ☐ always

22 c. The basic search interface was easy to use.

☐ True

☐ False

23. Did you use the Advanced Search Interface?

☐ No

☐ Yes → 23 a. I had to submit additional search requests to find the information I was looking for...

☐ rarely ☐ some ☐ often ☐ always

23 b. When using the advanced search interface I found what I was looking for...

☐ rarely ☐ some ☐ often ☐ always

23 c. Having more than a single entry field for terms was useful...

☐ rarely ☐ some ☐ often ☐ always

23 d. The advanced search interface was easy to use.

☐ True

☐ False

24. Of the two interfaces I preferred to use:

☐ the advanced search interface

☐ the basic search interface

☐ neither

☐ no clear preference

Appendix E: Sites Indexed and Spider Parameters

Document Roots

<ftp://ftp.isi.edu/in-notes/rfc822.txt>
<ftp://ftp.isi.edu/in-notes/rfc959.txt>
<http://hoohoo.ncsa.uiuc.edu/cgi/primer.html>
<http://ils.unc.edu/~bert/Authoring1998/>
<http://www.boutell.com/faq/>
<http://www.con.wesleyan.edu/~triemer/network/docservs.html>
http://www.extensibility.com/main_best.htm
<http://www.hotwired.com/webmonkey/>
<http://www.hunnysoft.com/mime/>
<http://www.ietf.org/>
<http://www.isoc.org/internet-history/>
<http://www.jmarshall.com/easy/http/>
<http://www.lights.com/hytelnet/>
<http://www.lynda.com/>
<http://www.networksolutions.com/internic/internic.html>
<http://www.opensource.org/>
<http://www.rfc-editor.org/>
<http://www.ucc.ie/xml/>
<http://www.useit.com/alertbox/>
<http://www.w3.org/MarkUp/>
<http://www.w3.org/Style/css/>
<http://www.zdwebopedia.com/>

Additional Parameters

Maximum number of directories: 10
Maximum number of hops from root URL: 50

Disallow all URLs to CGI scripts
Disallow all URLs with query strings
Disallow parent directory links from apparent directory listing documents.
Allowed Languages: English

(continued on next page)

Filters

<ftp://ftp.isi.edu/in-notes/>*
<http://hoohoo.ncsa.uiuc.edu/cgi/>*
<http://ils.unc.edu/~bert/Authoring1998/>*
<http://www.boutell.com/faq/>*
<http://www.con.wesleyan.edu/~triemer/network/>*
<http://www.hotwired.com/webmonkey/>*
<http://www.hunnysoft.com/mime/>*
<http://www.isoc.org/internet-history/>*
<http://www.jmarshall.com/easy/http/>*
<http://www.lights.com/hytelnet/>*
<http://www.networksolutions.com/internic/>*
<http://www.ucc.ie/xml/>*
<http://www.useit.com/alertbox/>*
<http://www.w3.org/MarkUp/>*
<http://www.w3.org/Style/css/>*

Other allowed sites for documents

www.extensibility.com
www.ietf.org
www.lynda.com
www.opensource.org
www.rfc-editor.org
www.zdwebopedia.com

Appendix: F Access and Query History

Accessed 32 times resulting in 36 queries

- 9/27 Advanced accessed – not used
 Basic used for a search – 1 term
 Advanced accessed – not used
 Help consulted
 Basic used for a search – 1 term
- 9/28 Advanced used – 2 terms multiple combinations of options:
 2 terms – both required in title
 2 terms – should be contained in body
 1 term required in title, 1 term should be contained in body
 1 term required in title, 1 term required in body
 Switched to Basic Interface
 Basic used – 2 searches – 2 terms, 2 terms
 (both attempted to use ‘with’)
- 9/29 Advanced accessed – not used
 Basic used – 3 searches – 1 term, 1 term, 2 terms
 Advanced used to search outside the 181 collection – 1 term
- 9/30 Basic search interface used – 8 searches – 1 term, 3 terms, 2 terms, 12
 terms, 3 terms, 3 terms, 3 terms
 Advanced search used – 2 searches 2 terms, 2 terms
- 10/3 Basic search accessed – not used
- 10/4 Advanced search accessed – not used
- 10/6 Basic search used – 1 term
 Advanced search accessed – not used
- 10/7 Basic search used – 2 terms
 Advanced search accessed – not used
 Basic search accessed – not used
- 10/8 Advanced search accessed – not used
 Basic search used – 3 searches - 1 term, 1 term, 1 term
 Advanced search accessed – not used
- 10/10 Basic search used – 1 term
 Advanced search used – 2 terms
 Switched to basic search
 Basic search used – 2 terms as before plus 1 additional term
 New search (BSI) – 2 terms
- 10/11 Advanced search used – 1 term
 Basic search accessed – not used
- 10/12 Advanced search used – 3 terms used internet not custom collection
- 10/18 Basic Search used - 2 terms
- 10/19 Basic Search Interface accessed – not used
 Advanced search engine interface accessed – not used
- 10/20 Basic Search Interface accessed – not used
 Advanced Search Interface used – 3 terms used internet not custom

collection

10/26 user searched using Basic. Ran 2 searches – 1 term, 2 terms
Switched to advanced interface
Advanced interface – not used