UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

COMCAST CABLE COMMUNICATIONS, LLC

Petitioner

v.

VEVEO, INC.

Patent Owner

Patent No.: 8,122,034
Filing Date: October 7, 2005
Issue Date: February 21, 2012
Title: METHOD AND SYSTEM FOR INCREMENTAL SEARCH WITH REDUCED TEXT ENTRY WHERE THE RELEVANCE OF RESULTS IS A DYNAMICALLY COMPUTED FUNCTION OF USER INPUT SEARCH STRING CHARACTER COUNT

DECLARATION OF DR. EDWARD A. FOX

Declaration in support of Petition 2 of 2

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I, Edward A. Fox, declare that I have personal knowledge of the facts set forth in this declaration and, if called to testify as a witness, could and would do so competently, for the above-referenced *inter partes* review proceeding.

I. INTRODUCTION

1. I have been retained as an expert witness on behalf of the Petitioner, Comcast Cable Communications, LLC ("Petitioner").

2. I reside in Blacksburg, Virginia.

3. I have been asked to provide testimony regarding systems and methods for processing a search request to provide a ranked ordering of items. I have also been asked to render opinions regarding certain matters pertaining to the subject of U.S. Patent No. 8,122,034 ("the '034 Patent") and the unpatentability ground set forth in the Petition for this proceeding.

4. I am being compensated at my usual consulting rate of $450 per hour ($550 per hour for time spent testifying at a deposition or trial) for my work on this matter. I also am being reimbursed for reasonable and customary expenses associated with my work and testimony in this investigation. My compensation is not dependent upon my opinions or testimony or the outcome of this matter.

II. PROFESSIONAL BACKGROUND AND QUALIFICATIONS

5. I believe that my extensive academic and industry experience and computer science background qualify me as an expert in the relevant field of

information retrieval, and particularly to techniques for performing searches for desired content. Having taught undergraduate and graduate students in the field since 1983, I am knowledgeable of the relevant skill set that would have been possessed by a hypothetical person of ordinary skill in the art at the time of the invention of the '034 Patent (in 2005), i.e., a POSA.

A. Education and Certifications

6. My Curriculum Vitae, including my publications and patent, is submitted as Exhibit A to this Declaration. As is detailed therein and below, I earned a bachelor's degree in electrical engineering (in the computer science option) from the Massachusetts Institute of Technology in 1972, a master's degree in computer science from Cornell University in 1981, and a Ph.D. degree in computer science from Cornell University in 1983. My graduate advisor was Gerard Salton, often called the "father of information retrieval" (IR). Some of my B.S. work was in the area of information storage and retrieval, and that area has been the focus of my work since 1978.

7. I have led development of a number of IR systems, including but not limited to: SMART, REVTOLC, CODER (including LEND), MARIAN, ENVISION, CITIDEL, CTRnet, and IDEAL. I have published about (hierarchical) thesauri and lexicons, query expansion (using both algorithmic and AI methods), relevance feedback, automatic Boolean query construction, extended Boolean

retrieval, hashing, clustering, categorizing, parallel and distributed approaches, advanced IR interfaces (including those helping with the management of result sets), metadata, digital libraries, Web archiving, text analysis, and many other of the subtopics related to IR.

8. I am a member of ACM (since 1967) and its Special Interest Group on Information Retrieval (SIGIR), for which I served 1987-1995 as vice chair and then chair; ACM has awarded me 6 recognition of service awards. I am a Fellow of IEEE (cited for leadership in digital libraries and information retrieval), and a member of IEEE-CS and its Technical Committee on Digital Libraries (including serving on its Executive Committee, and its chairman from 2004-2008).

9. Since 1987, I have led activities so that theses and dissertations could be prepared, archived, and made accessible in electronic forms. Since 1996, I have served as Executive Director of the Networked Digital Library of Theses and Dissertations, which was incorporated in 2003. I also serve as Founder and Chairman of the Board for NDLTD, which now has over 4.5 million electronic theses and dissertations in its Union Catalog.

B. Career Synopsis

10. I have been a professor at Virginia Polytechnic Institute & State University ("Virginia Tech") since September 1983, in the Department of Computer Science. Since February 2016, I also have a courtesy appointment in the Department

of Electrical and Computer Engineering. Since January 1998, I have also been the Director of the Digital Library Research Laboratory at Virginia Tech. From June 1990 to June 2014, I was the Associate Director for Research at Virginia Tech's Computing Center, which evolved to Faculty Advisor to Information Technology.

11. Prior to that, during August 1982 to April 1983, I was Manager of Information Systems at the International Institute of Tropical Agriculture, in Ibadan, Nigeria.

12. Prior to that, from September 1978 to August 1982, I was Instructor, Research Assistant, and Teaching Assistant at the Department of Computer Science at Cornell University.

13. Prior to that, from September 1972 to August 1978, I was Data Processing Manager in the Vulcraft Division of NUCOR Corporation.

14. Prior to that, from September 1971 to June 1972, I was Data Processing Instructor at Florence Darlington Technical College.

C. Career Milestones

15. I have been the recipient of a number of honors and awards relating to my work in information retrieval and other areas. The most recent related honor at Virginia Tech is the XCaliber Award 2016 "for extraordinary contributions to technology-enriched learning activities" for project called "Enhanced problem-based learning connecting big data research with classes."

16. I have held numerous board positions in various editorial, professional, and industry organizations and groups. For example, I served 2010-2013 as an elected member of the Computing Research Association Board, broadly representing the US computing research community.

17. I have an international reputation in many of the key areas related to handling information with computers, including information retrieval, digital libraries, and Web archiving. This work involves theory, algorithms, systems, and interfaces/user studies. It also is described currently by buzz words like search engines, big data, data analytics, machine learning, and natural language processing.

18. In these areas I have participated in, organized and presented at various conferences and workshops. Related keynotes, papers, posters, and demonstrations total over 425, and other presentations exceed 320.

19. I have conducted over 80 tutorials in over 28 countries.

20. I have received over 123 grants to fund my research, have (co)authored 18 books, and have edited book series for two publishers. In addition, I have (co)authored 118 journal or magazine articles. Google Scholar reports my works have been cited 14,973 times, with an h-index of 56 and i10-index of 203.

21. I have been involved in numerous software and information systems projects and products over the years.

22. I am a longstanding member of multiple professional societies.

23. My Curriculum Vitae (Exhibit A) provides a more complete listing of these honors, awards, and my activities.

D. Detailed Research Activity

24. The following four paragraphs describe in more detail some of the research work I have been involved in. Much of this research involves areas of technology that are most directly related to the subject matter of the patent at issue in this IPR.

25. One topic of research relates to queries, query operations, searching, ranking, and related sub-topics.

26. Another topic of research relates to content, text, multimedia, and related types of information and data.

27. Another topic of research relates to indexing and related work with indexes and other data structures to improve retrieval performance.

28. Another topic of research relates to human-computer interaction, presentation of results and content items, information visualization, and other aspects of user interfaces and retrieval system usage.

E. Invention

29. I am an inventor on U.S. Patent No. 7,346,621, issued March 18, 2008 and entitled "Method and System for Ranking Objects Based on Intra-type and Inter-type Relationships." I have participated in U.S. patent prosecution, and have a

general understanding of the process, and of the novelty and non-obviousness requirements for patentability.

III. MATERIALS REVIEWED

30. The analysis that I provide in this Declaration is based on my education, research, and experience in the field of information storage and retrieval, as well as the documents I have considered, including the '034 Patent, Ex.-1101 to the Petitioner's petition for *inter partes* review ("the Petition"), which states on its face that it claims priority to a provisional application filed on June 30, 2005. I have also reviewed the file history for the '034 Patent, including the excerpts that are Exhibits 1108-1112 to the Petition.

31. Furthermore, I have reviewed various relevant publications from the art at the time of the alleged invention of the '034 Patent, to which this Declaration relates. These publications include those listed below:

- U.S. Patent No. 7,039,635 ("Morgan") (Ex.-1102 to the Petition).
- U.S. Patent No. 6,718,324 ("Edlund") (Ex.-1103 to the Petition).
- PCT Publication No. WO 2004/010323 ("Lowles") (Ex.-1104 to the Petition).
- U.S. Patent Application Publication No. 2004/0267815 ("De Mes") (Ex.-1105 to the Petition).

- Ricardo Baeza-Yates & Berthier Ribeiro-Neto, *Modern Information Retrieval* (1999) (excerpts) (Ex.-1106 to the Petition).

32. I may rely upon these materials and/or additional materials to rebut arguments raised by the patentee. Further, I also may consider additional documents and information in forming any necessary opinions—including documents that may not yet have been provided to me.

33. My analysis of the materials produced in this investigation is ongoing and I will continue to review any new material as it is provided. This report represents only those opinions I have formed to date. I reserve the right to revise, supplement, and/or amend my opinions stated herein based on new information and on my continuing analysis of the materials already provided.

IV. UNDERSTANDING OF APPLICABLE LEGAL STANDARDS

34. I am not a patent attorney, nor have I independently researched the law on patent validity. Attorneys for the Petitioner have explained certain legal principles to me that I have relied upon in forming my opinions set forth in this report.

35. I understand that, in an *inter partes* review, Petitioner has the burden of proving that each challenged claim is unpatentable by a preponderance of the evidence.

A. Person Having Ordinary Skill in the Art

36. I understand that my assessment of claims of the ’034 Patent must be undertaken from the perspective of what would have been known or understood by a person of ordinary skill in the art (“POSA”), reading the ’034 Patent on its relevant filing date and in light of the specification and file history of the ’034 Patent.

37. For the relevant priority date for the ’034 Patent, I have used in my declaration the earliest application date on the face of the patent: June 30, 2005. However, I have not yet analyzed whether the ’034 Patent is entitled to that date for its priority.

38. Counsel has advised me that to determine the appropriate level of one of ordinary skill in the art, the following four factors may be considered: (a) the types of problems encountered by those working in the field and prior art solutions thereto; (b) the sophistication of the technology in question, and the rapidity with which innovations occur in the field; (c) the educational level of active workers in the field; and (d) the educational level of the inventor.

39. With over 40 years of experience in digital libraries and information retrieval, I am well acquainted with the level of ordinary skill required to implement the subject matter of the ’034 Patent. I have direct experience with and am capable of rendering an informed opinion on what the level of ordinary skill in the art was for the relevant field as of June 30, 2005.

40. The relevant technology field for the ’034 Patent is data/information search techniques. Based on this, and the four factors above, it is my opinion that a POSA would have had at least a bachelor’s degree in computer science and at least two years of experience in the relevant field designing, constructing, and/or testing systems that utilize data and/or information search techniques. My analysis and opinions regarding the ’034 Patent have been based on the perspective of a POSA as of June 30, 2005.

B. Obviousness

41. I understand that the law provides categories of information that constitute prior art that may anticipate or render obvious patent claims. To be prior art to a particular patent claim under the relevant law, I understand that a reference must have been published, or patented, or be the subject of a patent application by another, before the priority date of the patent. I also understand that the POSA is presumed to have knowledge of the relevant prior art.

42. I understand that a patent claim is unpatentable if, at the time of the invention, it would have been obvious to one of ordinary skill in the art to combine the teachings of the prior art to yield the patent claim. I also understand that it is not required (although it is acceptable) that each element/limitation of a patent claim be found in a single reference in order to find a patent claim obvious. Rather, for a patent claim to be found obvious, all the elements/limitations of the patent claim

must be found in a combination of references at which a person of ordinary skill in the art would have been reasonably expected to arrive.

43. I understand that a proper analysis of whether an invention is unpatentable for obviousness includes a review of the scope and content of the prior art, the differences between the patent claims and the prior art, and the level of skill in the pertinent art at the time of the invention.

44. I understand that a claim may be considered unpatentable for obviousness if there is a teaching or suggestion to combine prior art references in a manner that yields the claimed invention. I understand that a showing of obviousness requires some articulated reasoning with a rational underpinning to support the combination of the references. I understand that in consideration of the issue, it is important to identify whether a reason existed at the time of the invention that would have led a person of ordinary skill in the pertinent art to combine elements of the references in a way that yields the claimed invention.

45. I understand that a claim may be considered unpatentable for obviousness for various reasons. I have been informed that the following exemplary rationales may support a finding of obviousness:

(A) combining prior art elements according to known methods to yield predictable results;

(B) simply substituting one known element for another to obtain predictable results;

(C) use of a known technique to improve similar devices in the same way;

(D) applying a known technique to a known device ready for improvement to yield predictable results;

(E) choosing from a finite number of identified, predictable solutions with a reasonable expectation of success;

(F) known work in a field that prompts variations in the work in the same or a different field that leads to predictable results; and

(G) some teaching, suggestion, or motivation in the prior art that would have led a person of ordinary skill in the art to modify a prior art reference or combine multiple prior art references or teachings to arrive at the claimed invention.

46. I understand that various objective or "real world" factors may be indicative of non-obviousness. I understand that such factors include:

(A) the commercial success of the claimed invention;

(B) the existence of a long-felt, unresolved need for a solution to the problem solved by the claimed invention;

(C) failed attempts to solve the problem solved by the claimed invention;

(D) copying of the claimed invention;

(E) unexpected results of the claimed invention;

(F) praise for the claimed invention by others in the relevant field; and

(G) willingness of others to accept a license under the patent because of the merits of the claimed invention.

C. Broadest Reasonable Interpretation

47. I understand that, in the present *inter partes* review proceeding, the patent claims are given their broadest reasonable interpretation in light of the specification of the patent at issue. I also understand that claim terms, which are not expressly defined in the patent, are to be given their plain and ordinary meaning as would be understood by one of ordinary skill in the art in view of the patent specification.

V. STATE OF THE ART AND OVERVIEW OF THE '034 PATENT

A. State of the Art

48. A broad overview of the state of the art is covered by Ricardo Baeza-Yates & Berthier Ribeiro-Neto, *Modern Information Retrieval* (1999). Ex.-1106 (pertinent excerpts). I co-authored Chapter 15 (Digital Libraries) with Ohm Sornil, then a Ph.D. student I advised. As is explained above in Section II.D, much of my research connects with the topics covered in many of the other chapters as well. As discussed in this book, "[i]nformation retrieval (IR) deals with the representation, storage, organization of, and access to information items. The representation and

organization of the information items should provide the user with easy access to the information in which he is interested." (Ex.-1106, p.15). Germane to discussion of obviousness in this matter is the focus of the book: "We put great emphasis on the integration of the different areas which are closed related to the information retrieval problem and thus, should be treated together." (Ex.-1106, p. 17). This is made clear in Figure 1.3, copied below.

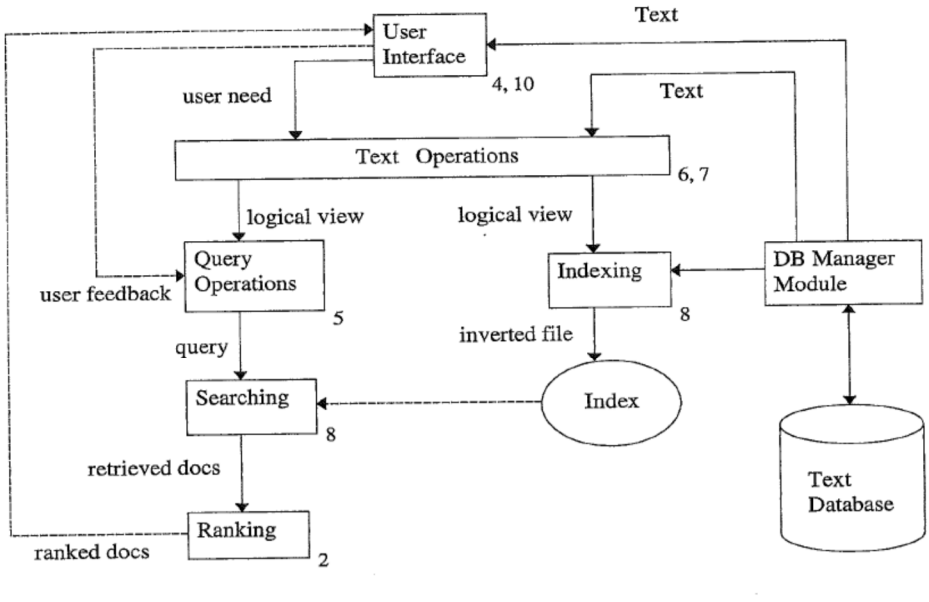


Figure 1.3 The process of retrieving information (the numbers beside each box indicate the chapters that cover the corresponding topic).

Ex.-1106, *Modern Information Retrieval*, Figure 1.3 (p. 24).

49. Chapter 2, Modeling, in Section 2.5.1 covering Basic Concepts (p. 38), explains "The classic models in information retrieval consider that each document is described by a set of representative keywords called index terms." (Ex.-1106, p.

38). For an index term in a documents, its ". . . weight quantifies the importance of the index term for describing the document semantic contents." (Ex.-1106, p. 39).

50. Chapter 4, Query Languages, includes in Section 4.3 a discussion of Pattern Matching, (Ex.-1106, p. 91), the broad method considered in the '034 Patent as successive characters are entered and matched with terms that begin with the characters already seen. Even more complex patterns are described than occur with overloaded keyboards: "For instance, consider a query like 'pro (blem | tein) (s | ε) (0 | 1 | 2)*' (where ε denotes the empty string). It will match words such as 'problem02' and 'proteins.' As in previous cases, the matches can be restricted to comprise a whole word, to occur inside a word, or to match an arbitrary text segment." (Ex.-1106, p. 93).

51. Chapter 8, on Indexing and Searching, in Section 8.2, (Ex.-1106, p. 128), explains Inverted Files, illustrated in Fig. 8.1 below, which shows how words are mapped to their occurrence locations in storage. The character count for the start of each word in the text string is shown at the top.

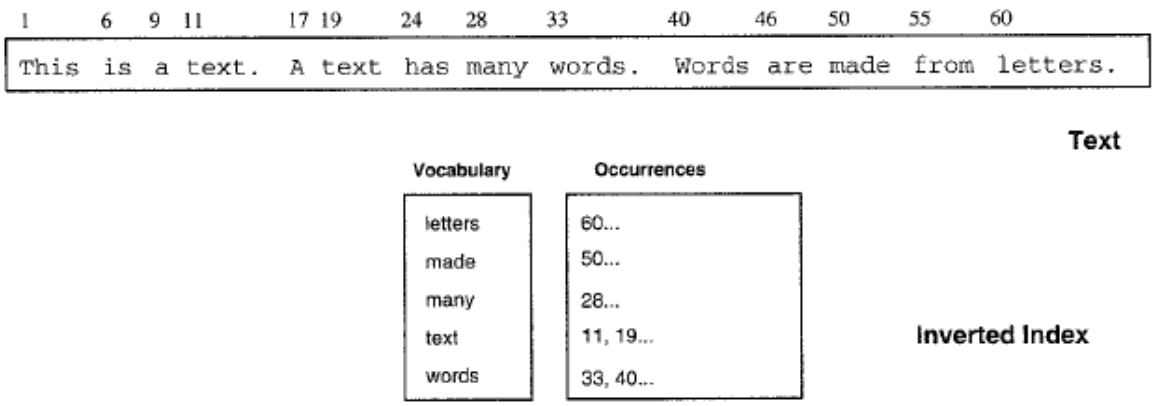


Figure 8.1 A sample text and an inverted index built on it. The words are converted to lower-case and some are not indexed. The occurrences point to character positions in the text.

Ex.-1106, *Modern Information Retrieval*, Figure 8.1 (p. 129).

52. Fig. 8.3, shown below, extends that discussion, explaining the building of an inverted index, which is an aid to fast retrieval, here organized so that prefixes of words are mapped to sub-trees of sets of words starting with those prefixes, and to the individual words and their occurrences. The character count for the start of each word in the text string is shown at the top. Thus, character counting is necessary in parsing the text to build an index into it. The vocabulary trie serves as one type of index into that text. If a word is being looked up in this type of inverted file, as characters are entered, possible text locations are identified. Thus, for a string of length 1 (character count 1) starting with "l," a position (character count) of 60 is returned, for the word "letters." For a character count of 1, with "m," followed by an "a" (character count 2), then if there is a "d" (character count 3) the word "made"

is found at position 50, while if there is an "n" (character count 3) the word "many" is found at position 28.

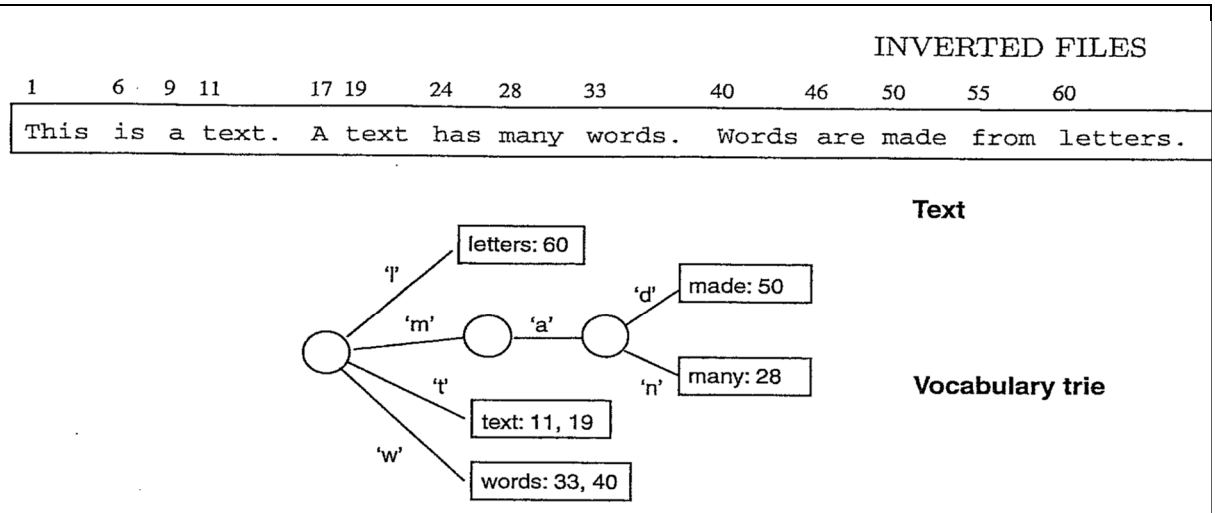


Figure 8.3 Building an inverted index for the sample text.

Ex.-1106, *Modern Information Retrieval*, Figure 8.3 (p. 133).

53. Section 8.3.1, on Suffix Trees and Suffix Arrays, explains, and illustrates in Fig. 8.6, shown below, one type of data structure (e.g., trie) that could index the terms so they can be identified quickly given a prefix of a term entered as discussed in the '034 Patent; the searching operation is explained on p. 138. As explained above, character counts for the text string are shown at the top, and whether one uses a suffix trie or suffix tree as index structure, character counts must be utilized when parsing the text during indexing, as well as during lookup of a string to find its occurrences in the text.

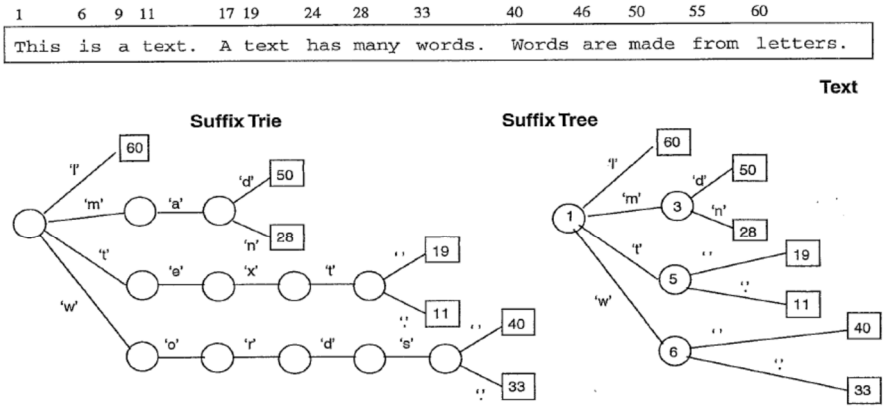


Figure 8.6 The suffix trie and suffix tree for the sample text.

Ex.-1106, *Modern Information Retrieval*, Figure 8.6 (p. 136)

54. Going beyond considering individual terms, Chapters 2 and 5 (Query Operations) discuss multiple approaches to

a. take queries made of multiple terms, associate weights (relevance values) with those query terms;

b. associate weights with terms in documents, namely a set of possibly desired items (popularity values); and

c. find and order a group of matching documents for a query.

55. Further, Chapter 10 discusses User Interfaces and Visualization, starting with an overview (Ex.-1106, p. 165):

> This chapter discusses user interfaces for communication between human information seekers and information retrieval systems. Information seeking is an imprecise process. When users approach an information access system they often have only a fuzzy understanding of how they can achieve their goals.

> Thus the user interface should aid in the understanding and expression of information needs. It should also help users formulate their queries, select among available information sources, understand search results, and keep track of the progress of their search.

56. As discussed herein, for example, several techniques were known in the art as of June 30, 2005, covering the various aspects of information retrieval, including indexing of desired items, allowing lookup using one or more characters as well as searching using relevance values, popularity values, and/or other weighted values associated with a search term for a desired item.

57. In short, many years of research and development in the field of the '034 Patent description had occurred prior to July 2005. I did my first work in this area by 1972, and my graduate advisor had managed research systems in the 1960s. Techniques for working with many types of input devices were well studied. By 2004, use of the WWW (*see* Ex.-1106, Chapter 13, Searching the Web, including discussion of popularity on pp. 232-33) was common, and searching was ubiquitous. More efficient ways to search with all types of input devices, including handheld units, were well understood.

58. Techniques for handling text items, often discussed using the general term document, had been well developed. Text documents were received, analyzed, indexed, categorized, and stored for subsequent access. Indexing typically included

tokenization, e.g., finding each word, counting the words to determine their frequency, storing frequencies or more advanced weights with those words, and later using those weights for ranking, ordering, and display to users. Manual and automatic categorization and classification were well understood to help with searching and browsing.

59. User input also was analyzed. String analysis, matching, and searching were supported with a broad range of data structures, algorithms, software, and systems. Prefixes and more advanced patterns were received and used in searching to identify words and find documents.

60. All of these and other advances related to information retrieval were reported in conference proceedings, journals, monographs, and textbooks. In my annual course on Information Retrieval, I taught from these works, so one of ordinary skill in the art would have understood the above mentioned content.

B. Overview of the ’034 Patent

61. The ’034 title is “Method And System For Incremental Search With Reduced Text Entry Where The Relevance Of Results Is A Dynamically Computed Function Of User Input Search String Character Count.” According to the Abstract, “A method and system are provided for processing a search request received from a user operating a text input device. The search request is directed at identifying a desired item from a set of items. Each of the items of the set of items has one or

more associated terms. The method includes receiving a query input from a user directed at identifying the desired item." '034 Patent, Abstract. Thus far, the discussion is exactly situated as information retrieval.

62. The Abstract continues to state: "The query input comprises one or more characters input by the user on the text input device. As each character of the query input is received from the user, a group of items having one or more terms matching the characters received thus far of the query input is dynamically identified." This description matches closely with well-known information retrieval techniques discussed above in Section V.A. The '034 Patent claims creates a "first ranking order of items" based in part on relevance values and popularity values associated with items with character(s) matching the query input. *See* '034 Patent, claims 1 and 16. As the user adds one or more characters to the query input, a "second ranking order of items" is determined based in part on popularity values and adjusted relevance values associated with items matching the now set of characters in the query input. '034 Patent, claims 1 and 16. Items are also categorized into "subspace categories" of interest—genres (e.g., TV shows or movie names, TV or movie casts, etc.), individual weighting-based categories, or personal search history,

see '034 Patent, 7:19-25[1]; Fig. 7—which may be used as filters. '034 Patent, 7:25-28. Subspace categories may have a relevance bias value that "causes certain subspace results to have a higher relevance than other subspaces." '034 Patent, 7:36-37, *see also* claims 1, 16. At least one of the "first ranking order of items" and "second ranking order of the items" is based on the relevance bias value of the subspace categories. '034 Patent, claims 1 and 16.

VI. PRIOR ART

63. I understand that Comcast Cable Communications, LLC is requesting *inter partes* review of claims 1-30 of the '034 Patent under the grounds set forth in the table below.

Ground	'034 Patent Claims	Basis for Unpatentability
1	1, 4, 6-8, 11-16, 19, 21-23, 26-30	Obviousness by U.S. Patent No. 7,039,635 ("Morgan") in view of U.S. Patent No. 6,718,324 ("Edlund")
2	2, 5, 9-10, 17, 20, 24-25	Obviousness by Morgan in view of Edlund and PCT Publication No. WO 2004/010323 ("Lowles")
3	3, 18	Obviousness by Morgan in view of Edlund and U.S. Patent Application Publication No. 2004/0267815 ("De Mes")

[1] The notation N:XX-YY refers to column (or page) number N, and lines XX to YY of a reference.

A. U.S. Patent No. 7,039,635 ("Morgan")

64. Morgan is a U.S. patent that issued on May 2, 2006 based on a patent application filed August 22, 2002 that claims priority to a provisional patent application filed June 11, 2002. I have been instructed that Morgan therefore is prior art under 35 U.S.C. § 102(e) (pre-AIA).

65. Morgan is relevant prior art because it discloses systems and methods for "dynamically updated quick searches and strategies." Morgan, Title; *see also* 1:13-19. It discloses users entering characters leading to search strategies and quick matches so the search result pane is dynamically updated as the user inputs additional characters. Morgan, Abstract. A user's entered characters constitutes "the search request directed at identifying a desired item from a set of items" ('034 Patent, claim 1) since Morgan discloses finding desired information from the "ENCARTA Reference Library" or "in almost any database," and "[v]irtually any searching activity conducted in response to an input of characters by a user to specify keywords or a search query." Morgan, 8:13-38. This is clearly addressing "the task of identifying specific data of interest." Morgan, 1:27-28.

66. As can be seen in Fig. 1 (reproduced below), Morgan describes the invention as operating on a conventional PC with a processing unit, system memory, disk drives, monitor, remote computer, and network interconnections. Morgan, 4:17-21, Fig. 1. However, "this invention may be practiced with other computer

system configurations . . . including handheld devices, pocket personal computing devices, digital cell phones . . . game consoles, TV set-top boxes . . . network PCs." Morgan, 5:12-18. It also may be practiced in distributed computing environments, with remote processing devices connected by network, and with local and remote memory storage devices. Morgan, 5:21-26, 6:40-42, *see also* 8:26-35, 8:52-65, 11:44-50.

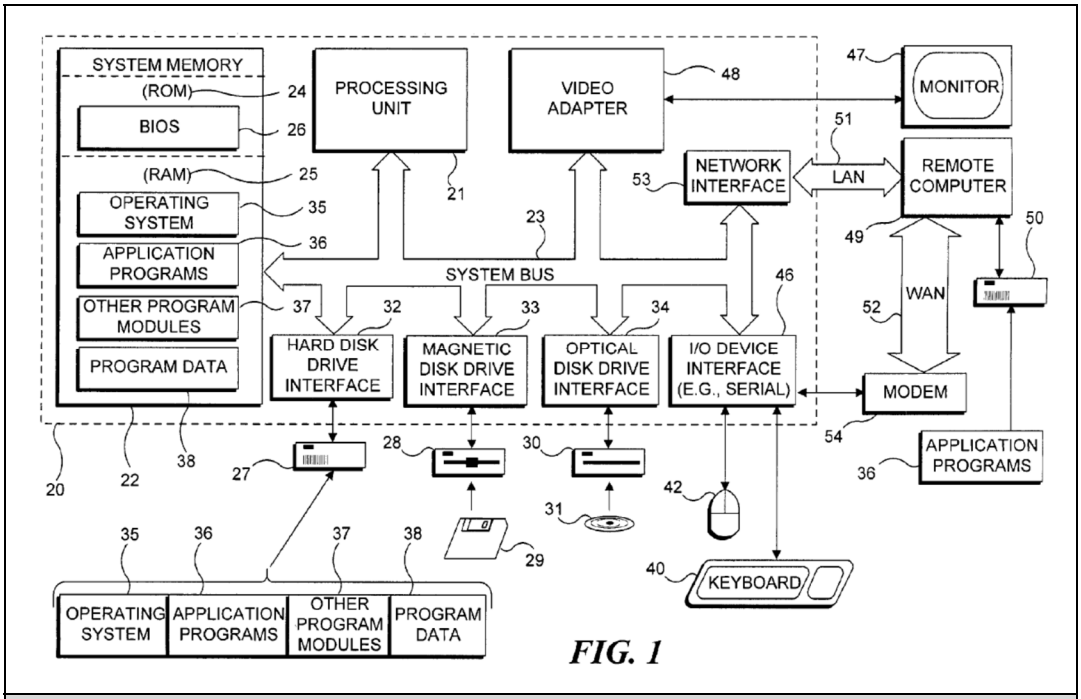


FIG. 1

Ex.-1102, Morgan, Fig. 1

67. As can be seen in Fig. 3 (reproduced below), Morgan's minifind window supports users typing characters one at a time, and searching and displaying results for each prefix of a search term. Results include English-like search suggestions, i.e., "search strategies" (that can be for different categories), as well as

"quick matches," both dynamically updated as characters are entered. Morgan, 2:64-3:2, 7:65-8:8, Fig. 3.

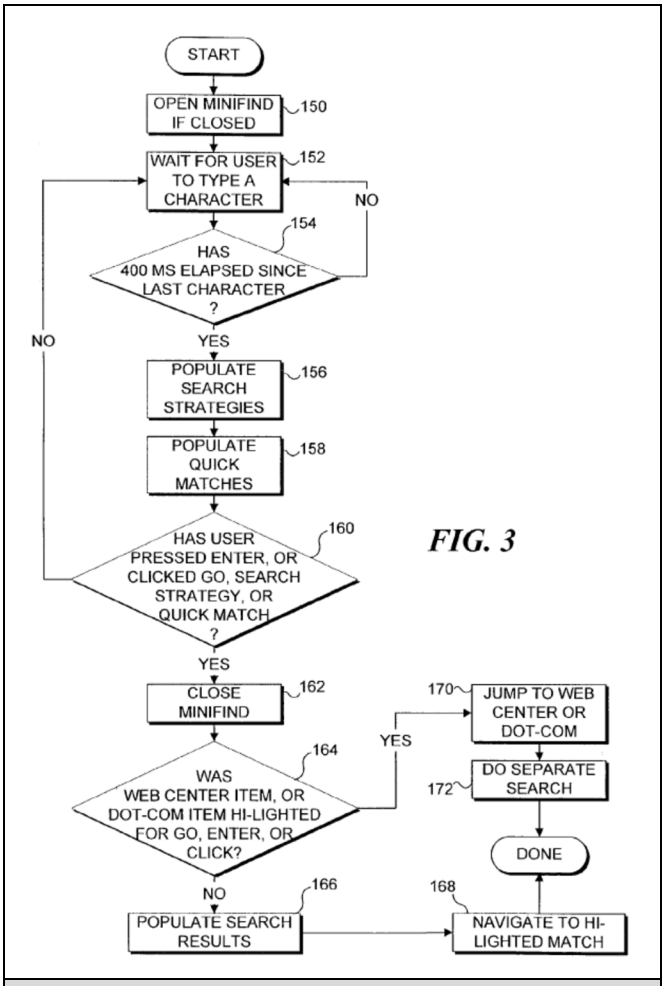
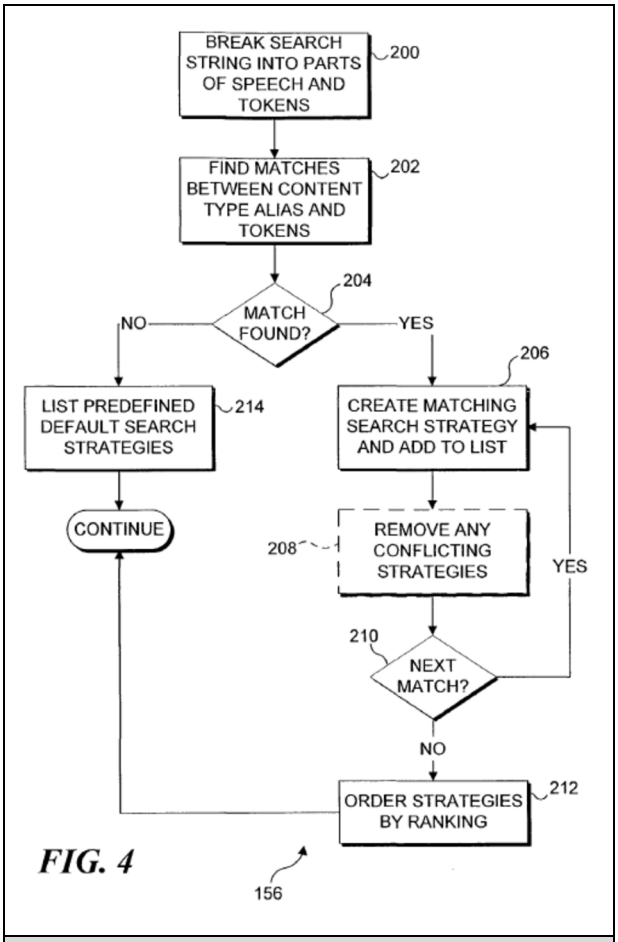


FIG. 3

Ex.-1102, Morgan, Fig. 3

68. As can be seen in Fig. 4, reproduced below, to populate a search strategies list (Morgan, 4:47-48, 12:1-2), Morgan breaks user input strings into tokens, each of which is considered during matching (searching), with ranking of "search results according to their likely relevance to the input text," and giving preference when more of the tokens (keywords) match. Morgan, 2:3-8. "Step 200 provides for parsing the string input by the user, which may comprise a portion of a

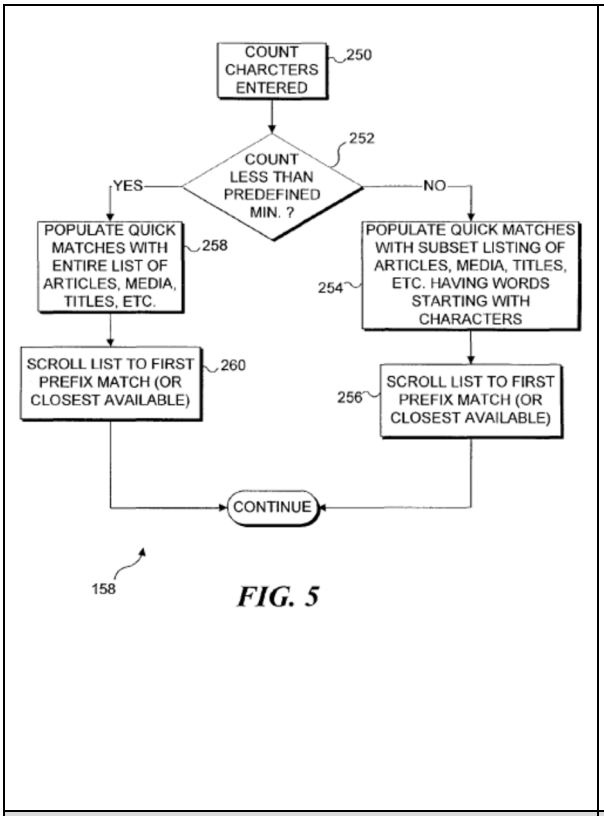
word or even a single character, or one or more words." Morgan, 12:4-6. Step 202 searches and finds matching terms based on that input. Morgan, 12:6-20.



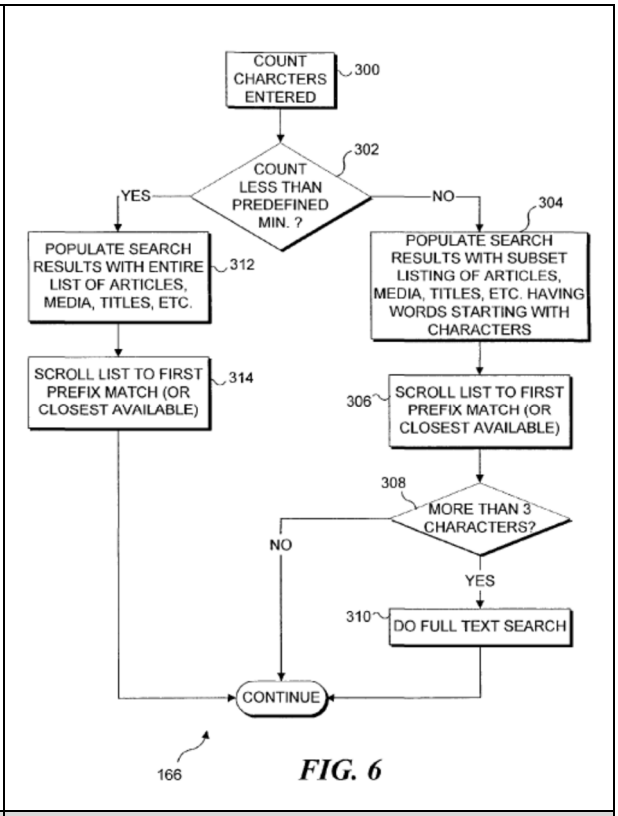
Ex.-1102, Morgan, Fig. 4

69. As can be seen in Morgan's Fig. 5 and Fig. 6, reproduced below, about populating a quick matches listing, the search processing depends on the count of characters entered. Morgan, 12:44-54, Fig. 5, Fig. 6. In Fig. 6 (step 308), a count of more than 3 characters controls the processing, for full text search. In both figures, results are chosen if they have words starting with the characters entered by the user (prefix match). Thus, "step 254 includes items with words that start with

the characters input by the user, even though the words are not the first words in the item as displayed. For example, if the user enters 'rup,' the quick matches listing will include 'Prince Rupert.'" Morgan, 13:4-8.



Ex.-1102, Morgan, Fig. 5



Ex.-1102, Morgan, Fig. 6

70. Morgan's Fig. 7B, reproduced below, shows this prefix matching after 4 characters, i.e., with "Turk" entered, and quick matches changed in response, including "Turk Broda," "Turk Edwards," "Turkana," "Turkana Bay," and "Turkana, Lake." Morgan, 4:56-59, 10:33-39, Fig. 7B. In addition, this figure allows spatial/geographic limitation of searching in "Find Atlas Maps of 'Turk.'" Morgan, Fig. 7B. The results given arise due to the entry of "Turk" into the initially

empty Find dialog box that is illustrated in Fig. 7A, reproduced below. Morgan, 4:53-55, Fig. 7A.

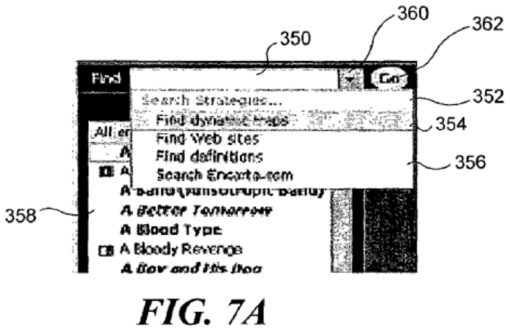


FIG. 7A

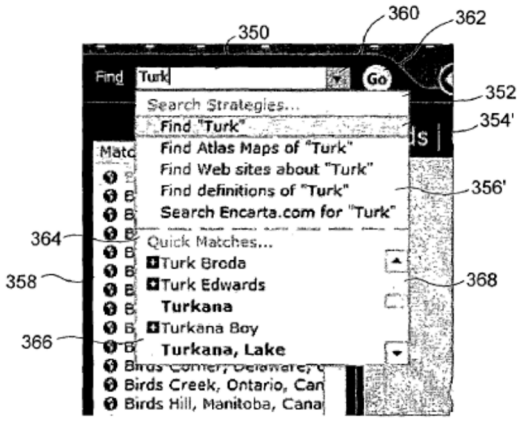


FIG. 7B

Ex.-1102, Morgan, Fig. 7A	Ex.-1102, Morgan, Fig. 7B

71. Continuing the entry of characters by the user leads to "Turkey" as the term given in Morgan's Fig. 8, reproduced below. Morgan, 10:44-47, Fig. 8. With that same input, Fig. 9, reproduced below, shows a longer and more organized set of results, after the user has pressed Enter or Go, and (not shown) "content search data relating to the country 'Turkey.'" Morgan, 10:59-11:2, *see also* 4:64-65, Fig. 9. There is an entry "Turkey: Historical Dates," and the bottom entries show a temporal/historical organization, with years including 1959, 1962, 1964, and 1979. Morgan, Fig. 9. Multiple entries in each show location related categories. Morgan, Fig. 8 ("Find Atlas Maps of 'Turkey,'" "Turkey (country)"), Fig. 9 ("Turkey country," "Turkey Creek," "Turkey Lake," "Van (city, Turkey)," "Yozgat (city, Turkey)").

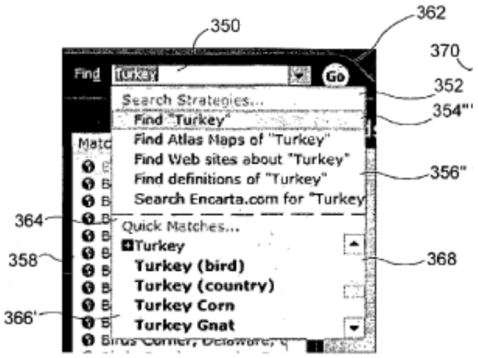
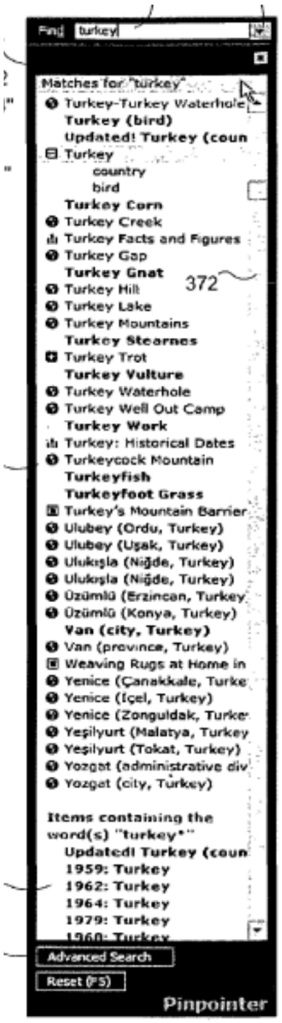


FIG. 8



Ex.-1102, Morgan, Fig. 8	Ex.-1102, Morgan, Fig. 9

72. Morgan's advanced search, illustrated in Fig. 10, reproduced below, allows filter/selection according to content type, or category/subcategory terms. Morgan, 11:3-8, Fig. 10. One possible selection shown is "Historical Maps" which allows controlling results on a temporal basis. Morgan, Fig. 10. Likewise, there are location related entries: "Africana Articles," and "Library of Black America." Morgan, Fig. 10. Therefore, search results can be constrained by location.

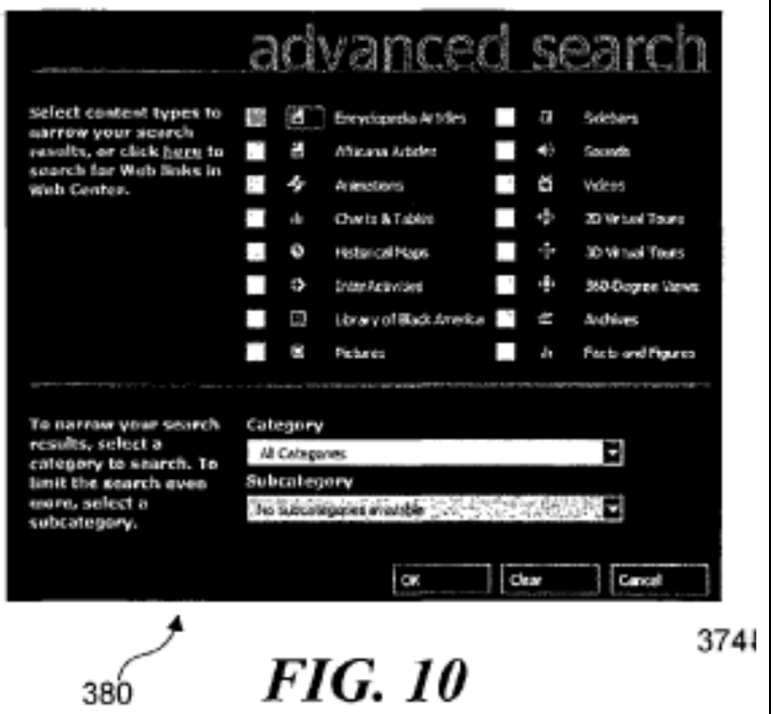


FIG. 10

Ex.-1102, Morgan, Fig. 10

B. U.S. Patent No. 6,718,324 ("Edlund")

73. Edlund is a U.S. patent that issued on April 6, 2004 based on an application filed on January 30, 2003. I have been instructed that Edlund is prior art under 35 U.S.C. § 102(b) (pre-AIA).

74. Edlund is relevant prior art because it discloses systems and techniques for searching for items of content that "utilizes a combination of popularity and/or relevancy to determine a search ranking for a given search result association." Edlund, Abstract.

75. Though Edlund describes the use of a personal computer, "any computing device may be utilized to implement the teachings of the present

invention." Edlund, 5:10-17. Edlund discloses storing personalized history information for users, recording which documents in results lists they prefer (Edlund, 19:66-67, 11:60-64), then:

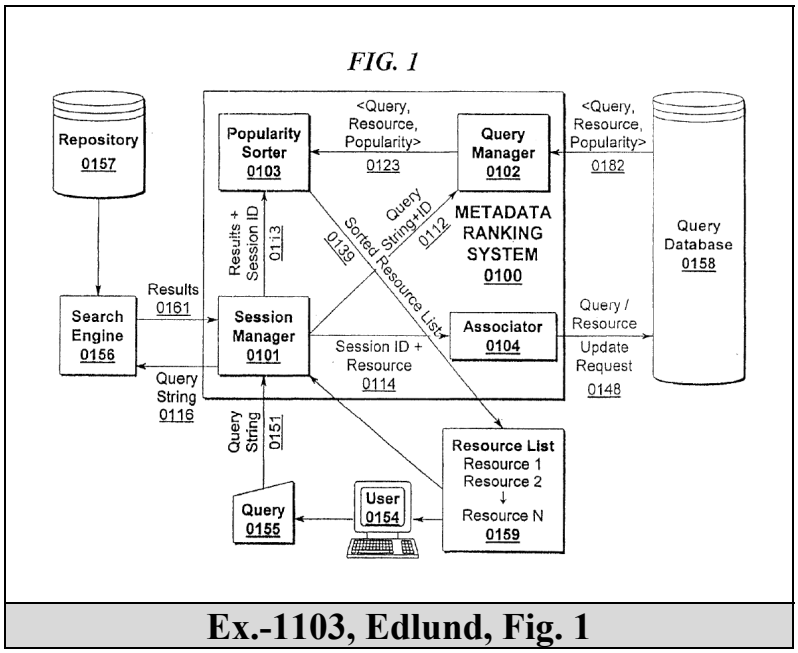
> [o]ne way to enhance a search engine upon receiving a query is to first use the search engine to find its ordered list of web pages for the query, then use the previous data on the preference to reorder the list. This technique will statistically improve the chance that better fit pages are on the top of the list.
>
> Edlund, 11:65-12:3.

76. Edlund discloses search techniques for locating information on the World-Wide-Web. Edlund, Abstract. Edlund discloses presenting a graphical user interface used to enter one or more keyword search terms. Edlund, 3:29-32. The keyword(s) is used to search indexed lists of information (for example, documents located on the World-Wide-Web). Edlund, 3:29-32, 11:60-62. Search examples include search strings (for example, "multi* near thread*") that can include one or more terms that each are viewed as a prefix of a word that appears in search result items. Edlund, 19:15-29.

77. Edlund assigns documents on the Web (i) a "content relevance" based on matching the keyword search terms to words in a particular document, (ii) a popularity value based on the number of times a document has been accessed, and

(iii) a temporal value which relates to the age of the document or its update frequency. Edlund, 3:46-51.

78. Figure 1 from Edlund, reproduced below, illustrates the data flow utilized to search for items based on a combination of an item's relevance value and popularity.



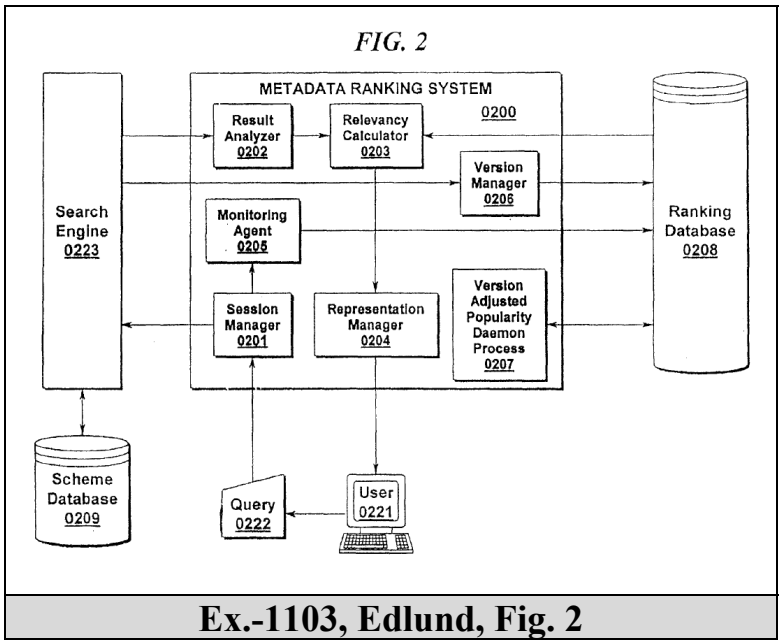
Ex.-1103, Edlund, Fig. 1

79. The user (0154) inputs, via a graphical user interface, keywords for a query (0155), hence query, string, search string, search query, or search query string. Edlund, 3:28-30, *see also* 2:53, 3:7, 5:45-47, 6:2, 6:28, Fig. 1, Fig. 3. A session manager (0101) receives the search string and passes the query to a search engine (0156). Edlund, 5:45-48, 62-66. The search engine (0156) "calculates the content relevance . . . and return [sic] a list of search results ranked based on this content relevance." Edlund, 6:10-12; 8:29-31. The user query string is also passed to a

query manager (0102) which uses the query string to generate a popularity value for documents that match the user query. Edlund, 6:34-43 ("The Query Manager (0102) then creates a list of the resources with the associated popularity vector . . . In general the popularity information is ranking information that indicates the popularity of a given resource."); 7:27-31 ("the popularity vector is a single element vector simply keeping track of the number of times a resource has been accessed . . .").

80. The content relevance value and popularity value for the resources that matched the user query are passed to a Popularity Sorter (0103) which ranks the resources based on popularity value followed by relevance value. Edlund, 6:51-63. Edlund "sorts resources with a higher popularity vector on top of the list, followed by the rest of the result set resources ranked by relevance (using the provided ranking information)." Edlund, 6:65-7:1. The sorted resource list (0159) is then returned and displayed to the user. Edlund, 7:1-4.

81. Figure 2 of Edlund, reproduced for convenience, describes an alternative search methodology that also displays a list of search results based on a combination of relevance values and popularity values for the items searched.



Ex.-1103, Edlund, Fig. 2

82. A session manager (0201) receives a query (0222) entered by the user at an input device such as a computer. Edlund, 8:12-13. The query is passed from the session manager to a search engine (0223) that will calculate the content relevance of documents and return a list of search results based on the relevancy rank, typically sorted in ascending or descending order, to a result analyzer. Edlund, 8:29-39.

83. Next, a result analyzer generates "a list data structure, containing the search result items, along with their content relevance." Edlund, 8:47-50. A ranking database (0208) is queried for each search result item to determine a popularity value and recency value. Edlund, 8:53-59, 10:2-4. The ranking database contains all information necessary to compute a popularity value (based on the number of hits for a particular item) and a recency value. Edlund, 10:2-7.

84. A ranked order of search results is finalized using the content relevance, popularity value, and recency value. Edlund, 8:60-67.

85. Hence, Edlund discloses multiple ways to utilize popularity so that "human knowledge is automatically collected and can then be reused by other users. Therefore, resources that are more often reviewed and visited will have a higher ranking." Edlund, 3:14-16.

86. Edlund discloses search techniques well-known to one of ordinary skill in the art utilizing a combination of criteria (relevancy and popularity values) for ordering search results.

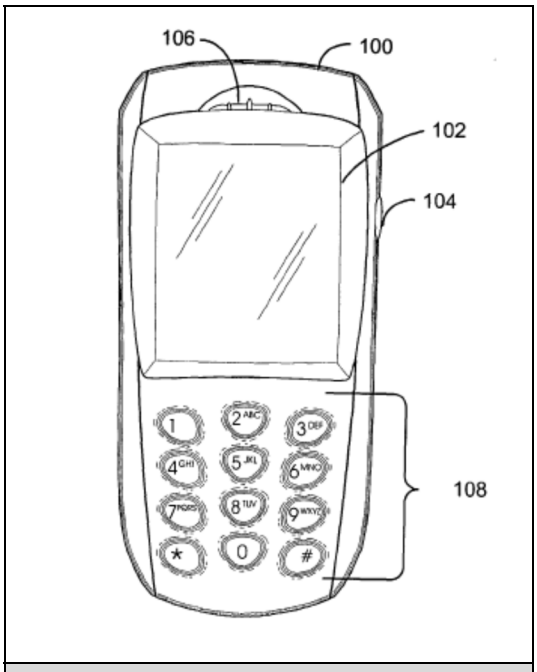
C. PCT Publication No. WO 2004/010323 ("Lowles")

87. Lowles is an international application published under the PCT that published on January 29, 2004. I have been instructed that Lowles therefore is prior art under 35 U.S.C. § 102(b) (pre-AIA).

88. Lowles is relevant prior art because it discloses systems and methods of building and using lists on an electronic device, with stored weightings assigned to words, allowing users to find desired text items. Lowles, Abstract.

89. Lowles discloses many different types of devices including "a mobile phone having an ITU E 1.161 Standard Key Pad . . . ," where "a user . . . typically uses a multi-tap method to achieve proper character inputs," and that "text methods are particularly helpful for devices with limited keyboards, in which text inputs may

be ambiguous because each key represents a plurality of characters", i.e., that these "[p]redictive text methods have been applied in conjunction with such keypads and keyboards to reduce the reliance on multi-tap methods." Lowles, 1:14-26; *see also* Fig. 6 (reproduced for convenience below). Clearly Lowles discloses methods to aid a user operating a hand-held text input device.



Ex.-1104, Lowles, Fig. 6

90. Lowles discloses about "building and using a custom word list", and how to "identify words in the text items." Lowles, Abstract. As is shown in Fig. 1 (reproduced below), "[t]he data store 16 stores text items that are associated with a user of the computer system 12 and the electronic device 14." Lowles, 4:24-25. Lowles discloses that "[t]ext items include, for example, sent email messages, documents, acronym lists, and existing word lists." Lowles, 5:2-3. The "words" in

the word lists can be words "delineated by spaces or punctuation" or "phrases or strings," such as "[e]mail addresses, hyperlinks, and signature blocks . . ." wherein the latter "comprise groups of words that frequently occur together at the end of a text item." Lowles, 8:2-11. Clearly, Lowles discloses about sets of text items that include words.

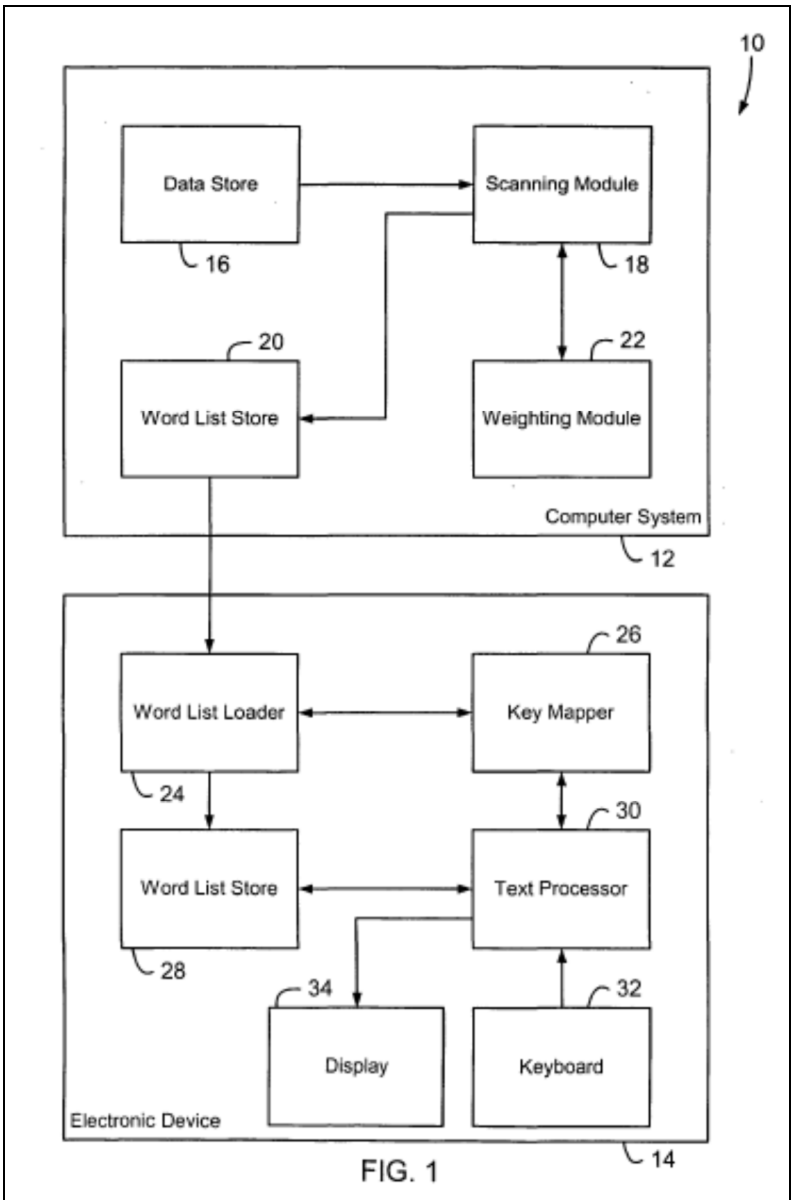


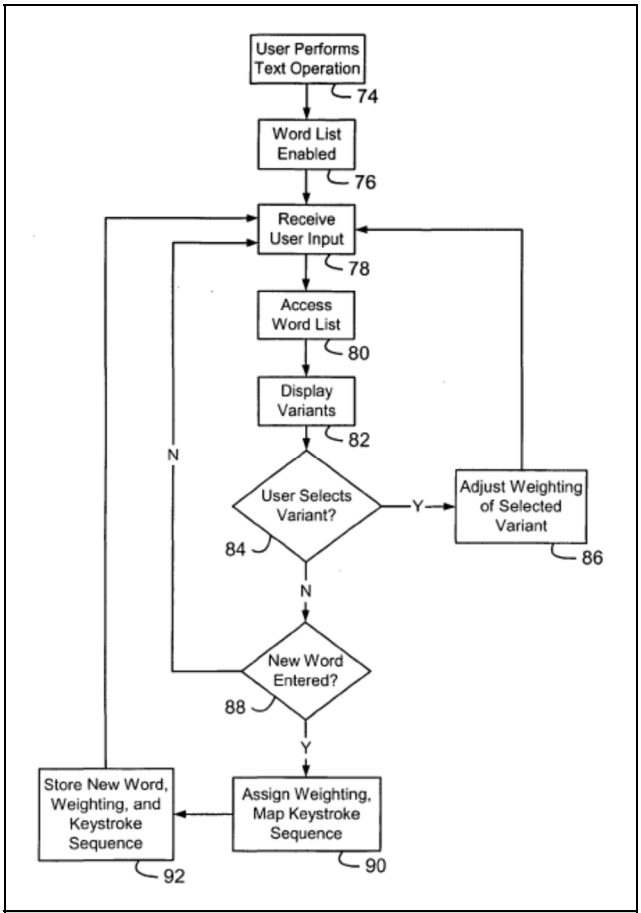
FIG. 1

Ex.-1104, Lowles, Fig. 1

91. Lowles discloses users of a device with a reduced keyboard typing in order to identify a desired item. As can be seen in Fig. 5 (reproduced below):

> User input is received at step 78, when the user begins typing . . . The custom word list is then accessed at step 80 to identify words in the custom word list representing possible variants of the received inputs. Where the keyboard is a reduced keyboard, then an input keystroke sequence may be ambiguous, such that more than one word in the custom word list is mapped to the input keystroke sequence.

Lowles, 16:4-9.



Ex.-1104, Lowles, Fig. 5

92. Lowles further discloses categorization of the items, and category based searching of those items. The categories can be used for filtering during accesses and searches, and can be prioritized so as to effect those operations, including through weighting adjustment. Lowles, 16:24-17:28. "Categories may include mailing address, email address, name, hyperlink, recurring word grouping, different language categories, acronyms, and user added words . . . ." Lowles, 10:22-23. Categories can be determined in several ways, including being inferred from context. Lowles, 17:10-16.

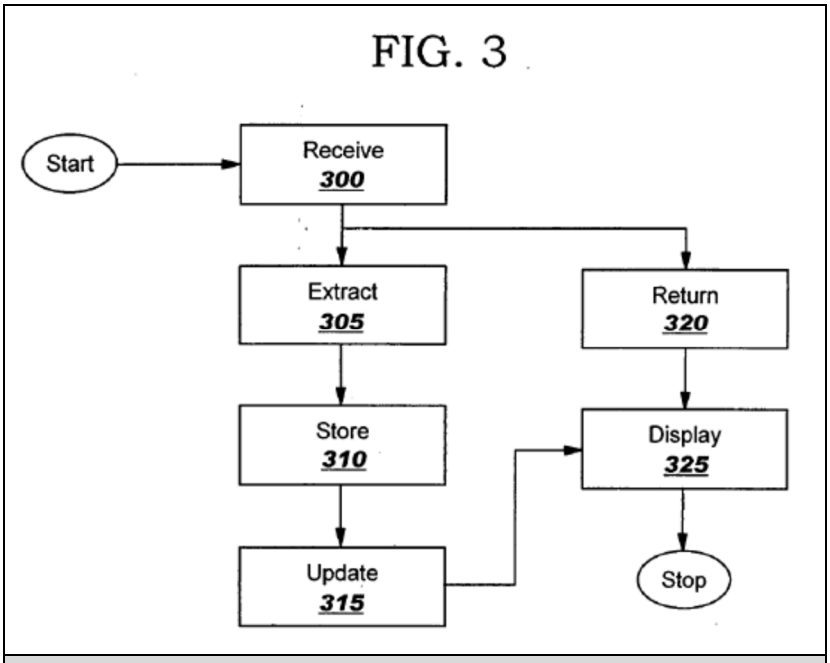
D. U.S. Patent Application Publication No. 2004/0267815 ("De Mes")

93. De Mes is a U.S. Patent Application Publication with publication number US2004/0267815 and publication date December 30, 2004. It was filed March 25, 2004, with Application Number 10/809,575. I have been instructed that De Mes therefore is prior art under 35 U.S.C. § 102(e) (pre-AIA).

94. De Mes is relevant prior art because it discloses systems and methods for creating and searching with a personal browsing history. It responds to user input, obtains web pages from the Internet, extracts metadata and textual data, indexes and stores those, and supports searching and display in categories using the index. De Mes, Abstract.

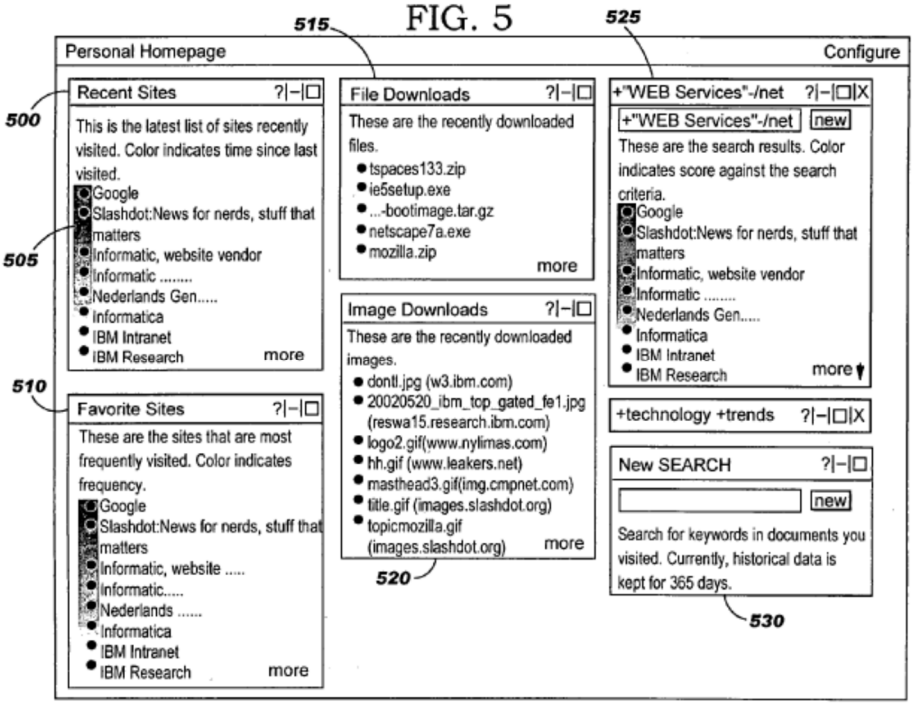
95. De Mes discloses creating a personal browsing history, as is shown in Fig. 3 (reproduced below). "At step 430 the personal browsing history application

125 creates a searchable personal browsing history" based on (multiple) search results, controlled by information provided by or related to the user. De Mes, ¶37.



Ex.-1105, De Mes, Fig. 3

96. De Mes discloses displaying a categorized browsing history, as is shown in Fig. 5 (reproduced below). This dynamic view changes as the user searches, and has different sections, including for sites that have been recently visited, for favorites, and for downloads. Scoring is reflected by color, with more intense colors for higher scores. De Mes, ¶38. The categorized view supports efficient searching and access to information. De Mes, ¶¶9, 12.



Ex.-1105, De Mes, Fig. 5

VII. CLAIM CONSTRUCTION

97. I construe the claim limitation "***item***" in light of the specification to mean a particular thing (such as, but not limited to, a part of an enumeration, a document, a channel or a type of content). *See* Merriam-Webster's Collegiate Dictionary, 622 (10th ed. 1993). The '034 Patent recites the term "item" in a number of portions of the specification and claims. '034 Patent, Abstract ("The search request is directed at identifying a desired item from a set of items."); 1:24-26 ("The present invention relates to data search techniques, and more particularly, to techniques for performing searches for television content and channels and other items."). The '034 Patent also states that its disclosure has broad application: "these

concepts can apply to processing search requests in a variety of environments in which particular data items or content is sought in response to a user query." '034 Patent, 4:20-22. In that regard, the '034 Patent provides examples of such environments. '034 Patent, 4:31-35 ("[t]elevision content items"); 6:66-67 ("content item (also referred to herein as a document, e.g., a particular movie"); Fig. 5 (box 502).

98. I construe the claim limitation "***the text having one or more text characters of one or more prefixes for terms the user is using to identify a desired item***" in light of the specification as the text having one or more characters associated with a string. '034 Patent, claim 1, 16. The '034 Patent provides examples of a user entering a prefix having one, two, or more characters of the intended search query. '034 Patent, 6:7-10 ("For example, to represent 'Brad Pitt,' the user may enter B P, BR P, B PI etc."); 9:45-50 ("For example, in the case of 'Everybody Loves Raymond' user could have entered 'E L' (E<space>L) instead of the query 'EV' . . . in one case the input characters represented one prefix . . . while the other represented two prefixes.").

99. I construe the claim limitation "***the count of the number of text characters***" in light of the specification to mean the numerical magnitude of characters. *See* '034 Patent, claim 1, 16. In other words, as the user enters more characters, the magnitude of characters increases from a first magnitude (to

determine the first ordered ranking of items) to a second magnitude (to determine the second ordered ranking of items). As the number of characters changes from one magnitude to another, the relevance value is adjusted. '034 Patent, 8:67–9:4 (increasing the number of characters). Similarly, as the user enters more characters, the characters change from a first group of characters (to determine the first ordered ranking of items) to a second group of characters (to determine the second ordered ranking of items). Moreover, the second group of characters necessarily has a greater magnitude than the first group of characters. As the group of characters changes, the relevance value is necessarily adjusted. During prosecution of the '034 Patent application, the Applicant asserted "count of the number of text characters" to mean a numerical value. Ex.-1111, p. 11.

100. I construe the claim limitation "***subspace category***" in light of the specification to mean a category, for part of a search space, associated with an item. The '034 Patent explains: "The creation of subspaces may be based on a wide range of criteria including, but not limited to, (1) broad genre based subspace categorization, (2) individual term weighting-based categorization, or (3) personal search history (time sensitive and/or user specific) based categorization." '034 Patent, 7:20-25. Examples of subspace categories include TV channel name, TV shows, TV casts, movie names, movie casts, personalized search history. '034 Patent, 7:37-46; Fig. 7.

101. I construe the term "***relevance bias value***" in light of the specification to mean a weighting or measure that gives preference over another. Relevance bias value can be a binary value, a real number value, or a constrained real number (e.g., a probability). For example, the relevance bias value of an item may be a weighting of a subspace category. The specification provides many examples of the relevance bias value. '034 Patent, 7:34-37, 7:46, 8:27, 8:34, 8:41-44, Fig. 7.

VIII. GROUND 1—MORGAN AND EDLUND RENDER OBVIOUS CLAIMS 1, 4, 6-8, 11-16, 19, 21-23, 26-30

102. For reasons that I will address in more detail below, it is my belief and opinion that, at the time of the invention, one of ordinary skill in the relevant art would have combined Morgan and Edlund in a manner that yields all of the limitations of each of claims 1, 4, 6-8, 11-16, 19, 21-23, 26-30.

103. Independent claim 1 of the '034 Patent reads as follows:

> 1. A method of processing a search request received from a user operating a hand-held text input device, the search request directed at identifying a desired item from a set of items, each of the items having one or more associated terms, the method comprising:
>
> [1] providing the set of items, the items having assigned popularity values to indicate a relative measure of a likelihood that the item is desired by the user;
>
> [2] for each item, associating a set of terms to describe the item and assigning a relevance value for each

term based on a relevance of the term in identifying the item,

[3] the terms associated with the items being organized into searchable subspace categories, each subspace category having a relevance bias value;

[4] receiving text on the hand-held text input device entered by the user, the text having one or more text characters of one or more prefixes for terms the user is using to identify a desired item;

[5] in response to receiving a text character, performing a first incremental find to compare the one or more user-entered prefixes with the terms associated with the items and to retrieve the relevance values for the one or more user-entered prefixes matching terms associated with the items;

[6] determining a first ranking order of items found in the first incremental find based at least in part on the retrieved relevance values and the assigned popularity values of the items found in the first incremental find;

[7] ordering and presenting one or more items to the user found in the first incremental find based on the first ranking order;

[8] in response to receiving at least one subsequent text character, performing a second incremental find to compare the one or more user-entered prefixes, including the at least one subsequent text character and any preceding text characters, with the terms associated with

the items and to retrieve the relevance values for said one or more user-entered prefixes matching terms associated with the items;

[9] determining a count of the number of characters of text received from the user;

[10] adjusting the relevance value assigned to at least one of the terms associated with one or more of the items retrieved in response to the one or more user-entered prefixes, wherein the adjusting of the relevance value is based on the count of the number of text characters received from the user;

[11] determining a second ranking order of the items found in the second incremental find based at least in part on the adjusted relevance values and the assigned popularity values of the items found in the second incremental find; and

[12] ordering and presenting one or more items to the user based on the second ranking order so that the relative order of the items found in both the first and second incremental finds is adjusted as characters are entered;

[13] wherein at least one of determining the first ranking order and determining the second ranking order is further based on the relevance bias values of the subspace categories.

A. Independent Claim 1

104. The preamble to claim 1 recites "A method of processing a search request received from a user operating a hand-held text input device, the search request directed at identifying a desired item from a set of items, each of the items having one or more associated terms, the method comprising." It is my opinion that Morgan discloses this limitation.

105. Morgan discloses a method of processing a search request directed at identifying a desired item from a set of items. Morgan, Abstract, 7:22-23. More specifically, Morgan discloses "[i]n response to characters entered within a Find dialog box, a minifind window is dynamically updated to provide corresponding search strategies and quick matches from content search data that are being searched." Morgan, Abstract. Search terms are associated with the items being searched. Morgan, Abstract, 3:32-40, 3:43-58, 4:10-12, 4:56-59, 7:61-8:8, 10:1-11, 10:33-43, Fig. 7B. Morgan also discloses the use of "handheld devices, pocket personal computing devices, digital cell phones adapted to connect to a network" to perform the features disclosed therein. Morgan, 5:14-16. Morgan discloses that "as the user inputs text on a character-by-character basis," the method should address when it is "difficult to type." Morgan, 7:5-13.

1. "providing the set of items, the items having assigned popularity values to indicate a relative measure of a likelihood that the item is desired by the user"

106. It is my opinion that Morgan discloses this limitation.

107. Morgan discloses a minifind window that is dynamically updated to provide corresponding search strategies and quick matches (i.e., "items") from content search data that are being searched. Morgan discloses search strategies that are grouped and ordered based on an assigned popularity value. For example, Morgan discloses "that the search strategies list will be reordered based upon a 'best match' determined algorithmically" and that reordering might lead to a popular search strategy likely to find what the user desires. Morgan, 9:19-27. Morgan also discloses a process step "which orders the strategies in the list by rank, with the higher priority strategies (i.e., the most likely intended strategies) moved near the top of the list and the lower priority strategies moved nearer the bottom of the list." Morgan, 12:32-36; Fig. 4 (step 212); *see also*, Morgan, 3:32-40, 3:64–4:1.

108. Comparing Morgan's Figs. 7A and 7B, the search strategies result list has "Find dynamic Maps" removed and the topmost entry "Find Atlas Maps of 'Turk'" inserted, which a POSA would understand shows giving preference based on popularity, since Atlas Maps would be more popular than the other types of search strategies among searchers who have entered the string "Turk." Additionally, a POSA would have understood the benefits of applying popularity values to quick

matches just as Morgan assigns popularity values to search strategies. Thus, it would have been obvious to modify Morgan to also assign popularity values to the quick matches.

109. To the extent Morgan does not assign popularity values to items, Edlund does. Edlund assigns documents on the Web a popularity value based on the number of times a document has been accessed, which is a relative measure of the likelihood that document is desired by the user. Edlund, 3:46-50 ("Three measures are combined when calculating the overall document relevance: . . . (b) version-adjusted popularity (e.g., number of accesses to each version of the document)"), 10:2-7 ("The Ranking Database (0208) contains all the data the present invention needs to calculate the version adjusted popularity and the document recency . . . . The value for each record is the number of hits used to count the popularity."), 7:27-31 ("Popularity Vector. In its simplest case, the popularity vector is a single element vector simply keeping track of the number of times a resource has been accessed (with regard to a particular query).").

110. I understand that if a technique has been used to improve one device, and a POSA would recognize that it would improve similar devices in the same way, using the technique is obvious unless its actual application is beyond his/her skill.

111. Edlund and Morgan both relate to searching for content based on user input search strings. Morgan discloses using popularity (i.e., the most likely

intended strategies) as part of a ranking methodology. It is therefore my opinion that a POSA would know that ranking of search strategies or quick matches according to popularity could be achieved by assigning popularity values to the search strategies and quick matches as disclosed in Edlund.

112. A POSA would have seen the benefits of assigning popularity values to the search strategies and quick matches (i.e., items) and would have known how to use popularity values (as shown in Edlund). Additionally, a POSA would have been motivated to use popularity values to quantify relative popularity of search strategies and quick matches as a way to efficiently rank them. Further, it would have been within the ability and capabilities of a POSA to implement popularity values. Thus, it would have been predictable for a POSA to assign popularity values to the search strategies and quick matches (i.e., items).

113. It would have been obvious to modify Morgan with the teachings of Edlund to assign popularity values to the search strategies and quick matches (i.e., items) of Morgan since it allows efficient searching for desired information in a body of data. Morgan, 1:13-19.

2. "for each item, associating a set of terms to describe the item and assigning a relevance value for each term based on a relevance of the term in identifying the item,"

114. It is my opinion that Morgan discloses this limitation. It is my opinion that Edlund also discloses this limitation and that it would have been obvious to modify Morgan in accordance with this disclosure in Edlund.

115. Morgan discloses a minifind window that is dynamically updated to provide corresponding search strategies and quick matches (i.e., "items") from content search data that are being searched. Morgan, 2:64-3:2, 7:65-8:8, Fig. 3. Morgan also discloses that the search strategies and quick matches are identified based on a relevance value of the term.

116. As to search strategies, Morgan discloses a process that identifies all of the potential search strategies that match the characters entered by the user (i.e., the search strategies that achieve the threshold on relevance value for the term):

> [Referring to Fig. 4] A decision step 204 determines if a match was found in step 202. If so, a step 206 creates a matching search strategy and adds it to the list of search strategies. Since a user may have input an additional character that substantially alters the previous search strategies listed, an optional step 208 removes any conflicting strategies that are inappropriate in view of the current search string that has been input by the user. Next, decision step 210 checks to determine if there is yet another match identified in step 202 and if so, the logic

returns to step 206 to add another search strategy to the list.

Morgan, 12:21-30, Fig. 4 (especially steps 206 and 210).

117. As to quick matches, Morgan discloses a process that identifies all the potential quick matches that match the characters entered by the user (i.e., the search strategies that achieve the threshold on relevance value for the term). Morgan, 12:49-52, Fig. 5 ("a step 254 populates the quick matches list of the minifind window with a subset listing of articles, media, titles, etc. having words that start with the characters currently input by the user."). Morgan also discloses that this step "substantially reduces the number of items included in the quick matches list" and "includes items with words that start with the characters input by the user, even though the words are not the first words in the item as displayed. For example, if the user enters 'rup,' the quick matches listing will include 'Prince Rupert.'" Morgan, 13:2-10, Fig. 5 (step 254).

118. To the extent Morgan does not expressly show this limitation, it would have been obvious to do so. For example, Edlund discloses terms having assigned relevance values based on the relevance of the term in identifying the item, especially with regard to its discussion of indexes and search engines. Edlund, 2:20-27, 3:25-32. A POSA would understand that it is common for search engines to compute and store in an index "a relevance value for each term based on a relevance of the term in identifying the item . . . ," as disclosed in this limitation of claim 1.

119. Edlund and Morgan both relate to searching for content based on user input search strings. Morgan discloses using relevancy as part of a ranking methodology. It is therefore my opinion that a POSA would know that ranking of search strategies and quick matches according to relevancy could be achieved by assigning relevancy values as disclosed in Edlund to the search strategies and quick matches (i.e., items) in Morgan.

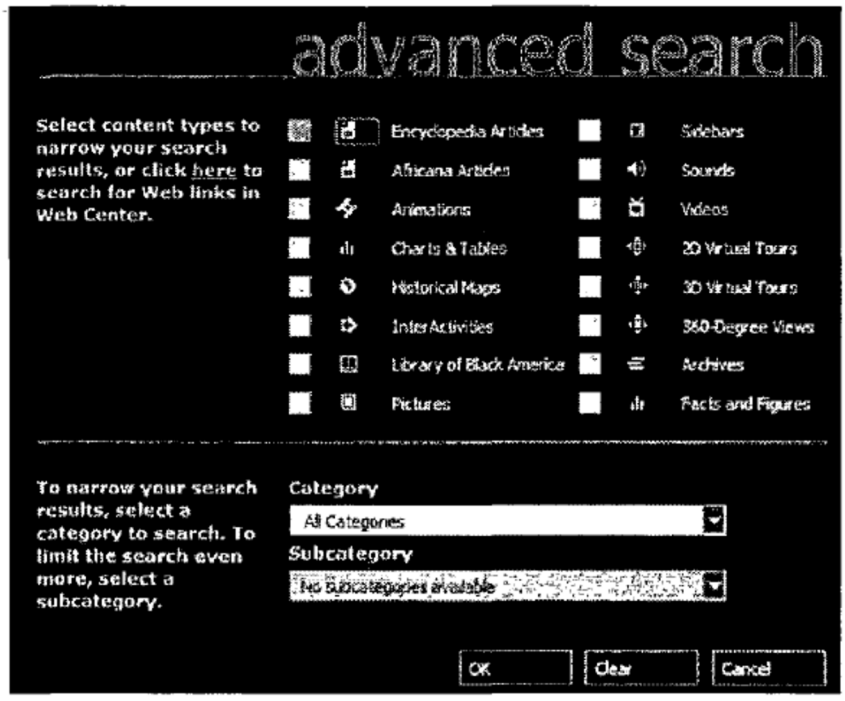
120. A POSA would have seen the benefits of assigning relevancy values to the search strategies and quick matches and would have known how to use relevancy values (as shown in Edlund). Additionally, a POSA would have been motivated to quantify relative relevance values of search strategies and quick matches as a way to efficiently rank them. Thus, assigning relevancy values would have been predictable for a POSA and would have had predicted results.

121. Thus, it would have been obvious to modify Morgan with the teachings of Edlund to assign relevance values to the search strategies and quick matches (i.e., items) of Morgan since it allows efficient searching for desired information in a body of data.

3. "the terms associated with the items being organized into searchable subspace categories, each subspace category having a relevance bias value"

122. FIG. 10 of Morgan (reproduced for convenience) shows subspace categories that can be selected to narrow the search results. The subspace categories

are described in FIG. 10 as "content types" that serve to "narrow your search results."



Ex.-1102, Morgan, FIG. 10 (excerpt)

123. Morgan also discloses that "the user can select an advanced search button 376, which displays advanced search options 380 as shown in FIG. 10. These advance[d] search options enable the user to filter the search results shown in search results pane 358, according to content type, or according to a selected category/subcategory." Morgan, 11:3-8, 4:14-16, 4:66-67.

124. In other words, Morgan discloses that (i) the terms associated with the items are organized into searchable subspace categories; (ii) each of the subspace categories initially has the same subspace category relevance bias value (i.e., there

is no difference among the values); and (iii) the user may adjust the relevance bias value of any subspace category by using the features described with respect to FIG. 10. Thus, Morgan discloses this limitation.

4. "receiving text on the hand-held text input device entered by the user, the text having one or more text characters of one or more prefixes for terms the user is using to identify a desired item"

125. This limitation can be separated into three parts, which are addressed below.

126. First, Morgan discloses that its system may be implemented with "handheld devices, pocket personal computing devices, digital cell phones adapted to connect to a network". Morgan, 5:15-17.

127. Second, Morgan discloses that "[i]n response to characters entered within a Find dialog box, a minifind window is dynamically updated to provide corresponding search strategies and quick matches from content search data that are being searched." Morgan, Abstract, 1:13-19, 2:64-3:2, 7:65-8:8, Fig. 3.

128. Third, Morgan discloses that the text may have one or more text characters of prefixes for the term the user is using to identify a desired item. (*See* Section VII above for claim constructions of "item" and "the text having one or more text characters of one or more prefixes for terms the user is using to identify a desired item.") For example, Morgan discloses that "for many words, it may be that typing only a portion of the word is sufficient to indicate the word in its entirety, or at least

to narrow the field of choices regarding related matching items" and that "Microsoft Corporation's INTERNET EXPLORER™ and other programs provide auto completion of text entries, using entries that were previously input in the program . . . ." Morgan, 2:53-61. Morgan then discloses that its system in "[s]tep 200 provides for parsing the string input by the user, which may comprise a portion of a word or even a single character, or one or more words." Morgan, 12:4-6; FIG. 4. Morgan also discloses that its system "finds any matches between search content data types, aliases, and tokens relative to the parts of speech and tokens identified in step 200." Morgan, 12:7-9; FIG. 4. Morgan further discloses that "the dynamically refined matches should be listed in a preferred order of priority, with the matching items having the characters input by the user as their first characters, followed by alternative choices that include the characters input by the user, as part of other words in the matching items." Morgan, 3:8-13.

129. Thus, Morgan discloses this limitation.

5. "in response to receiving a text character, performing a first incremental find to compare the one or more user-entered prefixes with the terms associated with the items and to retrieve the relevance values for the one or more user-entered prefixes matching terms associated with the items"

130. It is my opinion that Morgan discloses this limitation and that the system of Morgan at least inherently retrieves "relevance values for the one or more user-entered prefixes matching terms associated with the items." It also is my

opinion that Edlund discloses retrieving relevance values and that it would have been obvious to modify Morgan in accordance with this disclosure in Edlund.

131. Morgan discloses a process in Fig. 3 that provides a first incremental find. Specifically, this process, at step 152, "waits for a user to type a character within the Find dialog box." Morgan then, at step 154, "determines if at least 400 milliseconds has elapsed since the last character was input by the user." If so, Morgan, at steps 156 and 158, "populates the search strategies list . . . [and] the quick matches list based upon the one or more characters input by the user." Morgan, 11:18-34, Fig. 3 (steps 152, 154, 156, and 158). Thus, dynamically varying results are supplied in reaction "to dynamically varying search data in response to an input by a user." Morgan, 1:13-14.

132. With respect to search strategies, Morgan discloses a process that "provides for parsing the string input by the user, which may comprise a portion of a word or even a single character, or one or more words." Morgan, 12:4-6. Morgan then "finds any matches between search content data types, aliases, and tokens relative to the parts of speech and tokens identified in step 200." Morgan, 12:6-9, Fig. 4 (steps 200, 202, 204). Morgan discloses that this begins "based upon the first character input by the user." Morgan, 9:52.

133. With respect to quick matches, Morgan discloses that the quick match listing "includes items with words that start with the characters input by the user,

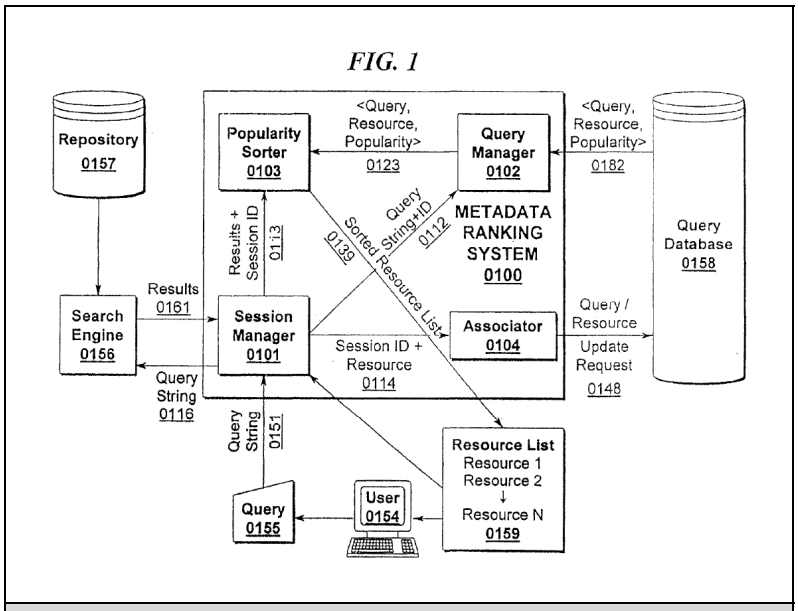
even though the words are not the first words in the item as displayed. For example, if the user enters 'rup,' the quick matches listing will include 'Prince Rupert.'" Morgan, 13:4-8, Fig. 5 (step 254). In the example of Fig. 7B in Morgan, the user entered in the text "Turk" and, in response, the system generated a quick matches list that includes items that not only are made up of the text "Turk," but also items that start with or contain the text "Turk." (e.g., "Turkana," "Turkana Boy" and "Turkana, Lake").

134. Thus, Morgan discloses that, after at least 400 milliseconds has elapsed since the last character input, the system identifies relevant search strategies and quick matches. *See, e.g.,* Morgan, Fig. 3 (steps 154, 156, 158). Morgan therefore must perform an incremental find to compare the user-entered prefixes with the terms associated with the items and to identify the items (i.e., search strategies and quick matches) that achieve a threshold relevance value relative to the user-entered prefixes.

135. Morgan identifies search strategies and quick matches that meet or exceed a threshold relevance such that they should be listed. Morgan, 2:3-8, 7:61-8:2, 8:52-63, 9:19-27. Morgan therefore retrieves "relevance values for the one or more user-entered prefixes matching terms associated with the items," as required by this limitation of claim 1.

136. To the extent Morgan does not expressly show this limitation, it would have been obvious to do so. It was known in the art to retrieve the relevance values for the one or more user-entered prefixes matching terms associated with the items. For example, Edlund assigns documents on the Web a "content relevance" based on matching the keyword search term to words in a particular document. Edlund, 3:46-48 ("Three measures are combined when calculating the overall document relevance: (a) content relevance (e.g., matching of query search terms to words in document) . . .").

137. Fig. 1 from Edlund (reproduced below for convenience) illustrates the data flow utilized to search for items based on a combination of an item's relevance value and popularity value. The user (0154) inputs, via a graphical user interface, keywords for a query (0155), or search string (0151). Edlund, 3:28-30, 2:51-53, 3:7, 5:45-47, 6:2, 6:28, Fig. 1, Fig. 3. The search engine (0156) "calculates the content relevance . . . and return[s] a list of search results ranked based on this content relevance." Edlund, 6:10-12; 8:29-31.



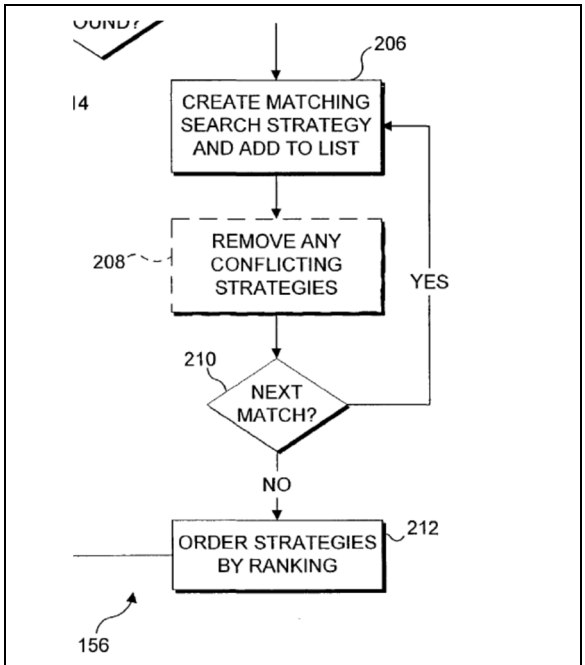
Ex.-1103, Edlund, Fig. 1

138. Accordingly, to the extent this feature is not inherent in Morgan, it would be obvious to modify Morgan to include the features disclosed in Edlund.

6. "determining a first ranking order of items found in the first incremental find based at least in part on the retrieved relevance values and the assigned popularity values of the items found in the first incremental find"

139. Morgan discloses a ranking of search strategies that are first identified by relevance and then ranked by popularity; see Fig. 4, reproduced below. At step 206, Morgan "creates a matching search strategy and adds it to the list of search strategies." Morgan, 12:22-23. At step 210, Morgan "checks to determine if there is yet another match identified in step 202." Morgan 12:28-29. If so, the process of Morgan "returns to step 206 to add another search strategy to the list." Finally, Morgan provides that "[a]fter no additional matches are identified in decision step 210, the logic proceeds to a step 212, which orders the strategies in the list by rank,

with the higher priority strategies (i.e., the most likely intended strategies) moved near the top of the list and the lower priority strategies moved nearer the bottom of the list." Morgan, 12:21-36, Fig. 4 (steps 206, 210, 212); 3:7-13. In other words, Morgan first identifies the items that achieve a threshold relevance value and then ranks those identified items according to popularity value. Thus, Morgan discloses this limitation.



Ex.-1102, Morgan, Fig. 4 (excerpt)

7. "ordering and presenting one or more items to the user found in the first incremental find based on the first ranking order"

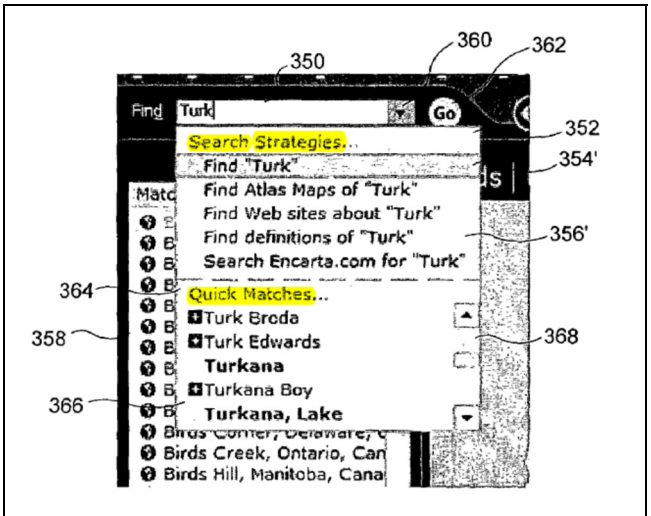
140. Morgan discloses a display of the ordered listing of search strategies and quick matches. For example, Morgan discloses a system having a display. Morgan, 4:17-21. Similarly, Morgan discloses that "FIG. 7B illustrates the

exemplary Find dialog box after four characters have been input, showing how the list of search strategies has changed in response thereto, and showing a list of corresponding quick matches." Morgan, 4:56-59.

141. Moreover, Morgan discloses:

> FIG. 7B illustrates Find dialog box 350 after the user has input 'Turk.' A search strategies list 356' now includes search strategies that correspond to the characters input by the user with a highlighted first entry. In addition, quick matches list 364 has been populated with a plurality of quick matches 366 that relate to the text string input by the user in Find dialog box 350, only a portion of which are shown. To access other of the quick matches, a scroll bar 368 can be manipulated using either the keyboard or a pointing device, such as a mouse to scroll through the other quick matches populating quick matches list 354'."

Morgan, 10:33-43, Fig. 7A, 7B.



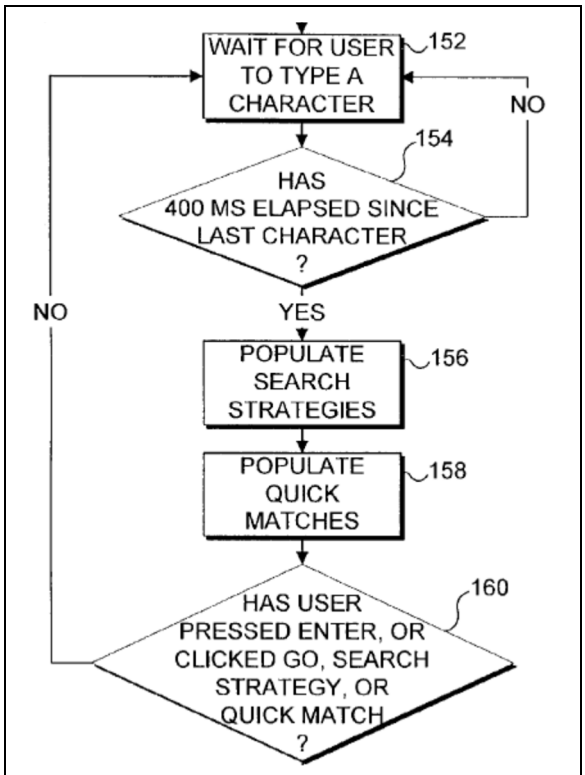
Ex.-1102, Morgan, Fig. 7B (annotated)

142. As indicated above, Morgan discloses dynamically regenerating the search strategies and quick matches as the user enters more text characters, thus ordering items, along with presenting items to the user. Thus, Morgan discloses this claim limitation.

8. "in response to receiving at least one subsequent text character, performing a second incremental find to compare the one or more user-entered prefixes, including the at least one subsequent text character and any preceding text characters, with the terms associated with the items and to retrieve the relevance values for said one or more user-entered prefixes matching terms associated with the items"

143. Morgan discloses dynamically regenerating the search strategies and quick matches as the user enters more text characters. Morgan discloses "it would be desirable to dynamically list proposed search strategies and possible matches that correspond to the characters input by the use[r], and to refine the list of proposed search strategies and matches as the user continues to input additional letters in a text box." Morgan, 2:64-3:2. Morgan further states that "[a]s the user inputs additional characters in the search string, search strategies list 110 and quick matches list 114 are revised or repopulated to include items starting with the characters that have been input." Morgan, 9:52-56. Finally, Morgan states that "[t]he search strategies and quick matches that are listed are dynamically updated as the user inputs additional characters in the Find dialog box." Morgan, Abstract. "As other

characters are input by the user, search strategies list 352 and quick matches list 364 are repopulated with corresponding related entries." Morgan, 10:44-46, Figs. 7A, 7B, 8. For example, "decision step 160 determines if the user has pressed Enter or activated the Go control, or selected one of the search strategies or quick match items in either of those lists. If not, the logic returns to step 152 to wait for the user to input another character (or to initiate a search by carrying out one of the user options indicated in decision step 160)." Morgan, 11:35-40, Fig. 3 (see excerpt below). Thus, Morgan discloses this limitation.



Ex.-1102, Morgan, Fig. 3 (excerpt)

9. "determining a count of the number of characters of text received from the user"

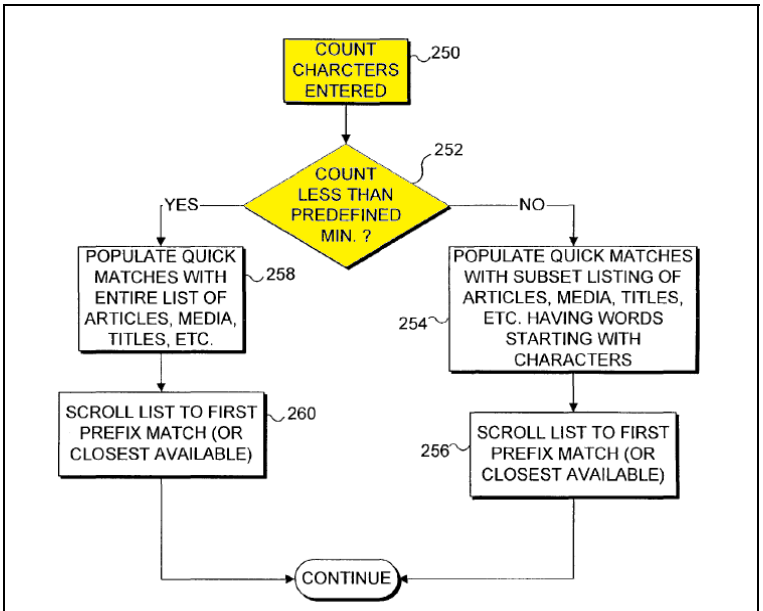
144. Morgan discloses a process by which quick match entries will vary depending on the number of characters of text entered by the user and received by the system. With reference to Morgan's Fig. 5 (depicted in the section below), Morgan discloses that "step 250 counts the number of characters entered." Morgan, 12:46, 12:64, 13:11-14, Figs. 5, 6, claim 9, claim 22. Thus, Morgan discloses this claim limitation.

10. "adjusting the relevance value assigned to at least one of the terms associated with one or more of the items retrieved in response to the one or more user-entered prefixes, wherein the adjusting of the relevance value is based on the count of the number of text characters received from the user"

145. Morgan also discloses that its process takes different actions depending on whether the count of the number of text characters received from the user is above, equal to, or below a threshold number.

146. Specifically, Morgan discloses that "[i]n the event that the count determined in step 250 is less than the predefined minimum in decision step 252, a step 258 populates the quick matches list with the ***entire list*** of articles, media, titles, etc. Next, the logic in a step 260 scrolls through the list to the first prefix match (or closest available match)." Morgan, 12:64-13:2, Fig. 5 (emphasis added). Alternatively, "[i]f the count obtained in step 250 is not less than (i.e., is greater than or equal to) a predefined minimum in a decision step 252, a step 254 populates the

quick matches list of the minifind window with a ***subset listing*** of articles, media, titles, etc. having words that start with the characters currently input by the user." Morgan, 12:47-52 (emphasis added); Fig. 5 (annotated excerpt reproduced below).



Ex.-1102, Morgan, Fig. 5 (excerpt, annotated)

147. Morgan discloses similar processing, and additional adjustment of relevance values, in Fig. 6, and in related discussion. Morgan, 13:11-37. Morgan also discloses determining matches according to the "count of the number of text characters entered by the user" in claim 9.

148. In other words, while the count of the number of text characters received from the user is below a certain threshold, Morgan assigns the same relevance value to the listings in the quick match field. Once the count of the number of text characters received from the user exceeds a certain threshold, Morgan adjusts

the relevance value assigned to at least one of the terms associated with one or more of the items retrieved.

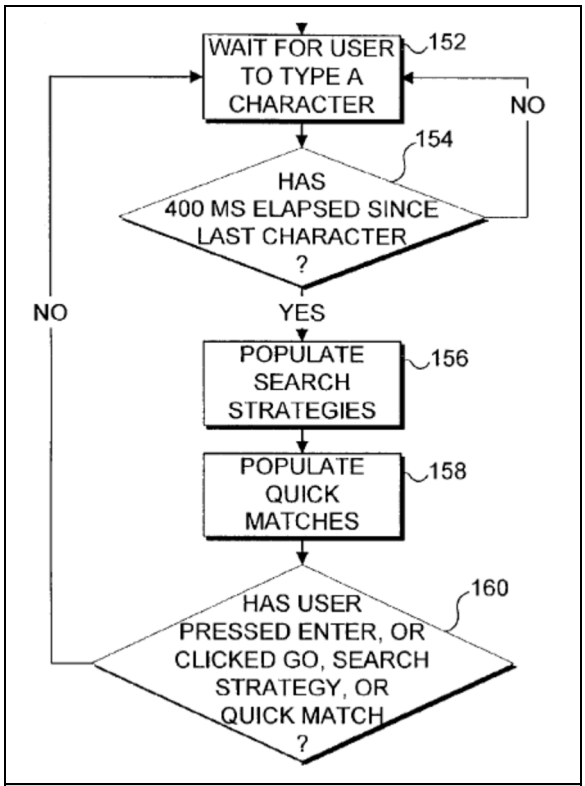
149. For search strategies, because the user has entered more characters, the user's text entry necessarily has a greater number of characters and the relevancy of any term as it relates to an item is different than before (i.e., therefore adjusted). For example, when the user enters "Turk," and then later enters "ey" (Morgan, 10:33-58), the relevancy of search strategies identified in the first ordered ranking will be different than the relevancy of the search strategies in the second ordered ranking. It should be noted that a POSA would understand that search strategies can serve as ranked "items retrieved in response to the one or more user-entered prefixes" and as "terms associated with one or more of the items retrieved in response to the one or more user-entered prefixes," (as claimed in claim 1 of the '034 Patent), since the two minifind windows show, respectively, search strategies and quick matches (wherein the search strategies are found based on the prefixes, and the quick matches can be found using the search strategies). Morgan, 7:61-8:8.

11. "determining a second ranking order of the items found in the second incremental find based at least in part on the adjusted relevance values and the assigned popularity values of the items found in the second incremental find"

150. Morgan discloses dynamically regenerating the search strategies and quick matches as the user enters more text characters. Morgan, Abstract ("The

search strategies and quick matches that are listed are dynamically updated as the user inputs additional characters in the Find dialog box.").

151. "As other characters are input by the user, search strategies list 352 and quick matches list 364 are repopulated with corresponding related entries." Morgan, 10:44-46, Figs. 7A, 7B, 8. For example, "decision step 160 determines if the user has pressed Enter or activated the Go control, or selected one of the search strategies or quick match items in either of those lists. If not, the logic returns to step 152 to wait for the user to input another character (or to initiate a search by carrying out one of the user options indicated in decision step 160)." Morgan, 11:35-40, Fig. 3 (*see* excerpt below).



Ex.-1102, Morgan, Fig. 3 (excerpt)

152. Thus, in the situation where the user enters more characters after the first incremental find, and where the number of characters passes a threshold, the relevancy value of the quick match entries is adjusted (as discussed above), such that the quick match entries listing is based on the adjusted relevance values. Also as discussed above, the search strategies listing will continue to be dynamically updated based on the relevancy and popularity values. Hence, Morgan discloses this claim limitation.

12. "ordering and presenting one or more items to the user based on the second ranking order so that the relative order of the items found in both the first and second incremental finds is adjusted as characters are entered"

153. Morgan discloses a display of the ordered listing of search strategies and quick matches. For example, as discussed above, "FIG. 7B illustrates the exemplary Find dialog box after four characters have been input, showing how the list of search strategies has changed in response thereto, and showing a list of corresponding quick matches" and "FIG. 8 illustrates the exemplary Find dialog box after a full word has been input, showing changes in the list of search strategies and quick matches." Morgan, 4:56-63, Figs. 7B, 8 (excerpt reproduced below).

Ex.-1102, Morgan, Fig. 8 (excerpt)

154. In other words, FIG. 8 shows a re-ordering and presenting of items (i.e., search strategies and quick matches) to the user based on the second ranking order so that the relative order of the items found in both the first and second incremental finds is adjusted as characters are entered by the user. Thus, Morgan discloses this claim limitation.

13. "wherein at least one of determining the first ranking order and determining the second ranking order is further based on the relevance bias values of the subspace categories"

155. As discussed above, Morgan discloses that "the user can select an advanced search button 376, which displays advanced search options 380 as shown in FIG. 10. These advance search options enable the user to filter the search results shown in search results pane 358, according to content type, or according to a selected category/subcategory." Morgan, 11:3-8, Fig. 10. As shown in FIG. 10

(reproduced below), Morgan depicts a listing of various subspace categories that can be selected to narrow the search results.

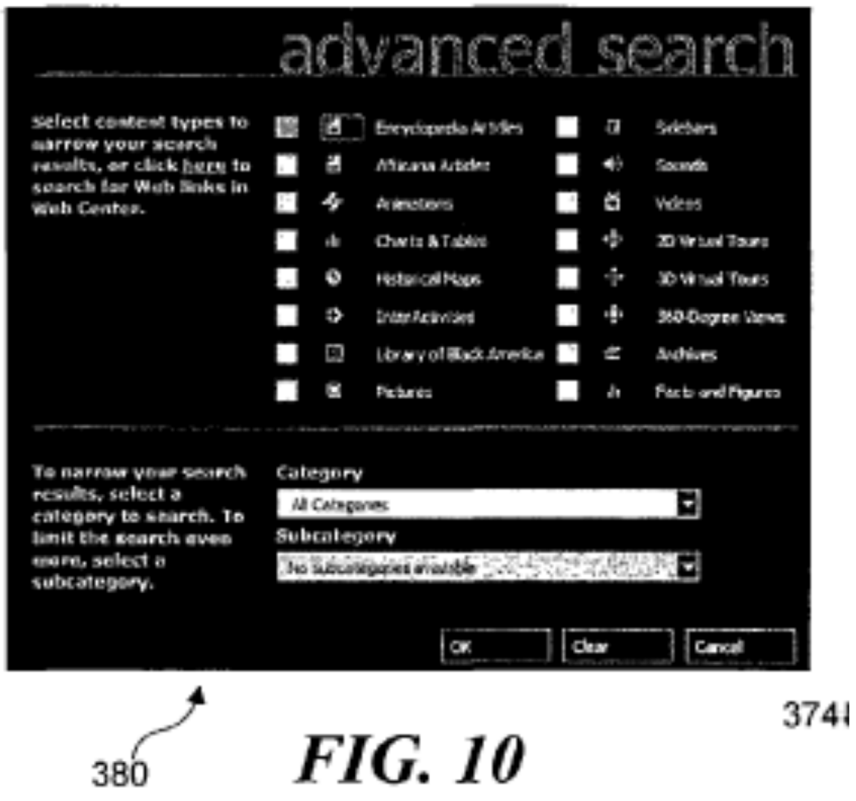


FIG. 10

Ex.-1102, Morgan, Fig. 10

156. While Morgan discloses that search results can be narrowed (i.e., ***after*** the search strategies and quick matches are generated), it would have been a matter of design choice to modify Morgan to allow for selecting subspace categories ***before*** the search strategies and quick matches are generated. The selection would happen either before or after the item lists are generated. Thus, it would have been obvious to utilize the advanced search option to allow the Morgan system to generate a ranking order (of the search strategies, quick matches, or the search results

themselves) that is limited to a selected category/subcategory. Likewise, a POSA would know that user profiles and preferences in search interfaces, or implicit personalization methods that learn user preferences, often record and allow subsequent incorporation of bias values for categories in ranking.

157. Thus, it would have been obvious to modify Morgan so the processes of determining the first and second ranking order can be based on the relevance bias values of the subspace categories (i.e., by the user implicitly or explicitly selecting the desired subspace categories).

B. Dependent Claim 4

158. Claim 4 depends from claim 1 and adds that "the ordering and presenting of one or more items is limited to items having associated terms of one or more selected subspace categories."

159. As discussed above with respect to claim 1, Morgan discloses that "the user can select an advanced search button 376, which displays advanced search options 380 as shown in FIG. 10. These advance search options enable the user to filter the search results shown in search results pane 358, according to content type, or according to a selected category/subcategory." Morgan, 11:3-8, Fig. 10. As shown in FIG. 10, Morgan depicts a listing of various subspace categories, one or more of which can be selected to narrow (limit) the search results. Morgan, 4:14-16. For example, the advanced search option allows the Morgan system to generate

a ranking order (of the search strategies, quick matches, or the search results themselves) that is limited to a selected category/subcategory. Thus, Morgan discloses that the processes of determining the first and second ranking order can be limited to items having associated terms of one or more selected subspace categories.

C. Dependent Claim 6

160. Claim 6 depends from claim 1 and adds that "the ordered and presented one or more items are presented on a display device, the display device having display space allocated according to the subspace categories."

161. Morgan discloses a display. Morgan, 4:17-21, 6:13-18. Morgan further discloses the display space separated, with a background window showing matches, and a foreground window showing a top portion for search strategies results (with separate space for categories, i.e., entries for Atlas Maps, Web sites, definitions, and Encarta.com), and a bottom portion showing quick matches. Morgan, 7:61-8:8, 4:61-63, 10:33-58, Figs. 7B, 8. Morgan also discloses that "the user can select an advanced search button **376**, which displays advanced search options **380** as shown in FIG. 10. These advance search options enable the user to filter the search results shown in search results pane **358**, according to content type, or according to a selected category/subcategory." Morgan, 11:3-8, 4:66-67. Morgan also discloses that "[r]eference works will sometimes enable a user to select a specific category prior to entry of a search query. For example, a user might selectively make a search

for a geographic location by initially limiting the search to data maintained in an atlas database. Alternatively, after the user enters a query, ***the search engine may provide a list of alternatives in different categories*** from which the user may choose to more accurately access information of interest." Morgan, 2:26-33 (emphasis added). As another example, Morgan discloses quick matches being displayed in groups, as shown in the expandable subspace categories of "Turk Broda," "Turk Edwards" and "Turkana Bay" in Fig. 7B. Morgan, Fig. 7B. Morgan discloses similar groupings in Fig. 8 (search strategies, and quick matches); Fig. 9 ("Turkey," "Items containing the word(s) 'turkey'"). Accordingly, Morgan discloses that the ordered and presented items are presented on a display device where space is allocated according to the subspace categories.

D. Dependent Claims 7 and 8

162. Claim 7 depends from claim 1 and adds that "the hand-held text input device includes a set of overloaded keys generating an ambiguous text input." Claim 8 depends from claim 7 and adds that "the hand-held text input device is a phone, a mobile computing device, or a remote control device for a television."

163. Morgan discloses that its "invention may be practiced with other computer system configurations, particularly in regard to a client device for displaying a Web page, including handheld devices, pocket personal computing devices, ***digital cell phones*** adapted to connect to a network, and other

microprocessor-based or programmable consumer electronic devices, game consoles, TV set-top boxes . . . and the like." Morgan, 5:11-22 (emphasis added). Morgan also discloses that a "user may enter commands and information . . . through input devices such as a keyboard 40 and a pointing device 42. Other input devices (not shown) may include a microphone, joystick, game pad, satellite dish, scanner, digital camera, or the like." Morgan, 6:4-8, 8:40-45. As of June 30, 2005, a POSA would understand that cell phones had a set of overloaded keys generating an ambiguous text input. The typical 12-key layout of a digital cell phone presents overloaded keys (e.g., the "2" key being mapped to letters "a", "b", and "c"). *See, e.g.,* Lowles, 16:4-9, Fig. 6. Morgan therefore discloses the use of digital cell phones that are a hand-held text input device that includes a set of overloaded keys generating an ambiguous text input.

E. Dependent Claim 11

164. Claim 11 depends from claim 1 and adds that "the assigned popularity values of one or more items of the set of items is based on a relative measure of popular opinion of the item." Morgan discloses a process step "which orders the strategies in the list by rank, with the higher priority strategies (i.e., the most likely intended strategies) moved near the top of the list and the lower priority strategies moved nearer the bottom of the list." Morgan, 12:32-36, Fig. 4 (step 212); 3:32-40, 3:64-5:1. Morgan also discloses "that the search strategies list will be reordered

based upon a 'best match' determined algorithmically" and that reordering might lead to a popular search strategy likely to find what the user desires. Morgan, 9:19-27.

165. To the extent Morgan does not expressly show that the assigned popularity values of one or more of the items (e.g., search strategies) is based on a relative measure of popular opinion of the item, it would have been obvious to do so. For example, Edlund assigns documents on the Web a popularity value based on the number of times a document has been accessed, which is a relative measure of popular opinion of the item. Edlund, 3:46-50 ("Three measures are combined when calculating the overall document relevance: . . . (b) version-adjusted popularity (e.g., number of accesses to each version of the document)"), 10:2-7 ("The Ranking Database (0208) contains all the data the present invention needs to calculate the version adjusted popularity and the document recency . . . . The value for each record is the number of hits used to count the popularity.").

166. The Edlund popularity vector (Edlund, 6:34-41, 7:28-31) may also take into account the number of times an item was presented to a user, but ignored, which further reflects popular opinion of the item. Edlund, 7:33-35.

167. It would have been obvious to a person of ordinary skill in the art to use the search technique taught in Edlund that uses popularity value as a search ranking methodology to improve the search strategy ranking methodology taught in Morgan.

F. Dependent Claim 12

168. Claim 12 depends from claim 1 and adds that "the assigned popularity values of one or more items of the set of items is based on a temporal relevance of the items or a location relevance of the items." Morgan describes the requirements of considering location when seeking desired information. Morgan, 7:38-47. Then Morgan discloses utilizing a content search provider where relevance is specialized for atlas, map, or timeline content. Morgan, 8:54-65, Fig. 8. Morgan discloses that "[r]eference works will sometimes enable a user to select a specific category prior to entry of a search query. For example, a user might selectively make a ***search for a geographic location*** by initially limiting the search to data maintained in an atlas database." Morgan, 2:26-30 (emphasis added). Similarly, Morgan discloses that "the user can select an advanced search button 376, which displays advanced search options 380 as shown in FIG. 10. These advance search options enable the user to filter the search results shown in search results pane 358, according to content type, or according to a selected category/subcategory" including a Historical Maps category. Morgan, 11:3-8, FIG. 10. Thus, Morgan discloses this claim limitation.

169. Edlund also discloses this claim limitation. For example, Edlund assigns documents on the Web a temporal value which relates to the age of the document or its update frequency: "Three measures are combined when calculating the overall document relevance: (a) content relevance (e.g., matching of query search

terms to words in document), (b) version-adjusted popularity (e.g., number of accesses to each version of the document), and (c) recency (e.g., age and update frequency of a document).” Edlund, 3:46-51.

G. Dependent Claim 13

170. Claim 13 depends from claim 1 and adds that “at least one of determining the first ranking order and determining the second ranking order is further based on the number of prefixes of the received text.”

171. Morgan discloses a process where the results vary depending on the number of prefixes of the received text. For example, Morgan discloses that the ranking order of search strategies may vary depending on the number and type of prefixes entered by the user: “it is contemplated that the search strategies list will be reordered based upon a ‘best match’ determined algorithmically. In this approach, certain items may be removed and other items added. For example, if the user types ‘map of Canada’ as the search string, search strategies list 110 might be reordered to put the item, ‘Find atlas maps of `Canada`’ at the top of the list, with a search strategy, ‘Find `map of Canada`’ lower down on the list and might remove the search strategy, ‘Find definitions of `Canada`.’” Morgan, 9:19-27. Thus Morgan discloses that matching both “map” and “Canada” (2 matches) leads to a higher ranking than matching just “Canada” (1 match), i.e., so the ranking order is based on the number of matches (where full words are prefixes of themselves).

172. As another example, Morgan discloses parsing of prefixes to identify best search strategies: "Search strategies list 110 is preferably populated by parsing the search string input by the user to identify certain keywords such as 'map,' or 'photo,' or 'video,' or to identify other appropriate keywords indicating the type of information desired by the user. For example, if the user enters a string 'photo of dolphin,' the keyword 'photo' would cause search strategies list 110 to be populated with a search strategy 'find images about `dolphin`.' In addition to including search strategies based upon keywords included in the string input by the user, the search strategies list also includes generic search strategies, such as 'Find [search string],' 'Find atlas maps of [search string],' 'Find definitions of [search string],' etc." Morgan, 9:6-19. Thus Morgan discloses that having both "photo" and "dolphin" leads to a ranking wherein having both of these (with "images" replacing "photo") is preferred.

173. As another example, Morgan discloses Figs. 5 and 6 about "first prefix match" (see steps 260 and 256, as well as 314 and 306, respectively). Morgan, 12:44-13:37. There is counting of the number of characters, and finding the first prefix match (indicating there could be more prefix matches and that the ranking is based on the number). Morgan, 12:46-63, 13:25-26 ("the first prefix match (or the closest available near match)."). Further, if the number of prefix matches is zero,

then the matching is broadened (Morgan, 12:56-63, 13:31-36), which also shows ranking based on number of prefixes.

H. Dependent Claims 14 and 15

174. Claim 14 depends from claim 1 and adds that "a portion of the set of items resides on a computer remote from the user." Claim 15 depends from claim 1 and adds that "a computer remote from the user performs at least one of the steps of receiving text entered by the user, performing the first incremental find, determining the first ranking order, performing the second incremental find, determining the count of the number of characters of text received, adjusting the relevance values of the terms associated with the items, and determining the second ranking order."

175. Morgan discloses that its invention may "be practiced in distributed computing environments where tasks are performed by ***remote processing devices*** that are linked through a communications network. In a distributed computing environment, program modules may be located in both local and ***remote memory storage devices***." Morgan, 5:22-27 (emphasis added). Morgan also discloses that "PC 20 may operate in a networked environment using logical connections to one or more ***remote sources, such as a remote computer*** 49. In regard to the present invention, the URI or address stored in the memory of the peripheral device may specify a location that is accessed through remote computer 49. ***Remote computer*** 49 may be another PC, a server (which is typically generally configured

much like PC 20), a router, a network PC, a peer device, a satellite, or other common network node, and typically includes many or all of the elements described above in connection with PC 20, although only an external memory storage device 50 has been illustrated in FIG. 1." Morgan, 6:40-51 (emphasis added).

176. Morgan discloses finding information regardless of whether it is "accessed locally, or over a network." Morgan, Abstract, 8:26-28, 8:33-35, 11:47-50. A variety of network environments and devices also are described. Morgan, 6:40-7:3. Thus, Morgan discloses that a portion of the set of search strategies or quick matches (i.e., items) resides on a computer remote from the user (e.g., remote processing and remote memory storage devices). Morgan also discloses that the various process steps of claim 1 may be performed on a remote processing device.

I. Independent Claim 16

177. Independent claim 16 is an apparatus claim reciting many features similar to independent claim 1. Although the features have been rearranged, there is little substantial difference between the features of claim 1 and claim 16 for purposes of unpatentability.

178. The preamble to claim 16 recites "A system for processing a search request received from a user operating a hand-held text input device, the search request directed at identifying a desired item from a set of items, each of the items having one or more associated terms, the system comprising." The preamble of claim

16 is nearly identical to claim 1, with the only difference being claim 16 is drawn to a system whereas claim 1 is drawn to a method.

179. Morgan discloses the features. For example, Morgan discloses "[i]n response to characters entered within a Find dialog box, a minifind window is dynamically updated to provide corresponding search strategies and quick matches from content search data that are being searched." Morgan, Abstract. Morgan also discloses that its system may be implemented in "handheld devices, pocket personal computing devices, digital cell phones adapted to connect to a network . . . ." Morgan, 5:11-17.

1. "a first memory for storing at least a first portion of the set of items, the items having assigned popularity values to indicate a relative measure of a likelihood that the item is desired by the user, and"

180. This limitation is similar to a corresponding limitation in claim 1, but recites "a first memory for storing at least a first portion of the set of items." This addition is insubstantial for purposes of unpatentability.

181. Morgan discloses "an exemplary system . . . includes . . . a system memory 22 . . . The system bus . . . may be any of several types of bus structures, including a memory bus or memory controller . . . . The system memory includes read only memory (ROM) 24 and random access memory (RAM) 25." Morgan, 5:28-38. Morgan also discloses that its purpose "is to enable a user to more efficiently find desired information within content search data 102" and that "[i]n

order to generate the quick matches list, the present invention accesses content search data 102." Morgan, 8:11-13, 8:52-53, FIG. 2. Accordingly, Morgan discloses a first memory for storing at least a first portion of the items.

2. "each item being associated with a set of terms to describe the item, each term being assigned a relevance value based on a relevance of an informational content of the term in identifying the item,"

182. This limitation is similar to a corresponding limitation in claim 1, with the exception that relevance value is "based on a relevance of an ***informational content*** of the term in identifying the item." There is no substantial difference between the features for purposes of prior art invalidity. As discussed with respect to claim 1, Morgan discloses a minifind window that is dynamically updated to provide corresponding search strategies and quick matches (i.e., "items") from content search data that are being searched. Morgan, 2:64-3:2, 7:65-8:8, Fig. 3. Morgan also discloses that the search strategies and quick matches are identified based on a relevance value of the term. Morgan, 2:3-8.

183. As to search strategies, Morgan discloses a process that identifies all of the potential search strategies that match the characters entered by the user ("search strategy generation also relies upon the content search provider to access the content search data to develop a search strategy to populate search strategies list"). Morgan, 8:66-9:1, Fig. 2. As to quick matches, Morgan discloses a process that identifies all the potential quick matches that match the characters entered by the user ("to

generate the quick matches list, the present invention accesses content search data 102 through one or more content search providers 104"). Morgan, 8:52-54, Fig. 2. A POSA would understand that the relevance value for any term is "based on a relevance of an informational content of the term in identifying the item."

184. To the extent Morgan does not expressly show this limitation, it would have been obvious to do so. Edlund discloses assigning documents a "content relevance" based on matching the keyword search term to words in a particular document. Edlund, 3:46-48 ("Three measures are combined when calculating overall document relevance: (a) content relevance (e.g., matching of query search terms to words in [sic] document . . ."). This results in assigning a relevance value based on the informational content of the term in identifying the document as recited in claim 16.

185. It would have been obvious for a POSA to combine and/or modify Morgan in view of Edlund. Edlund and Morgan both relate to searching for content based on user input search strings. The Morgan search methodology identifies items based on relevancy. Morgan, 2:3-8, 12:21-36, Fig. 4 (especially steps 206 and 210), 12:49-52, Fig. 5. Assigning relevance values based on informational content to terms as taught in Edlund was a known technique that could be used to improve the similar search methodology in Morgan in the same way.

3. "the terms associated with the items being organized into searchable subspace categories, each subspace category having a relevance bias value;"

186. This limitation is identical to a corresponding limitation in claim 1 and is taught by Morgan for the reasons set forth above in paragraphs 122-124.

4. "a device input for receiving text entered by the user on a hand-held text input device, the text having two or more text characters of one or more prefixes for terms the user is using to identify a desired item,"

187. This limitation is similar to a corresponding limitation in claim 1, but recites "a ***device input***" for receiving text entered by the user and requires that the input text have "***two or more text characters*** of one or more prefixes." These minor claim language differences do not impact the unpatentability of claim 16.

188. First, Morgan discloses that its system may be implemented with "handheld devices, pocket personal computing devices, digital cell phones adapted to connect to a network . . ." (Morgan, 5:14-17), which are a "device input for receiving text entered by the user on a hand-held text input device" as claimed.

189. Second, the Morgan search technique begins with a user entering a search string of characters. Morgan provides examples of a user input "text having two or more text characters of one or more prefixes for terms the user is using to identify a desired item." Morgan, Figs. 7B (text entered is "Turk"), 8, and 9.

5. "the two or more text characters including a first text portion and a second text portion, the second text portion being received subsequent to the first text portion;"

190. This limitation is taught in Morgan. Again, Morgan provides examples of a user input text having "two or more text characters" where a second text portion is received subsequent to a first text portion. *See* Morgan, Figs. 7B (text entered is "Turk"), 8, and 9.

6. "a processor for performing a first incremental find in response to receiving the first text portion and for ordering one or more items found in the first incremental find based on a first ranking order, the first incremental find comparing the one or more user-entered prefixes with the terms associated with the items and retrieving the relevance values for the one or more user-entered prefixes matching terms associated with the items,"

191. This limitation is similar to a corresponding limitation in claim 1, but with a couple of differences. One difference is that claim 16 recites "a ***processor*** for performing the first incremental find . . . ordering . . . a first ranking order." Another difference is that claim 16 recites that the performing the first incremental find is done "in response to receiving the ***first text portion***" of input text characters.

192. Morgan discloses that its "system includes . . . a processor . . . [that] executes the machine instructions to implement functions generally consistent with the above described method." Morgan, 4:18-23, 4:37-39, 5:11-6:66, Fig. 1 (processing unit, box 21). Similarly, the processor interacting with the search engine performs the "first incremental find" for the same reasons discussed with respect to

claim 1. *See* ¶139. In addition, the processing steps are performed in response to receiving a "first text portion" sent to a search engine. *See* Morgan, Figs 7B (text entered is "Turk"), 8, and 9. The same processor performs "ordering . . . based on a first ranking order." *See* ¶¶140-142 above.

7. "the first ranking order of the one or more items found in the first incremental find being based on the assigned popularity values of the items and being based on the retrieved relevance values for the one or more user-entered prefixes matching terms associated with the items, so that relatively more popular and more relevant items appear earlier in the order for user selection or activation,"

193. This limitation is similar to a corresponding "first ranking order" limitation in claim 1. As in claim 1, this limitation recites a "first ranking order" of one or more items using popularity values and retrieved relevance values. Whereas the "first ranking order" in claim 1 is based "in part" on the two values, claim 16 requires the "first ranking order" "being based on" the two values. This difference is inconsequential for purposes of my analysis of unpatentability in view of the prior art.

194. This limitation also recites a requirement not found in claim 1, namely that the "first ranking order" results in the "relatively more popular and more relevant items appear[ing] earlier in the order for user selection or activation . . . ." As discussed regarding claim 1, Morgan discloses retrieving popularity and relevance values for content items and ordering them such that relatively more

popular and more relevant items appear earlier in the order presented to a user for selection. Morgan, 10:33-43, Fig. 7A, 7B; *see* ¶¶140-142 above. Morgan discloses search strategies that are grouped and ordered based on an assigned popularity value. For example, Morgan discloses "that the search strategies list will be reordered based upon a 'best match' determined algorithmically" and that reordering might lead to a popular search strategy likely to find what the user desires. Morgan, 9:19-21. Morgan also discloses a process step "which orders the strategies in the list by rank, with the higher priority strategies (i.e., the most likely intended strategies) moved near the top of the list and the lower priority strategies moved nearer the bottom of the list." Morgan, 12:32-36; Fig. 4 (step 212); *see also*, Morgan, 3:32-40, 3:64–4:1. Thus, this limitation is taught in the prior art.

8. "the processor also for performing a second incremental find in response to receiving the second text portion and for ordering one or more items found in the second incremental find based on a second ranking order, the second incremental find comparing the one or more user-entered prefixes with the terms associated with the items and retrieving the relevance values for the one or more user-entered prefixes matching terms associated with the items,"

195. This limitation is similar to a corresponding limitation in claim 1, but includes "a ***processor*** also for performing a second incremental find in response to receiving the ***second text portion*** . . . ." The same processor that performs "the first incremental find" as discussed above also performs the second incremental find, and

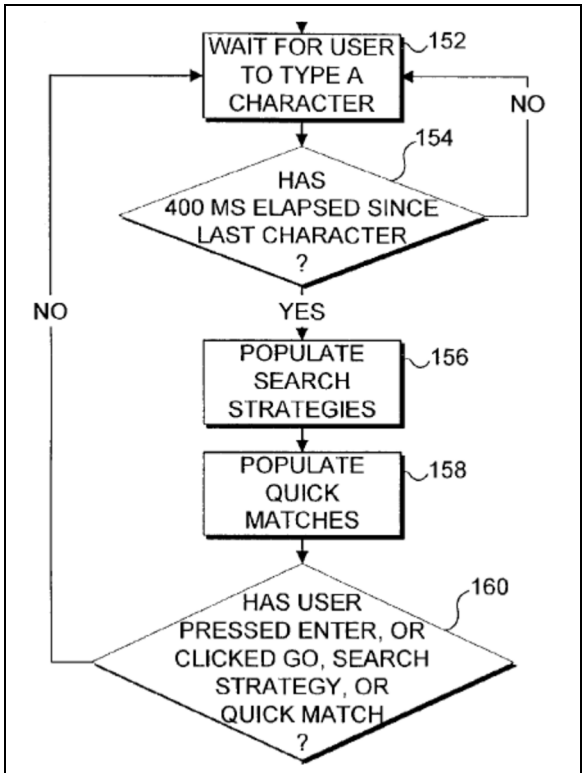
the "second incremental find" occurs upon receiving a "second text portion." *See* ¶¶191-192 above.

9. "the second ranking order of the one or more items found in the second incremental find being based on the assigned popularity values of the items and being based on adjusted relevance values for the one or more user-entered prefixes matching terms associated with the items,"

196. This limitation is similar to a corresponding "second ranking order" limitation in claim 1. As in claim 1, this limitation recites a "second ranking order" of one or more items using popularity values and adjusted relevance values. Whereas the "second ranking order" in claim 1 is based "in part" on the two values, claim 16 requires the "second ranking order" "being based on" the two values. This difference is inconsequential for purposes of my analysis of unpatentability in view of the prior art.

197. Morgan discloses dynamically regenerating the search strategies and quick matches as the user enters more text characters. Morgan, Abstract ("The search strategies and quick matches that are listed are dynamically updated as the user inputs additional characters in the Find dialog box."). "As other characters are input by the user, search strategies list 352 and quick matches list 364 are repopulated with corresponding related entries." Morgan, 10:44-46, Figs. 7A, 7B, 8. For example, "decision step 160 determines if the user has pressed Enter or activated the Go control, or selected one of the search strategies or quick match items in either

of those lists. If not, the logic returns to step 152 to wait for the user to input another character (or to initiate a search by carrying out one of the user options indicated in decision step 160)." Morgan, 11:35-40, Fig. 3 (*see* excerpt below).



Ex.-1102, Morgan, Fig. 3 (excerpt)

198. Thus, in the situation where the user enters more characters after the first incremental find, and where the number of characters passes a threshold, the relevancy value of the quick match entries is adjusted (as discussed above), such that the quick match entries listing is based on the adjusted relevance values. Also as discussed above, the search strategies listing will continue to be dynamically updated based on the relevancy and popularity values. Hence, Morgan discloses this claim limitation. The second incremental search proceeds in the same manner as discussed

above regarding the first incremental search, but with different relevance values for quick matches.

10. "the relevance values of the terms associated with the items being adjusted in response to the count of the number of text characters received from the user,"

199. This limitation differs slightly from the "second ranking order" limitation in claim 1. Claim 16 requires that the "second ranking order" is "being based on" the relevance and popularity values, whereas in claim 1 it is "based at least in part" on the two values. This difference in language does not change the claim scope, and this limitation is taught for the reasons discussed previously. *See* ¶¶145-149.

11. "the order of at least a portion of the one or more items being changed based on the adjusted relevance values of the terms, and"

200. This limitation adds that "the order of at least a portion of the one or more items being changed based on the adjusted relevance values . . . ." This limitation is not found in claim 1. There is no impact of "at least a portion of" for purposes of prior art unpatentability.

201. It is not clear from claim 16 whether "the order of at least a portion of the one or more items" refers to an item in the "first ranking order" or the "second ranking order." Thus, under the broadest reasonable interpretation, this phrase refers to either the "first ranking order" or the "second ranking order." As discussed above

in paragraphs 145-149, the order of items changes following adjustment of relevance values.

12. "at least one of the first ranking order and the second ranking order being further based on the relevance bias values of the subspace categories; and"

202. This limitation is nearly identical to a corresponding limitation in claim 1. This limitation is found in the prior art for the same reasons as discussed regarding claim 1. *See* ¶¶155-157.

13. "a device output for presenting at least one of the first and the second ordered one or more items to the user."

203. Morgan teaches this limitation. Morgan discloses a device output having a display space separated, with a background window showing matches, and a foreground window showing a top portion for search strategies results and a bottom portion showing quick matches. Morgan, 7:61-8:8, 4:61-63, 10:33-58, Fig. 7B, Fig. 8. Accordingly, Morgan discloses a device output[2] for presenting the first and the second ordered items to the user.

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[2] The term "device output" is found only in claim 16. It is not found in the '034 Patent specification. A generic "201 display" is contemplated as part of the '034 Patent system. *See* Ex.-1101, Fig. 2.

J. Dependent Claim 19

204. Dependent claim 19 depends from independent claim 16 and recites limitations similar to those in claim 4. Dependent claim 19 recites "the system of claim 16, wherein the incremental find is limited to items having associated descriptive terms of one or more selected subspace categories." It is not clear from claim 19 whether "the incremental find" refers to the "first incremental find" or the "second incremental find." Thus, under the broadest reasonable interpretation, this phrase refers to either the "first incremental find" or the "second incremental find." This claim is unpatentable for similar reasons as those of claim 4. *See* discussion of claim 4 above, ¶¶ 158-159.

205. Morgan discloses that determining the first and second ranking order can be limited to items having associated descriptive terms of one or more selected subspace categories. For example, FIG. 10 of Morgan discloses subspace categories that can narrow the search results. This advanced search option allows Morgan to generate a ranking order (of the search strategies, quick matches, or the search results themselves) that is limited to the selected subspace categories. Morgan, 11:3-8.

K. Dependent Claim 21

206. Dependent claim 21 depends from independent claim 16 and recites limitations similar to those in claim 6 and is unpatentable for similar reasons.

Namely, the proposed combination of Morgan and Edlund yields the limitations of claim 21. *See* claim 6 discussion above.

L. Dependent Claims 22 and 23

207. Dependent claims 22 and 23 depend from independent claims 16 and 22, respectively, and recite limitations similar to those in claim 7 and 8, respectively, and are unpatentable for similar reasons. Namely, the proposed combination of Morgan and Edlund yields the limitations of claims 22 and 23. *See* discussions of claims 7 and 8, respectively, above.

M. Dependent Claim 26

208. Dependent claim 26 depends from independent claim 16 and recites limitations similar to those in claim 11 and is unpatentable for similar reasons. Namely, the proposed combination of Morgan and Edlund yields the limitations of claim 26. *See* claim 11 discussion above.

N. Dependent Claim 27

209. Dependent claim 27 depends from independent claim 16 and recites limitations similar to those in claim 12 and is unpatentable for similar reasons. Namely, the proposed combination of Morgan and Edlund yields the limitations of claim 27. *See* claim 12 discussion above.

O. Dependent Claim 28

210. Dependent claim 28 depends from independent claim 16 and recites limitations similar to those in claim 13 and is unpatentable for similar reasons.

Namely, the proposed combination of Morgan and Edlund yields the limitations of claim 28. *See* claim 13 discussion above.

P. Dependent Claims 29 and 30

211. Dependent claims 29 and 30 depend from independent claim 16 and recite limitations similar to those in claim 14 and 15, respectively, and are unpatentable for similar reasons. Namely, the proposed combination of Morgan and Edlund yields the limitations of claim 29 and 30. *See* discussion of claims 14 and 15, respectively, above. The similarities of these claims is depicted in the table below.

Claim 14	**Claim 29**
14. The method of claim 1, wherein a portion of the set of items resides on a computer remote from the user.	29. The system of claim 16, further comprising a second memory on a computer remote from the user for storing at least a second portion of the set of items.
Claim 15	**Claim 30**
15. The method of claim 1, wherein a computer remote from the user performs at least one of the steps of receiving text entered by the user, performing the first	30. The system of claim 16, wherein the processor is disposed in a computer remote from the user.

incremental find, determining the first ranking order, performing the second incremental find, determining the count of the number of characters of text received, adjusting the relevance values of the terms associated with the items, and determining the second ranking order.	

212. Claims 29 and 30 are unpatentable for similar reasons as claims 14 and 15. *See* discussion of claims 14 and 15, respectively, above.

213. Morgan discloses "a second memory on a computer remote from the user for storing at least a second portion of the set of items" of claim 29 as well as "the processor is disposed in a computer remote from the user" of claim 30. Morgan discloses that its invention may "be practiced in distributed computing environments where tasks are performed by ***remote processing devices*** that are linked through a communications network. In a distributed computing environment, program modules may be located in both local and ***remote memory storage devices***." Morgan, 5:22-27 (emphasis added). Morgan also discloses that "PC 20 may operate in a networked environment using logical connections to one or more ***remote sources,***

such as a remote computer 49. In regard to the present invention, the URI or address stored in the memory of the peripheral device may specify a location that is accessed through remote computer 49. ***Remote computer*** 49 may be another PC, a server (which is typically generally configured much like PC 20), a router, a network PC, a peer device, a satellite, or other common network node, and typically includes many or all of the elements described above in connection with PC 20, although only an external memory storage device 50 has been illustrated in FIG. 1." Morgan, 6:40-51 (emphasis added), Fig. 1.

GROUND 2—MORGAN, EDLUND, AND LOWLES RENDER OBVIOUS CLAIMS 2, 5, 9-10, 17, 20, AND 24-25

214. For reasons that I will address in more detail below, it is my belief and opinion that, at the time of the invention, one of ordinary skill in the relevant art would have combined Morgan, Edlund, and Lowles in a manner that yields all of the limitations of each of claims 2, 5, 9-10, 17, 20, and 24-25.

Q. Dependent Claims 2 and 5

215. Claim 2 depends from claim 1 and adds that "the relevance bias values are based on the count of the number of text characters received from the user." Similarly, claim 5 depends from claim 4 and adds that "the one or more selected subspace categories are selected based on the count of the number of text characters received from the user."

216. Morgan discloses a search methodology whereby a character count is utilized to determine the relevance of a term to a search result. With reference to Morgan's Fig. 5, Morgan discloses that "step 250 counts the number of characters entered." Morgan, 12:46; *see also* 12:64, Fig. 5, Fig. 6, claim 9, claim 22. While the count of the number of text characters received from the user is below a certain threshold, Morgan assigns a low relevance value to terms associated with the listings in the quick match field. Morgan, 12:64–13:2, Fig. 5. Once the count of the number of text characters received from the user exceeds a certain threshold, Morgan adjusts the relevance value assigned to at least one of the terms associated with one or more of the items retrieved. Morgan, 12:47-52, Fig. 5.

217. Morgan discloses similar processing, and additional adjustment of relevance values, in Fig. 6, and in related discussion. Morgan, 13:11-37, Fig. 6. Morgan also discloses determining matches according to the "count of text characters entered by the user" in both claims 9 and 22.

218. Lowles discloses utilizing similar character counting to determine relevance bias values or selecting subspace categories. Lowles discloses that when searching, "[c]ategories may be used to establish access or searching priority, so that words in certain categories are accessed in some predetermined order, or filtering rules, where only particular categories are accessed or searched." Lowles, 16:26-29. For example, Lowles describes, "[c]ategories might also be inferred from a current

context, such that ***words in an acronym category are accessed when a user inputs two uppercase letters*** in sequence . . . ." Lowles, 17:10-12 (emphasis added). Lowles further describes:

> A variation of category-based custom word list access is "on-the-fly" weighting adjustment. If a current text operation is normally associated with a particular category, then weightings of words in that category are increased, by applying a predetermined adjustment factor to the weightings, for example. Words in the associated category thereby have a more significant weighting during an associated text operation. The adjustment factor is selected to achieve a desired effect. A higher adjustment factor ensures that words in the category have higher adjusted weightings than words in other categories, whereas a lower adjustment factor may prevent infrequently used words in the category from displacing more frequently used words in other categories."

Lowles, 17:17-26.

219. Thus, Lowles describes that relevance bias values of subspace categories are based on the count of the number of text characters received from the user (e.g., the bias value for a subspace category for acronyms is increased when two or more uppercase characters are entered in a sequence). Similarly, Lowles describes selecting a subspace category based on the count of the number of text

characters received from the user (e.g., a subspace category for acronyms is selected when two or more uppercase characters are entered in a sequence).

220. It would have been obvious to one of skill in the art to combine Morgan's description of using categories to find results relevant to search terms with Lowles's description of adjusting weightings of categories or selecting a category based on the number of characters received by the user (e.g., selecting an acronym category when two or more uppercase characters are entered in sequence or increasing the bias value for an acronym category when two or more uppercase characters are entered in sequence) "to enable the user to more efficiently search and access desired information in a body of data." Morgan, 1:17-19.

221. Like Morgan, Lowles is in the field of string-based searching. Morgan already discloses (i) that subspace categories may be used for ranking; and (ii) the number of text characters can adjust relevance values. *See* claim 1 discussion above. Lowles provides an obvious and straightforward extension of Morgan to apply the concept of using the text character count to also adjust weightings of categories (i.e., relevance bias values).

222. A POSA would know to adjust weightings of categories to enable more efficient searching. A POSA would have had the ability to adjust weightings of categories of Lowles to efficiently rank the search strategies or quick matches. A POSA would have recognized the advantages of adjusted weightings of categories

and would have been motivated to do so to best rank the search strategies or quick matches. This would have been predictable for a POSA and would have had predicted results.

223. Thus, it would have been obvious to modify Morgan with the teachings of Lowles to use character counting to further adjust weightings of categories.

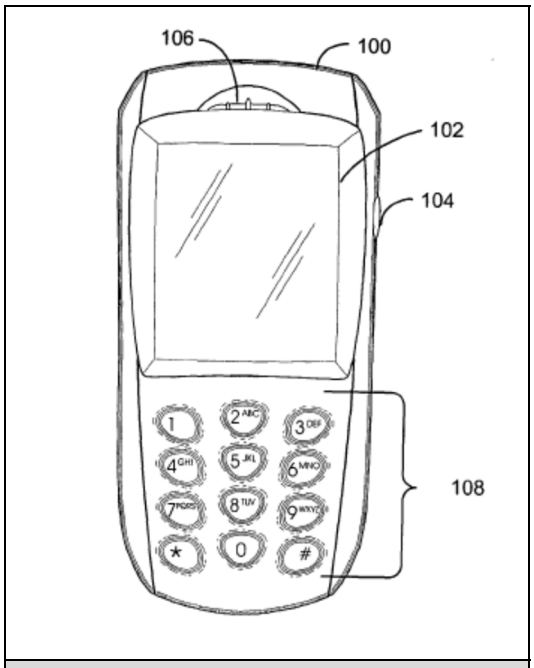
R. Dependent Claims 9 and 10

224. Claim 9 depends from claim 1 and adds that "the ordered and presented one or more items are presented on a display constrained device." Claim 10 depends from claim 9 and adds that "the display device is a phone, a mobile computing device, or a non-intrusive interface display area of a television."

225. Morgan discloses that its "invention may be practiced with other computer system configurations, particularly in regard to a client device for displaying a Web page, including handheld devices, pocket personal computing devices, ***digital cell phones*** adapted to connect to a network, and other microprocessor-based or programmable consumer electronic devices, game consoles, TV set-top boxes . . . and the like." Morgan, 5:11-22 (emphasis added). Morgan also discloses that a "user may enter commands and information . . . through input devices such as a keyboard 40 and a pointing device 42. Other input devices (not shown) may include a microphone, joystick, game pad, satellite dish, scanner, digital camera, or the like." Morgan, 6:4-8, 8:40-45. Morgan therefore discloses the

use of digital cell phones (i.e., display constrained devices) that display the ordered items.

226. To the extent Morgan does not expressly show that the cell phone is a display constrained device, it would have been obvious to use such a device. For example, Lowles discloses "[u]ser input is received at step 78, when the user begins typing on a keyboard . . . [w]here the keyboard is a reduced keyboard, then an input keystroke sequence may be ambiguous, such that more than one word in the custom word list is mapped to the input keystroke sequence." Lowles, 16:4-9. For example, Fig. 6 in Lowles (reproduced below for convenience) discloses a display-constrained device much like a cell phone.



Ex.-1104, Lowles, Fig. 6

S. Dependent Claims 17 and 20

227. Dependent claim 17 depends from independent claim 16 and dependent claim 20 depends from dependent claim 19. Both claims 17 and 20 recite limitations similar to those in claims 2 and 5, respectively, and are unpatentable for similar reasons. Namely, the proposed combination of Morgan, Edlund, and Lowles yields the limitations of claims 17 and 20. *See* claims discussions of 2 and 5, respectively, above.

T. Dependent Claims 24 and 25

228. Dependent claims 24 and 25 depend from independent claim 16 and dependent claim 24, respectively. Both claims 24 and 25 recite limitations similar to those in claims 9 and 10, respectively, and are unpatentable for similar reasons. Namely, the proposed combination of Morgan, Edlund, and Lowles yields the limitations of claims 24 and 25. *See* discussions of claims 9 and 10, respectively, above.

IX. GROUND 3—MORGAN, EDLUND AND DE MES RENDER OBVIOUS CLAIMS 3 AND 18

229. For reasons that I will address in more detail below, it is my belief and opinion that, at the time of the invention, one of ordinary skill in the relevant art would have combined Morgan, Edlund, and De Mes in a manner that yields all of the limitations of claims 3 and 18.

A. Dependent Claim 3

230. Claim 3 depends from claim 1 and adds that "the subspace categories include a personalized history category containing terms associated with items identified from previous incremental finds conducted by the user."

231. Morgan discloses "[a]fter initiating a search, the user can return to the previous list of quick matches and search strategies, by selecting a designated control provided in the user interface." Morgan, 4:10-12.

232. In the case that this is not considered expressly disclosing a personalized history category, De Mes discloses a method for creating a searchable personal browsing history. De Mes, Abstract. Specifically, De Mes describes "creat[ing] a ***searchable personal browsing history*** which is tailored to the search results, the statistical information and the configuration settings as defined by the user and displayed . . . The searchable browsing history may contain the results of multiple searches (iterations . . .) and their results." De Mes, ¶37 (emphasis added). De Mes also describes, "Subsequently, ***the stored metadata and textual data are displayed in categories*** based on the indexing, to enable searching of the displayed categories of metadata and textual data." De Mes, ¶9 (emphasis added).

233. It would have been obvious to one of skill in the art to combine the teachings of Morgan with the teachings of De Mes to incorporate an option for

providing a personal browsing history into the system of Morgan. Both Morgan and De Mes are in the field of searching for content based on user input search strings.

234. Morgan describes the purpose of its system "is to enable a user to more efficiently find desired information within content search data . . ." Morgan, 8:11-13. Morgan also discloses the desire to rank quick matches with "higher priority strategies (i.e., the most likely intended strategies) moved near the top. . ." Morgan, 12:33-36. The most likely intended strategies would have been made by considering the user's search history.

235. Similarly, De Mes describes "that a user is able to view his or her browsing activity in categorized views which provides efficient access to the required information." De Mes, ¶12. Thus, in order to further enable a user to efficiently find desired information within content search data, it would have been obvious to one of ordinary skill in the art to incorporate a personal browsing history in categorized views into the categories described by Morgan.

B. Dependent Claim 18

236. Dependent claim 18 depends from independent claim 16 and recites limitations similar to those in claim 3 and is unpatentable for similar reasons. Namely, the proposed combination of Morgan, Edlund, and De Mes yields the limitations of claim 18. *See* claim 3 discussion above.

X. CONCLUSION

I hereby declare under penalty of perjury that all statements made in this Declaration of my own personal knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements are made with the knowledge that willful false statements and the like are punishable by fine, imprisonment, or both, under Section 1001 of Title 18 of the U.S. Code.

Date: 14 Feb. 2017 Signature: Edward A. Fox

Edward A. Fox

EXHIBIT A

EDWARD A. FOX

PERSONAL INFORMATION:

- **HOME:** 203 Craig Dr., Blacksburg, VA 24060, +1-540-552-8667
- **WORK:** 114 McBryde Hall, Dept. of Computer Science, M/C 0106, Virginia Tech, Blacksburg, VA 24061 USA; +1-540-231-5113 [direct], x6931 [dept.], x6075 [FAX]; Digital Library Research Lab, x3615 (2030 Torgersen Hall)
- **CITIZENSHIP:** USA
- Skype, Twitter ID: edwardafox; LinkedIn: Edward Fox; Facebook: Edward Alan Fox
- Google Scholar Edward Fox; ORCiD: 0000-0003-1447-6870

EDUCATION:

- 8/83 Ph.D. Computer Science, Cornell University
  Area: information storage and retrieval
  Minor: linguistics; Advisor: Gerard Salton
  Title: Extending the Boolean and Vector Space Models of Information Retrieval with P-Norm Queries and Multiple Concept Types
- 1/81 M.S. Computer Science, Cornell University
- 2/72 B.S. Electrical Engineering (Computer Science Option), M.I.T.
  Advisor: J.C.R. Licklider (Director of Project MAC)
  Thesis advisor: Michael M. Kessler (Asst. Director of Library)

RECENT EMPLOYMENT:

- 2/2016- Professor (by courtesy), Dept. of Electrical and Computer Engineering, Virginia Tech
- 4/95- Professor, Dept. of Computer Science, Virginia Tech (VPI&SU)
- 1/98- Director, Digital Library Research Laboratory (Virginia Tech)
- 6/90-6/2014 Associate Director for Research, VPI&SU Computing Center; evolving into position of Faculty Advisor to Information Technology
- 5/88-4/95 Associate Professor, Dept. of Computer Science, VPI&SU
- 9/83-5/88 Assistant Professor, Dept. of Computer Science, Virginia Polytechnic Institute & State Univ. (Virginia Tech) Blacksburg VA 24061-0106
- 8/82-4/83 Manager of Information Systems, International Inst. of Tropical Agriculture, P.M.B. 5320, Ibadan, Nigeria
- 9/78-8/82 Instructor, Research Assistant, Teaching Assistant, Dept. of Computer Science, Cornell Univ., Ithaca NY 14853
- 9/72-8/78 Data Processing Manager, Vulcraft, Div. of NUCOR Corporation, Florence, SC 29501
- 9/71-6/72 Data Processing Instructor, Florence Darlington Technical College, Florence, SC 29501

MEMBERSHIP IN PROFESSIONAL SOCIETIES:

- Association for Information Science & Technology (ASIS&T) and SIGDL
- ACM (Member since 1967) and SIGIR, SIGCSE
- IEEE (Fellow starting 2017, Senior Member since 2004), IEEE-CS, and Technical Committees on Digital Libraries (including on Executive Committee)+ Multimedia Computing
- Sigma Xi (Assoc. Member 7/1/1972, Full Member 7/1/1985)
- Upsilon Pi Epsilon

HONORS AND AWARDS:

- While at VPI&SU
    - IEEE Fellow, effective 1/1/2017, for leadership in digital libraries and information retrieval
    - XCaliber Award 2016 "for extraordinary contributions to technology-enriched learning activities" for project "Enhanced problem-based learning connecting big data research with classes", with students: Mohamed Farag, Richard Gruss, Tarek Kanan, Sunshin Lee, Xuan Zhang
    - Research Impact in Human-Computer Interaction, conferred by VT Center for HCI, October 16, 2015
    - Honeywell (2nd) Best Student Paper Award at IEEE BTAS 2012 for Robust Feature Extraction in Fingerprint Images Using Ridge Model Tracking: Nathaniel Short, Lynn Abbott, Michael Hsiao, Edward Fox
    - Virginia Tech Scholar of the Week, recognized by the Office of the Vice President for Research, for weeks of Dec. 10, 17, and 24, 2007
    - College of Engineering Dean's Award for Excellence in Service, April 2005
    - 1st Annual NDLTD Leadership Award, May 2004
    - Best Student Paper Award (as supervisor and 2nd author) at JCDL 2004: M. A. Goncalves, E. A. Fox, A. Krowne, P. Calado, A. Laender, A. S. da Silva, and B. Ribeiro-Neto. The Effectiveness of Automatically Structured Queries in Digital Libraries. pp. 98-107
    - First Prize Winner for Track 3, for presentation "Open Digital Libraries", $1500 prize, based in part on doctoral work of Hussein Suleman, AOL-CIT Finding Common Ground University Research Day, Nov. 6, 2002, Herndon, VA
    - Honorable Mention, Poster, MARIAN - Next Generation Digital Library System Built on 5S, $100 prize, with M. Goncalves, W. Richardson, and M. Luo, AOL-CIT Finding Common Ground University Research Day, Nov. 6, 2002, Herndon, VA
    - ACM Recognition of Service Award, 2012, for Associate Editor, ACM J. of Computing and Cultural Heritage (JOCCH) 2006-2012
    - ACM Recognition of Service Award, 1999, for Program Chair Digital Libraries '99
    - ACM Recognition of Service Award, 1996, for Program Chair Digital Libraries '96

- ACM Recognition of Service Award, 1995, for SIGIR Chair 1991-1995
- ACM Recognition of Service Award, 1995, for Program Chair SIGIR '95
- ACM Recognition of Service Award, 1991, for Editor-in-Chief, ACM Press Database and Electronic Products
- Awards for GeoSim: A GIS-Based Simulation Laboratory for Introductory Geography, L.W. Carstensen, Jr., C.A. Shaffer, R.W. Morrill, E.A. Fox:
    1. Computational Science award, Ames Lab., U.S. Dept. of Energy, 9/16/94;
    2. Best Article Related to Teaching in a University or College in National Council for Geographic Education's J. of Geography, May '92 - April '94.
- Choice (Current Reviews for College Libraries) selection as one of 1989-90 Outstanding Academic Books and Nonprint Materials for "Hypertext on Hypertext" which I proposed, coordinated, and served as editor for ACM
- Election to Phi Beta Delta (Honor Society for International Scholars), March 1999, http://www.vt.edu:10021/international/PhiBetaDelta/index.html
- Election to Upsilon Pi Epsilon computing sciences honor society 3/17/98
- Election to Sigma Xi (full member)
- International Directory of Distinguished Leadership, Who's Who in the South and Southwest, Who's Who of Emerging Leaders in America, Who's Who in America, Who's Who in Science and Engineering, Who's Who in American Education, Young Community Leaders of America

- While at M.I.T.
    - William Stewart Award (founding and serving as first president of the ACM student chapter, founding and serving as first chairman of the Student Information Processing Board, serving as instructor and head of the engineering department of the student-run Saturday program for high school students)
    - Election to Sigma Xi (associate member)

PROFESSIONAL SERVICE:

CURRENT - major responsibilities:

1. 1996- Executive Director, Chairman of the Board, and Founder, Networked Digital Library of Theses and Dissertations (NDLTD, incorporated 5/2003), http://www.ndltd.org

CURRENT - Editor / Editorial Board Member:

1. 2017- IEEE Thesaurus Editorial Board
2. 2015- Editorial board, IEEE-TCDL Special Issue on Data Curation
3. 2014- PeerJ Computer Science, launched 2/3/15, https://peerj.com/computer-science/
4. 2012- Editorial Advisory Board, Thailand's National Institute of Development Administration (NIDA) Development Journal
5. 2012- Editorial Advisory Board, Thailand's National Institute of Development Administration (NIDA) International Journal of Development Administration
6. 2008- Editorial board, Journal of Intelligent Information Systems (JIIS)
7. 2004- Editorial board, International Journal on Digital Libraries (www.dljournal.org)

8. 1994- Editorial board, Multimedia Tools and Applications (Kluwer)
9. 1994- Foundation Editor, The Journal for Universal Computer Science (Springer)
10. 1990- Editorial board, Journal of Educational Multimedia and Hypermedia (AACE)

CURRENT - conferences/workshops (selected):

1. Meta-reviewer, Senior Program Committee, ACM/IEEE-CS Joint Conference on Digital Libraries (JCDL 2017, http://2017.jcdl.org/), Toronto, Canada, 19-23 June 2017
2. Member, Program Committee, BIR 2017 (5th International Workshop on Bibliometric-enhanced Information Retrieval)
3. Member, Steering Committee, Joint Conference on Digital Libraries (JCDL), member since 2003, chair from 2010 to 9/2014
4. Member, International Advisory Committee, International Conference of Asian Digital Libraries (ICADL)

CURRENT - other (selected):

1. Group manager of Web 2.0 services: LinkedIn groups on: Digital Libraries, VT Computer Science, ...
2. 1999- Member, Advisory Board for D-Lib Forum, www.dlib.org

CONFERENCES/WORKSHOPS CHAIRED:

1. Chair, Web Archiving and Digital Libraries (WADL 2016), held with JCDL, Rutgers Univ., Newark, NJ, June 19-23, 2016, with co-chairs Zhiwu Xie and Martin Klein
2. Chair, Web Archiving and Digital Libraries (WADL 2015), held with JCDL, June 24-24, 2015, Knoxville, TN
3. Chair, Web Archiving and Digital Libraries (WADL 2013), workshop at JCDL 2013, Indianapolis, July 25-26
4. Co-chair, Webinar on Emergency Informatics and Digital Libraries, July 24, 2012, http://www.ctrnet.net/webinars (with S. Sheetz as Chair)
5. Chair, Digital Libraries and Education, 1/2 day workshop at JCDL/ICADL 2010, June 21-25, Gold Coast, Australia
6. Chair, Development and Adoption of Computational Thinking Curricular Guidelines Across Disciplines, Living In the KnowlEdge Society (LIKES) Workshop 6 (http://www.likes.org.vt.edu/?q=node/203), Feb. 24-26, 2010, Durham, NC, workshop for the NSF-funded LIKES project, http://www.livingknowledgesociety.org
7. Chair, Curricular Guidelines Connecting Computing with Other Disciplines, Living In the KnowlEdge Society (LIKES) Workshop 5 (http://www.likes.org.vt.edu/?q=node/196), Nov. 12-13, 2009, Virginia Tech, Blacksburg, VA, workshop for the NSF-funded LIKES project, http://www.livingknowledgesociety.org
8. Co-Chairs Edward A. Fox, Seungwon Yang, Steve Sheetz, Christopher Zobel, and Patrick Fan. Coordinating FDI Track E: About LIKES - Living In the KnowlEdge Society, July 21-23, 2009, Virginia Tech

9. PC chair of the Information Retrieval track, ACM CIKM 2006 (http://sa1.sice.umkc.edu/cikm2006/), Arlington, VA, Nov. 6-11, 2006
10. Co-chair, Program Committee, 8th International Conference of Asian Digital Libraries (ICADL 2005), Bangkok, Thailand, Dec. 12-15, 2005
11. Co-Chairs Steve Edwards, Dwight Barnette, and Edward Fox: JETT (JAVA Engagement for Teacher Training) Workshop, supported by IBM ECLIPSE, Virginia Tech, Blacksburg, VA, July 21-22, 2004
12. Chair: Digital Libraries: Global Reach and Impact, JCDL 2004 workshop, June 10-11, 2004, Tucson, AZ, co-chair: Ching-chih Chen
13. Co-organizers/coordinators Manuel A. Perez-Quinones, Lillian Cassel, Edward Fox, John Impagliazzo, J.A.N. Lee, C. Lee Giles: Using the NSF Digital Library to Enhance Your Teaching, workshop 8 at ACM SIGCSE 2004, Norfolk, VA, March 3-7, p. 503
14. Chair: Indo-US Workshop on Open Digital Libraries and Interoperability, Arlington, VA, June 23-25, 2003, 39 participants from the United States and India, sponsored by Indo-US Science and Technology Forum and CIT, http://fox.cs.vt.edu/IndoUSdl
15. Chair: Open Source Roadshow, Case Study: Mozilla Project, Virginia Tech, October 24, 2002, assisted by Netscape/AOL/Mozilla and CIT, http://fox.cs.vt.edu/opensource.htm
16. Co-organizer: Project Kaleidoscope (PKAL) 2002 Summer Institute Cluster II (DL and CS), http://www.pkal.org/siplanning/index.html, June 2-5, 2002, Williamsburg, VA
17. Chair: NDLTD and OAI: A Case Study of a Worldwide Community Sharing (Multilingual, Multimedia) Electronic Theses and Dissertations through the Open Archives Initiative, CNI Spring Meeting session, 4/15/2002, Washington, D.C.
18. Chair: Open Archives: Communities, Interoperability, and Services; Workshop for 24th Annual International SIGIR Conference on Research and Development in Information Retrieval, New Orleans, ULA, Sept. 13, 2001, Proceedings (w. H. Suleman): http://purl.org/net/oaisept01
19. Chair: First ACM/IEEE-CS Joint Conference on Digital Libraries, JCDL'2001, Hotel Roanoke and Conference Center, Roanoke, VA, June 24-28, 2001, www.jcdl.org (and helped run PC mtg at UCLA, March 2-5, 2001)
20. Chair: Electronic Theses and Dissertations Standards Meeting. OCLC, Dublin, Ohio, Jan. 9-10, 2001.
21. Chair: Expanding the Information and Data Management (IDM) Research and Education Community, NSF-funded workshop, Hotel Roanoke and Conf. Center, Roanoke, VA, Oct. 2-4, 2000. http://fox.cs.vt.edu/IDM/
22. Chair: Extending Interoperability of Digital Libraries: Building on the Open Archives Initiative. ECDL Workshop, Lisbon, Portugal, Sept. 21, 2000. http://purl.org/net/oaisept00
23. Chair: US-Korea Joint Workshop on Digital Libraries: Removing Barriers to International Collaboration on Research and Education through Digital Libraries, Aug. 10-11, 2000, San Diego Supercomputer Center, San Diego, CA. http://fox.cs.vt.edu/UKJWDL/
24. Chair: Extending Interoperability of Digital Libraries: Building on the Open Archives Initiative. Workshop for ACM Hypertext'2000 and ACM Digital Libraries'2000. San Antonio, TX, June 3, 2000 http://purl.org/net/oaijune00
25. Chair, Steering Committee meetings of NDLTD on 3/15/2000, 9/15/2000, 3/21/2001, 10/26/2001

26. Program Chair: Virginia Internet Technology Week (VIT'99), Virginia Tech, Blacksburg, VA, September 13-17, 1999 (http://manta.cs.vt.edu/vit/)
27. Program Chair: ACM Digital Libraries '99, Berkeley, CA, Aug. 11-14, 1999
28. Co-Chair: 1999 NSF Information and Data Management Workshop: Research Agenda for the 21st Century - IDM'99, UCLA, March 7-9, 1999, http://www.cs.ucla.edu/csd/IDM99/index.html
29. Chair: Multimedia Education, workshop at ACM Multimedia'98, Bristol, England, Sept. 12, 1998 (with R. Heller, GWU).
30. Co-Chair: ETD/NTLTD Workshop, MECCA Conf., Memphis, TN, June 10-11, 1998, http://www.mecca.org/mecca-itec-conf/conftopics.html
31. Chair: IBM Renaissance Meeting, Oct. 20-22, 1997, Virginia Tech, Blacksburg, VA
32. Chair: Education and Curriculum Development for Multimedia, Hypertext, and Information Access: Focus on Digital Libraries and Information Retrieval workshop, sponsored by both ACM Digital Libraries'97 and ACM SIGIR'97, July 23, 1997, Philadelphia.
33. Chair: Interactive Learning with a Digital Library in Computer Science workshop, June 15-21, 1997, Virginia Tech, Blacksburg, VA funded in part by NSF (as supplement to EI grant 1993-97)
34. Chair: Courseware, Education and Curriculum in Multimedia workshop, held with ICMCS'97, IEEE International Conference on Multimedia Computing and Systems, June 6, 1997, Ottawa, Canada
35. Chair: Joining the National Digital Library of Theses and Dissertations, half-day pre-conference seminar for CAUSE/CNI regional conference, Univ. of Del., May 21, 1997
36. Chair: Courseware, Training and Curriculum in Multimedia workshop, held with ACM Multimedia'96, Boston, MA, Nov. 19, 1996
37. Chair: Courseware, Training and Curriculum in Information Retrieval workshop, held after ACM SIGIR'96, Zurich, Switzerland, Aug. 22, 1996.
38. Chair: Workshop on Electronic Theses and Dissertations in the Southeast, sponsored by SURA, hosted by UNC Charlotte, Charlotte, NC, Aug. 1-2, 1996.
39. Program Chair: Digital Libraries'96, First ACM International Conference on Digital Libraries, March 20-23, 1996, Bethesda, MD
40. Chair: Workshop for Working Group on Theses, Technical Reports, and Dissertations, in Monticello Electronic Library Initiative, sponsored by SURA and SOLINET, Aug. 12-13, 1994, Virginia Tech, Blacksburg, VA
41. Conference chair: Workshop on Information Retrieval and Genomics, sponsored by ACM SIGIR and SIGBIO, Lister Hill National Center for Biomedical Communications, National Library of Medicine, Bethesda, MD, May 2-4, 1994
42. Chair: Workshop on Information Access and the Networks, IANET'93, held in conjunction with ACM SIGIR '93, July 1, 1993
43. Program chair: 18th Intern'l Conf. on R & D in Information Retrieval, SIGIR '95, July, 1995, Seattle, WA

EARLIER (major responsibilities):

1. 2013-2016 Editor, ACM Book Series section on Information Retrieval and Digital Libraries (with Morgan and Claypool Publishers)

2. 1987-2014 Editorial board, Information Processing & Management (Elsevier)
3. 2010-2013 Member, CRA Board, and Member, CRA-E (Computing Research Association Committee on Education); Member, Review Committee, Outstanding Undergraduate Research Awards 2011; Member, Scholarly Publications Group; Co-chair (July 1, 2011 to June 30, 2013) of Membership Committee
4. 2013 Editorial board, The Open Information Science Journal (TOISJ)
5. 2006-2012 Editorial board, ACM Journal on Computers and Cultural Heritage (JOCCH), and serving 2008-2009 on search committee for next editor-in-chief
6. 2002-2011 (and 1989-1993) Editorial board, ACM Transactions on Information Systems (TOIS)
7. 2011 Editorial board, ACM Computers in Entertainment (CiE)
8. 2005-2009 Member, Advisory Group for Programmes on Digital Repositories and on Digital Asset Management and Preservation (assisting JISC, the NSF-equivalent in UK, including attending London meeting on 25 July 2006)
9. 2004-2008 Chairman, IEEE-CS Technical Committee on Digital Libraries
10. 2004-2008 Member, Advisory Board, DELOS Network of Excellence on Digital Libraries (http://www.delos.info/), funded by the European Union's 6th Framework Programme, first meeting December 9, 2004 in Athens, second meeting December 7-8, 2005 in Sophia-Antipolis, France, third meeting January 14-15, 2007 in Rome, fourth meeting Dec. 7, 2007 in Italy
11. 1995-2008 Editor, Morgan Kaufmann Publishers, Inc. Series on Multimedia Information and Systems. Books in series include:
    1. How to Build a Digital Library - by Witten and Bainbridge
    2. Digital Watermarking - by Cox, Miller, and Bloom
    3. Readings in Multimedia Computing and Networking - edited by Jeffay and Zhang
    4. Introduction to Data Compression, Second Edition - by Sayood
    5. Multimedia Servers: Applications, Environments, and Design - by Sitaram and Dan
    6. Managing Gigabytes: Compressing and Indexing Documents and Images, Second Edition - by Witten, Moffat, and Bell
    7. Digital Compression for Multimedia: Principles and Standards - by Gibson, Berger, Lookabaugh, Lindbergh, and Baker
    8. Practical Digital Libraries: Books, Bytes, and Bucks - by Lesk
    9. Readings in Information Retrieval - by Jones and Willett
12. 2005-2007 Member, Computational and Informational Sciences Directorate Review Committee, Pacific Northwest National Laboratory (PNNL), Richland, WA
13. 2007 Editorial board, The Open Information Systems Journal (TOIJ)
14. 2001-2006 Director, Computing and Information Technology Interactive Digital Educational Library (CITIDEL), www.citidel.org
15. 2000-2006 Co-editor-in-chief, ACM Journal of Education Resources In Computing (JERIC - and lead proposer 1998-2000), http://www.acm.org/pubs/jeric/
16. 2000-2006 Member, ACM SIG Multimedia Executive Board
17. 1999-2006 Member, Steering Committee, Open Archives Initiative http://www.openarchives.org
18. 2004-2005 Member, Advisory Board, Development of a Distributed Digital Library Training Certificate Program, University of North Carolina at Chapel Hill

19. 2002-2005 Member, Policy Committee, NSDL, National Science Digital Library, old long name: National STEM (Science, Technology, Engineering, and Mathematics) education Digital Library, www.nsdl.org (the steering committee of an initiative with over $150M NSF funding, to transform education throughout the USA at all levels in STEM areas), chair 1/2002 - 5/2003
20. 2001-2005 Advisory board, IMEJ of Computer-Enhanced Learning (http://imej.wfu.edu)
21. 1997-2005 Editor, Computer Science Teaching Center (CSTC, www.cst.org)
22. 1998-2004 Member, Governing Board, Internet Technology Innovation Center http://www.internettic.org
23. 2000-2003 Executive Editor, TICtalk Newletter, a monthly publication of Internet Technology Innovation Center
24. 1997-2003 Editorial board, IEEE Multimedia (IEEE-CS)
25. 1992-2001 Editorial board, Multimedia Systems (ACM/Springer-Verlag)
26. 1995-2001 Member, NCSTRL (Networked CS Tech. Report Library) working group (part of D-Lib working group program)
27. 1997-2000 Member, Steering Committee, ACM Preprint Database (and CoRR, Computing Research Repository, http://xxx.lanl.gov/archive/cs/intro.html)
28. 1995-2000 Co-chair, ACM SIGMM Education Committee
29. 1994-99 Editorial board, Electronic Publishing - Origination, Dissemination and Design Journal (Wiley)
30. 1996-98 Chair, Steering Committee, ACM Digital Libraries conf. series
31. 1994-95 Past Chair, member ACM Multimedia Conferences Steering/Advisory Committee
32. 1991-95 Chairman, ACM SIGIR (Special Interest Group on Information Retrieval)
33. 1992-94 Chair and Founder, ACM Multimedia Conferences Steering/Advisory Committee
34. 1989-93 Associate editor, ACM Transactions on Information Systems
35. 1988-92 Member ACM Publications Board
36. 1988-91 Editor-in-chief ACM Press Database and Electronic Products. Responsible for electronic publishing plans, products, and services. Publications include "Hypertext on Hypertext;" the "Resources in Computing" book series; CD-ROMs in the DALibrary and Computer Archive products; a videotape documentary, etc.
37. 1987-91 Vice chairman ACM SIGIR (Special Interest Group on Information Retrieval)
38. 1987-91 Editor ACM Press Books Database Products
39. 1985-89 Editor, mailing list maintainer, and founder of IRList, an electronic digest on information retrieval and related topics.
40. 1985-87 Co-editor for ACM SIGIR Forum, the newsletter for SIGIR

EARLIER (other):

1. Meta-reviewer, Program Committee, ACM/IEEE-CS Joint Conference on Digital Libraries (JCDL 2016, http://www.jcdl2016.org/), Rutgers Univ., Newark, NJ, June 19-23, 2016
2. Member, Program Committee, BIRNDL, Bibliometric-enhanced Information Retrieval and Natural Language Processing for Digital Libraries, a workshop federating the 4th Bibliometric-enhanced Information Retrieval (BIR) and the 2nd Workshop on text and

citation analysis for scholarly digital libraries (NLPIR4DL), at JCDL, Rutgers Univ., Newark, NJ, June 19-23, 2016

3. Member, Program Committee, TPDL 2016, 20th International Conference on Theory and Practice of Digital Libraries, September 5-9, 2016, Hannover, Germany
4. Member, Program Committee, CERI 2016 Teaching IR Track, 4th Spanish Conf. in Information Retrieval, http://www.ugr.es/~ceri16/ss.php
5. Chair for plenary session 3, Open Access, 19th International Symposium on Electronic Theses and Dissertations, ETD 2016 "Data and Dissertations", 11-13 July 2016, Lille (France)
6. Meta-reviewer, Program Committee Member, 19th International Conference on Theory and Practice of Digital Libraries, TPDL 2015, Sept. 14-18, 2015, Poznan, Poland
7. Member, Program Committee, 2015 NSF Workshop on Curricular Development for Computing in Context, CIC15, May 13, 2015, Stetson U., Deland FL, http://cbia.stetson.edu/cic
8. Meta-reviewer, Program Committee Member, JCDL 2015, June 21-25, 2015, Knoxville, TN
9. Member, Program Committee, Knowledge Maps and Information Retrieval (KMIR), workshop at JCDL2015, June 24-25, 2015, Knoxville, TN
10. Meta Reviewer, Digital Libraries 2014, conjoined conference for Joint Conference on Digital Libraries (JCDL) and Theory and Practice of Digital Libraries (TPDL) Conference
11. Member, Program Committee, Knowledge Maps and Information Retrieval (KMIR), workshop at DL 2014, London, 11 Sept. 2014
12. Member, Program Committee, ECIR 2015 workshop "Bibliometric-enhanced Information Retrieval", part of the 37th European Conference on Information Retrieval (ECIR), March 29, 2015, Vienna, http://www.gesis.org/en/events/events-archive/conferences/ecirworkshop2015/
13. Senior Program Committee Member, TPDL 2013, and TPDL Workshops Program Committee Member
14. Senior Program Committee Member, JCDL 2013
15. Member, Organizing Committee, Contemplative Practices for a Technological Society, April 11-13, 2013, Blacksburg, VA
16. Invited Attendee, Scholarly Communications Workshop, U. Pittsburgh, Jan. 13-15, 2013
17. Reviewer for ISCRAM 2013
18. Member, Program Committee, ICADL2012, International Conference on Asia-Pacific Digital Libraries, Taipei, Taiwan, 12-15 Nov., http://www.icadl2012.org/
19. 2011-2 Member, CS2013 Committee for Knowledge Areas: Computational Science, Information Management
20. Member, Program Committee, 16th International Conference on the Theory and Practice of Digital Libraries (TPDL 2012 -- http://www.tpdl2012.org/), Cyprus, September 23-27, 2012
21. Member, Workshop Committee, 16th International Conference on the Theory and Practice of Digital Libraries (TPDL 2012 -- http://www.tpdl2012.org/), Cyprus, September 23-27, 2012
22. Senior Member, Program Committee, JCDL 2012, Washington, D.C., June 10-14

23. Member, Steering Committee, NSF-funded CCC Vision Workshop on Computing for Disaster Management, Washington, D.C., April 24-25, 2012 (including work on report to NSF due in June)
24. Member, Program Committee, 34th European Conference on Information Retrieval (ECIR 2012), Barcelona, Spain, 1-5 April 2012 (http://ecir2012.upf.edu)
25. Member, Program Committee, ACM SIGCSE 2012, Feb. 29 - March 3
26. Member, Program Committee, Personal Information Management 2012, workshop at CSCW, Seattle, Feb. 11-12, 2012
27. Member, Program Committee, ACM Multimedia 2011, Scottsdale, AZ, Nov. 28 - Dec. 1, 2011
28. Member, Program Committee, ICADL2011, International Conference on Asia-Pacific Digital Libraries, Beijing, China, 24-27 Oct., http://www.icadl2011.org/
29. Member, Program Committee, Information and Data Management Track, 26th Brazilian Symposium on Databases, SBBD, Florianopolis, Brazil, Oct. 3-6, 2011
30. Senior Program Committee Member, International Conference on Theory and Practice of Digital Libraries, TPDL, Berlin, Germany, September 25-29, 2011 (http://www.tpdl2011.org/)
31. Area Chair, Program Committee, 34th ACM International Conference on Research and Development in Information Retrieval (SIGIR 2011 -- http://www.sigir2011.org/) Beijing, China, July 24-28, 2011
32. Invited Attendee, Microsoft Research Faculty Summit, Redmond, WA, July 18-20, 2011
33. Member, Program Committee, 19th International Symposium on Methodologies for Intelligent Systems, ISMIS 2011, June 28-30, Warsaw, Poland, http://ismis2011.ii.pw.edu.pl/
34. Member, Program Committee (and attending PC meeting), Joint Conference on Digital Libraries (JCDL 2011), June 13-17, Ottawa, www.jdcl2011.org.
35. Member, Programme Committee, European Conference on Information Retrieval (ECIR) 2011, 18-21 April, Dublin, Ireland
36. 2009-2011, Member, DL.org (EU funded organization for digital libraries) Working Group on Functionality, meeting in Greece June 2009 and in Rome May 2010, along with periodic online meetings
37. 2009-2010, Chair, Working Group on Interdisciplinary Computing Curricula, at the 2009 Rebooting Computing Summit and following up into the future
38. Member, Program Committee, Information Retrieval track, 25th Brazilian Symposium on Databases (SBBD 2010), Belo Horizonte, Brazil, Oct. 5-8
39. Senior Program Committee Member, ECDL 2010, 14th European Conference on Digital Libraries, Glasgow, September 6-10, 2010, http://www.ecdl2010.org/
40. Member, Program Committee, Fourth Annual Workshop on Human Computer Interaction and Information Retrieval (HCIR 2010), New Brunswick, NJ, August 22, 2010
41. Senior Program Committee Member and Area Chair (Applications), SIGIR 2010, 33rd ACM International Conference on Research and Development in Information Retrieval, Geneva, Switzerland, July 18-23, 2010
42. Member, Program Committee, CRA Biennial Conference at Snowbird, 2010, Cliff Lodge, Snowbird Resort, Utah, July 18-20
43. Attendee, Media Computation Workshop, Virginia Tech, July 7-9, 2010

44. Member, Program Committee, ITiCSE 2010, The 15th Annual Conf. on Innovation and Technology in Computer Science Education, Bilkent, Ankara, Turkey, June 26-30, 2010, http://iticse2010.bilkent.edu.tr/
45. Member, Program Committee, JCDL 2010, Joint Conference on Digital Libraries, Gold Coast, Australia, June 21-25, 2010
46. Member, Program Committee, ICADL2010, International Conference on Asia-Pacific Digital Libraries, Brisbane, Australia, 21-25 June 2010, http://www.jcdl-icadl2010.org/
47. Member, Program Committee, Doctoral Consortium, JCDL/ICADL 2010, June 21-25, Gold Coast, Australia
48. Member, Program Committee, ETD 2010, June 16-18, Austin, TX
49. Member, Paper Review Committee, 4th International Symposium on Information Technology 2010, ITSIM 2010, Kuala Lumpur, June 15-17, http://www.itsim.org/
50. Member, Programme Committee, 32nd European Conference on Information Retrieval (ECIR 2010), The Open University in Milton Keynes, UK, March 28-31, http://kmi.open.ac.uk/events/ecir2010/
51. Member, Program Committee, ACM SIGCSE 2010, Milwaukee, March 10-13
52. 2008-2009, Co-editor of ACM TOMCCAP special issue, led by Christoph Rensing, http://tomccap.acm.org/special2009.html
53. Member, Program Committee, ECDL 2009, Sep. 27 - Oct. 2, 2009, Corfu
54. Member, Program Committee, ISMIS'09, Prague, Czech Republic, September 14-17, 2009
55. Area Chair (AC, Senior Program Committee member) for IR Applications, 32nd ACM International Conference on Research and Development in Information Retrieval, SIGIR 2009, http://www.sigir2009.org, Boston, July 19-23, 2009
56. Mentor for SIGIR 2009
57. Member, Program Committee, ITiCSE 2009, July 6-8, 2009, Paris
58. Member, Program Committee, JCDL 2009, Austin, TX, June 15-19, 2009
59. Member, Program Committee, 12th Intl. Symposium on Electronic Theses and Dissertations (ETD 2009), Pittsburgh, PA, June 10-13
60. Reviewer, DigCCurr2009: Digital Curation Practice, Promise, and Prospects, Chapel Hill, NC, April 1-3, 2009
61. Member, Program Committee, ECIR'09: 31st European Conference on Information Retrieval, April 2009
62. 2001-2008 Member, NCSTRL (Networked Computer Science Technical Reference Library, www.ncstrl.org) Committee
63. Member, Program Committee, 11th International Conference on Asian Digital Libraries, ICADL 2008, Bali, Indonesia, Dec. 2-5, 2008
64. Member, Steering Committee, 2008 NSF CISE Pathways to Revitalized Undergraduate Computing Education, CPATH 2008, Arlington, VA, Nov. 12-14, 2008
65. Member, Program Committee, SPIRE 2008, 15th String Processing and Information Retrieval Symposium, Melbourne Australia, November 10-12, 2008
66. Member, Program Committee, HCIR 2008, Workshop on Human-Computer Interaction and Information Retrieval, October 23, Microsoft Research, Redmond, Washington
67. Member, Program Committee, Brazilian Symposium on Databases (SBBD), Campinas, Brazil, October 13-15, 2008

68. Member, Program Committee, European Conference on Research and Advanced Technology for Digital Libraries: Towards the European Digital Library, ECDL2008, Aarhus, Denmark, September 14 - 19, 2008
69. Senior Member, Program Committee, SIGIR 2008, July 20-24, 2008, Singapore
70. Member, Program Committee, JCDL 2008, June 15-20, 2008, Pittsburgh
71. Member, Program Committee, ISMIS 2008, May 20-23, 2008, Toronto
72. Co-chair, Panels, ECDL 2007, Budapest, September 2007
73. Senior PC member, ACM SIGIR 2007, attending PC meeting March 29-30, 2007 in Delft, Netherlands, 30th Annual International ACM SIGIR Conference, 23-27 July 2007, Amsterdam
74. Co-chair (with Donatella Castelli), JCDL 2007 Workshop 2: 1st Workshop on Digital Library Foundations, with 2007 Joint Conference on Digital Libraries, June 23, 2007, Vancouver
75. Co-chair (with Geneva Henry) standing in for Chair Nadia Caidi who could not attend, JCDL 2007 Doctoral Consortium, with 2007 Joint Conference on Digital Libraries, June 19, 2007, Vancouver
76. Member (of 6), Organizing Committee, JCDL 2007 Workshop 1: Developing a Digital Libraries Education Program, with 2007 Joint Conference on Digital Libraries, June 18, 2007, Vancouver
77. Member, Program Committee, JCDL 2007, 2007 Joint Conference on Digital Libraries, June 17-23, 2007, Vancouver
78. Member, Program Committee, ETD 2007, 10th International Symposium on Electronic Theses and Dissertations, Uppsala, Sweden, June 13-16, 2007, http://epc.ub.uu.se/etd2007/
79. Member, Program Committee, MUE 2007, 26-28 April 2007, Seoul, Korea
80. Member, Program Committee, 29th European Conference on Information Retrieval (ECIR 2007), Rome, April 2-5, http://ecir2007.fub.it
81. Invited IMA workshop attendee, The Evolution of Mathematical Communication in the Age of Digital Libraries, Dec. 8-9, 2006, hosted by the Institute for Mathematics and its Applications (IMA), Minneapolis, http://www.ima.umn.edu/2006-2007/SW12.8-9.06/index.html
82. Member, Program Committee, ICADL 2006, Kyoto, Japan, Nov. 2006, http://www.icadl.org/
83. Member, Program Committee, SPIRE 2006, 13th ed. Symposium on String Processing and Information Retrieval (http://www.cis.strath.ac.uk/external/spire06/), 11-13 Oct. 2006, Glasgow
84. Member, Program Committee, ECDL 2006, Alicante, Spain, 17-22 Sept. 2006, http://www.ecdl2006.org/, and Accompanying Professor, Doctoral Consortium
85. Co-organizer, ETANA Workshop, Vanderbilt University, Nashville, Sept. 8-9, 2006
86. Member, Program Committee, SIGIR 2006 Workshop "Evaluating Exploratory Search Systems" (http://www.sigir2006.org/), Aug. 6-11, Seattle; Area Coordinator (AC) for ACM SIGIR 2006, for Web IR and Digital Libraries, coordinating the work of the reviewers in that area
87. Member, JCDL 2006 program committee, June 11-15, 2006, Chapel Hill, NC
88. Accompanying Professor, Doctoral Consortium, JCDL 2006, June 11-15, 2006, Chapel Hill, NC, http://www.jcdl2006.org/

89. Member, Program Committee, ETD 2006, 9th International Symposium on Electronic Theses & Dissertations, June 7-10, 2006, Quebec City, http://www6.bibl.ulaval.ca:8080/etd2006/
90. Member, Program Committee, Southeast Workshop on Data and Information Management, Raleigh, NC, March 30-31, 2006
91. Member, Program Committee, 10th International Conference on Extending DataBase Technology (EDBT 2006), Munich, GE, March 27-31, 2006
92. Member, Program Committee, ACM Conference on Information and Knowledge Management (CIKM) 2005 (http://www.tzi.de/CIKM2005/), Bremen, Germany, October 31 - November 5
93. Member, Program Committee, ETD 2005, 8th International Symposium on Electronic Theses & Dissertations, Sydney, Australia, Sept. 28-30, 2005
94. Member, Organizing Committee and Co-chair for Panels, European Conference on Digital Libraries, ECDL 2005, Vienna, September 18-23, 2005, http://www.ecdl2005.org
95. Reviewer, SIGIR 2005, 28th Annual International ACM SIGIR Conference, Salvador, Brazil, August 15-19, 2005
96. Member, Program Committee, Fifth Joint Conference on Digital Libraries, JCDL 2005, June 7-11, 2005, Denver, Colorado
97. Member, Program Committee, 8th International Workshop of the DELOS Network of Excellence on Digital Libraries on Future Digital Library Management Systems (System Architecture & Information Access), Schloss Dagstuhl, Germany, March 29 - April 1st, 2005
98. 2001-2005 Member, Institutional Asset Submission Programme Steering Group (assisting JISC, the NSF-equivalent in UK, for FAIR program), including March 14, 2002 teleconference review panel
99. 2003-2004 Member, Energy Sciences & Technology Directorate Review Committee, Pacific Northwest National Laboratory (PNNL), Richland, WA
100. 2001-2004, Member, National Visiting Committee, "Web-Network Technology Curriculum Development" NSF grant to Erie Community College, SUNY Buffalo, ...; attending meetings in Buffalo, NY on 11/7/2001; June 11-13, 2002; June 18-19, 2003; June 15-16, 2004
101. Co-chair, Program Committee, ICADL 2004, 7th International Conference of Asian Digital Libraries, Shanghai, China, Dec. 13-17, 2004
102. Member, Program Committee, CIKM 2004, 13th Conference on Information and Knowledge Management, Nov. 8-13, 2004, Washington, D.C.
103. Member, Program Committee, SCCC'04, XXIV International Conference of the Chilean Computer Science Society, Nov. 11-12, 2004, Arica, Chile
104. Member, Program Committee, AIRS 2004, Asia Information Retrieval Symposium, Beijing, Oct. 14-16, 2004
105. Moderator, Discussion group on Information Integration, NSF IDM PI Workshop, Oct. 10-12, 2004, Cambridge, MA
106. Member, Program Committee, SPIRE 2004, String Processing and Information Retrieval Symposium, Padova, Italy, Oct. 5-8
107. Member, Program Committee, SIGIR 2004, 27th Annual International ACM SIGIR Conference, University of Sheffield, UK, July 25-29, 2004

108. Member, Program Committee, ELPUB 2004, ICCC 8th International Conference on Electronic Publishing, University of Brasilia, Brazil, June 23 - 26, 2004
109. Member, Program Committee, ISI-2004, 2nd Symposium on Intelligence and Security Informatics, Tucson, Arizona, June 10-11, 2004
110. Member, Program Committee, JCDL 2004, ACM/IEEE-CS Joint Conference on Digital Libraries, Tucson, Arizona, June 7-11, 2004
111. Member, Program Committee, ETD 2004, The 7th International Symposium on Electronic Theses & Dissertations: Distributing knowledge worldwide through better scholarly communication, Lexington, KY, June 3-5, 2004
112. Member, Program Committee, DLKC'04, International Symposium on Digital Libraries and Knowledge Communities in Networked Information Society, March 2-5, 2004, University of Tsukuba, Japan
113. Member, Program Committee, CIKM'2003, New Orleans, LA, Nov. 2-8, 2003
114. Member, Program Committee, SPIRE-2003, String Processing and Information Retrieval Symposium, Manaus, Brazil, October 8-10, 2003
115. Member, Program Committee, ENC 2003, Encuentro, biannual conf. of Mexican Computer Society (SMCC), Sept. 8-12, Apizaco, Mexico
116. Member, Program Committee, ECDL'2003, Trondheim, Norway, Aug. 17-22, 2003
117. Member, Program Committee, SIGIR'2003, Toronto, July 28-Aug.1, 2003
118. Member, Program Committee, Elpub 2003, 7th International Conference on Electronic Publishing, June 25-28, 2003, Guimaraes, Portugal
119. Member, Program Committee, The First NSF/NIJ Symposium on Intelligence and Security Informatics (ISI 2003), June 2-3, 2003, Tucson, AZ, http://ecom.arizona.edu/ISI/
120. Member, Program Committee, JCDL'2003, Houston, May 27-31, 2003
121. 2001-2 Program Co-Chair, ICADL'2002, Singapore, Dec. 17-20, 2002, http://www.cais.ntu.edu.sg:8000/icadl02
122. Member, Program Committee, ECDL'2002 (and co-chair, demos and posters), Rome, Sep. 16-18, 2002
123. Member, Program Committee, SPIRE'2002, Lisbon, Portugal, Sep. 11-13
124. Member, Program Committee, JCDL'2002, Portland, July 14-18, 2002 (attending PC meeting March 8-10, 2002, Chapel Hill, NC)
125. Member, Int'l Program Committee, 2002 Workshop on Multimedia Information Retrieval and Management, June 5, 2002, Hong Kong Poly. U.
126. Member, Organizing Committee, OCKHAM (Open Community Knowledge Hypermedia Administration and Metadata), May 3, 2002, Atlanta, GA (sponsored by Digital Library Federation)
127. 2002 Co-organizer: Deborah Knox, Lillian Cassel, John Impagliazzo, Edward Fox, JAN Lee, Manuel Perez, and C. Lee Giles. "Submission, Evaluation, and Refinement of Resources to CITIDEL". Full day workshop (scheduled but cancelled due to attendance,attended only by co-PIs) at ACM SIGCSE Symposium 2002, http://www.cs.cofc.edu/sigcse2002/, in Proc. of the 33rd SIGCSE Technical Symposium on Computer Science Education, Feb. 27 - March 3, 2002, Covington, KY, p. 421
128. 2002 Invited participant, NIMD'2002 Workshop, Jan. 7-9, 2002, Arlington, VA (Novel Intelligence from Massive Data program of ARDA)

129. Member, Program Committee, ICADL 2001, Dec. 10-12, 2001, Bangalore, India, 4th Int'l Conf. of Asian Digital Libraries
130. Member, Program Committee and Area Coordinator, 24th Annual International SIGIR Conference on Research and Development in Information Retrieval, New Orleans, LA, Sept. 2001 (and attending PC meeting 3/23-25/2000)
131. Member, Program Committee, ECDL 2001, 5th European Conference on Research and Advanced Technology for Digital Libraries, September 4-8 2001, Darmstadt, Germany, http://www.ecdl2001.org
132. Member, Program Committee, SPIRE'2001 - String Processing and Information REtrieval, Laguna de San Rafael, Chile, Nov. 13-15,2001
133. 2001 Invited participant, SMETE.ORG workshop, PKAL Summer Institute, July 15-18, 2001, Snowbird, Utah
134. 2001 Invited participant, brainstorming meeting on "Digital Libraries: Future Directions for a European Research Programme", organized by the DELOS Network of Excellence on Digital Libraries, in cooperation with the Cultural Heritage Applications Unit of the 5th FP IST programme, 13-15 June 2001, S. Cassiano, Italy, Brainstorming Report ERCIM-02-W02, http://delos-noe.org/
135. 2001 Member, Steering Committee, NSF IDM'2001, April 29 - May 1, 2001, Fort Worth, Texas, http://itlab.uta.edu/idm01/
136. 2001 Member, Review team for UMBC CS program, April 16, 2001, Baltimore
137. 2000-01 Member, Program Committee, WWW10 Conference, 10th International World Wide Web Conference, Hong Kong, June 2001, http://www.www10.org
138. 1999-01 Member, ACM Content Steering Committee (w. John White, charge at http://www.cs.arizona.edu/people/rts/Portal/hidden/steering.charge)
139. 1998-01 Member, Curriculum 2001 (CC2001) Review Committee (and member of focus group on Information Management)
140. 1998-01 Member, Ad Hoc Committee on Being a Scholar in the Digital Age, that helped to prepare "Issues for Science and Engineering Researchers in the Digital Age", National Research Council, ISBN 0-309-07417-7, Washington, D.C.: National Academy Press, 2001, 57 pages
141. 2000 Member, Board of Experts for NCLIS
142. 2000 Member, Program Committee, MMM 2000, November, 13-15, 2000, Nagano Japan, http://www.phys.waseda.ac.jp/shalab/mmm2000/
143. 2000 Member, Program Committee for The Ninth International Conference on Information and Knowledge Management (CIKM'2000), Nov. 6-11, 2000, Washington, DC, http://www.csee.umbc.edu/cikm/2000/
144. 2000 Member, Organizing Committee (OC) for the International Conference on Information Society in the 21 Century: Emerging Technologies and New Challenges (IS2000), November 5-8, 2000, The University of Aizu, Aizu-Wakamatsu City, Fukushima, Japan
145. 2000 Member, review panels, NSF, Jan. 12-13, 2000 and May 22-25, 2000
146. 1999-2000 Member, Committee for National Research Council to prepare "On Being a Researcher in the Digital Age", for booklet published by NRC/NAS
147. 1999-2000 Member, Program Committee, ACM Multimedia 2000, Los Angeles, Oct. 30 - Nov. 3, 2000, http://www.acm.org/sigs/sigmm/MM2000/

148. 1999-2000 Member of the International Program Committee, SIGIR 2000, Athens, July 25-28, 2000
149. 1999-2000 Member, Coordination Group (led by R. Steinmetz, with W. Effelsberg and N. Georganas), "Multimedia for Multimedia: Learning and Teaching in the Next Decade", Dagstuhl seminar, Castle Dagstuhl, Germany, June 11-16, 2000
150. 1999-2000 Member, Program Committee, ACM Digital Libraries '2000, San Antonio, TX, June 2-7, 2000, http://www.dl00.org/
151. 1999-2000 Member, Program Committee, Web9 Conference, 9th International World Wide Web Conference, The Web: The Next Generation, Amsterdam, May 15-19, 2000, http://www.www9.org
152. 1999-2000 Member, Steering Committee, NSF IDM'2000, Chicago, March 5-7, 2000, http://boston.cwru.edu/idm00/
153. 1999-2000 Member, Program Committee, ICDE'2000, 16th International Conf. on Data Engineering, San Diego, CA, Feb. 28-March 3, 2000 http://research.microsoft.com/icde2000/
154. 1999 Member, Program Committee, 5th International Computer Science Conference (ICSC '99), Hong Kong, December 15-17, 1999
155. 1999 Participant, 7th Dublin Core Metadata Workshop, Die Deutsche Bibliothek, Frankfurt, October 25-27, 1999 (and presenter at Discussion Group - Dissertation Online - Oct. 27)
156. 1999 Invited participant and presenter, Workshop on an international project of electronic dissemination of theses and dissertations, UNESCO, Paris, Sep.27-28, 1999
157. 1999 Chair, Steering Committee meeting of NDLTD, 9/24/99, Washington
158. 1999 Member, Program Committee, 5th Eurographics Workshop on Multimedia Media Convergence: Models, Technologies and Applications, EG Multimedia'99, Milan, Italy, Sep. 7-8, 1999 http://egmm99.di.fct.unl.pt
159. 1999 Invited expert, by NSF, for Digital Library for Education (DLE) meeting, Washington, D.C., June 10, 1999
160. 1998- Member, Steering Committee, ACM Digital Libraries conf. series
161. 1998-2000 Member, Program Committee of 4th European Conf. for Digital Libraries, ECDL'2000, Lisbon, Sept. 18-21, 2000, http://www.bn.pt/org/agenda/ecdl2000/
162. 1998-99 Member, Program Committee for The Eighth International Conference on Information and Knowledge Management (CIKM'99), Kansas City, Missouri, Nov. 2-6, 1999, http://www.cs.umbc.edu/cikm
163. 1998-99 Member, Program Committee, Fifth International Workshop on Multimedia Information Systems (MIS'99), Palm Springs Desert Resorts area, CA, Oct. 21-23, 1999
164. 1998-99 Member, Program Committee, ICON'99, International IEEE Conf. on Computer Networks, Brisbane, Australia, Sept. 9-10, 1999
165. 1998-99 Member, Review Committee for ACM SIGIR'99, Aug.15-19, Berkeley,CA
166. 1997-99 Associate Program Chair, ACM Multimedia'99, 7th ACM Int'l Multi-media Conf., Nov. 1999, Orlando, http://www.acm.org/sigmm/MM99/
167. 1997-99 Member, Program Committee for CoLIS 3, Dubrovnik, May 1999

168. 1999 Chair of Technical Committee meeting, for Networked Digital Library of Theses and Dissertations, held before Coalition for Networked Information Spring Meeting, Renaissance Washington D.C. Hotel, April 26-27, 1999
169. 1999 Participant, NSF Digital Library Workshop on undergraduate education, Arlington, VA, Jan. 4-6, http://www.dlib.org/smete/
170. 1998-99 Member, ASIS 1999 Mid-Year Meeting program committee
171. 1996-99 Member, OCLC's Research Advisory Council
172. 1995-99 Member, Columbia U. Digital Library Advisory Committee
173. 1998 Participant, University of Missouri-Columbia's Delphi Study of Digital Libraries. For details of the study and report see http://www.coe.missouri.edu/~is334/projects/Delphi_DL/Default.htm
174. 1998 Participant, NSF Workshop on Digital National Library for Undergraduate Science, Mathematics, Engineering, and Technology Education, Arlington, VA, July 21-23, http://www.dlib.org/smete/
175. 1998 Chair of Steering Committee meetings, for Networked Digital Library of Theses and Dissertations, held at Coalition for Networked Information offices, Washington, D.C, March 27, 1998; Sept.25,1998
176. 1998 Chair of Technical Committee meeting, for Networked Digital Library of Theses and Dissertations, held before Coalition for Networked Information Spring Meeting, Arlington, VA, April 14, 1998
177. 1998 Participant, D-Lib Metrics Working Group Meeting, Stanford, CA, Jan. 7-8, 1998
178. 1997-98 Member, Program Committee for IEEE Multimedia Systems'98, IEEEMM98
179. 1997-98 Member, Program Committee for ACM SIGIR '98, Aug., Melbourne, Australia
180. 1997-98 Member, Program Committee for The Seventh International Conference on Information and Knowledge Management (CIKM'98), Nov. 1998
181. 1997-98 Associate Program Chair, ACM Multimedia '98, 6th ACM Int'l Multimedia Conf., 12-16 Sept. 1998, Bristol, UK http://www.acm.org/sigmm/MM98/
182. 1997-98 Member, Program Committee of 2nd European Conf. for Digital Libraries, Crete
183. 1997-98 Member, Program Committee, SICON '98, IEEE Int'l Conf. on Networks, 30 June - 3 July 1998, Singapore (and session chair)
184. 1997-98 Member, Program Committee for ACM Digital Libraries '98, Pittsburgh, PA, June 23-26, 1998, http://www.ks.com/dl98 (also, Workshop Chair, committee to select winner of the Vannevar Bush award)
185. 1997-98 Member, Program Committee for BAS98, The 3rd Symposium on Computer Networks, June 25-26, 1998, Dokuz Eylul University, Izmir, Turkey
186. 1997-98 Member, Program Committee for RIDE98, Eighth International Workshop on Research Issues in Data Engineering: Continuous-Media Databases and Applications, February 23-24, 1998, Orlando, Florida, Sponsored by IEEE Computer Society Technical Committee on Data Engineering
187. 1996-98 Member, Steering Committee, Monticello Electronic Library, a project of SURA and SOLINET (re TIAPP grant)
188. 1995-98 Member, ACM SIGIR Executive Committee (as Past Chair)

189. 1995-98 Member, ACM SIGIR Electronic Publishing Committee
190. 1993-98 Member, ACM SIGIR Education Committee
191. 1997 Chair, Nominations Committee, ACM SIGIR
192. 1997 Chair of Technical Committee meeting, for Networked Digital Library of Theses and Dissertations, held before Coalition for Networked Information Spring Meeting, Minneapolis, Oct. 26, 1997
193. 1997 US Representative, Workshop on Curricular Development on Information Management and Digital Libraries, Lisbon, Portugal, Oct. 3-4, 1997
194. 1997 Chair of Steering Committee meeting, for Networked Digital Library of Theses and Dissertations, held at Coalition for Networked Information offices, Washington, D.C, Sept. 19, 1997
195. 1997 Member, workshop on a Digital National Library for Science, Mathematics, Engineering and Technology, sponsored by National Research Council, Washington, D.C., August 7-8, 1997
196. 1996-97 Program committee member, First European Conference in Research and Advanced Technology for Digital Libraries, Pisa, Italy, 9/1-3/97
197. 1996-97 Program committee member, 20th Intern'l Conf. on R&D in Information Retrieval, SIGIR '97, July 27-31, 1997, Philadelphia; also chair of session on Image Retrieval; also on Best Paper Committee
198. 1996-97 Technical papers committee member, 2nd ACM Int'l Conf. on Digital Libraries, DL'97, July 21-23, 1997, Philadelphia
199. 1995-97 Program committee member, IEEE Multimedia Systems'97, the IEEE International Conference on Multimedia Computing and Systems (ICMCS), June 3-6, 1997, Ottawa, Canada
200. 1995-97 Program comm. member, 1997 International Conference on Software Engineering, ICSE 97, May 17-24, 1997, Boston, MA
201. 1996-97 Organizing comm. member, Workshop on R&D Opportunities in Federal Information Services, 5/13-15/97, Arlington, VA; also met 12/3-5/96
202. 1997 Chair of Technical Committee meeting, for National Digital Library of Theses and Dissertations, held before Coalition for Networked Information Spring Meeting, Crystal City, VA, 4/1-2/97
203. 1997 Invited attendee, Computing and Humanities workshop, Computer Science and Telecommunications Board, National Research Council, March 28, 1997, Washington, D.C.
204. 1997 Chair of Steering Committee meeting, for National Digital Library of Theses and Dissertations, held at Coalition for Networked Information offices, Washington, D.C, March 14, 1997
205. 1997 Invited attendee and co-chair of one of four working groups, NSF Workshop for a Research Initiative on Distributed Knowledge-Work Environments, Santa Fe, March 9-11, 1997
206. 1997 NSF Database and Expert Systems panel, Feb. 3, 1997
207. 1996-97 Program committee member, Multimedia Computing and Networking 1997 (MMCN97) Conference (sponsored by SPIE and IS&T), San Jose, Feb. 10-12, 1997.

208. 1996 Chair of Technical Committee meeting, for National Digital Library of Theses and Dissertations, held after Coalition for Networked Information Fall Meeting, San Francisco, Dec. 7, 1996
209. 1996 Program review committee member, ACM Multimedia '96 conference, November 18-22, 1996, Boston, MA, http://www.acm.org/sigmm/MM96/
210. 1996 Member, NSF DLI Site Review Team, visiting 2 institutions, May, 1996
211. 1995-96 Steering committee member, NSF-sponsored 38th Allerton Institute, Oct. 27-29, 1996, Monticello, IL; co-chaired session with G. Marchionini
212. 1995-96 Program committee member, 19th Intern'l Conf. on R&D in Information Retrieval, SIGIR '96, Aug. 18-22, 1996, Zurich, Switzerland
213. 1995-96 Technical Program Committee member, HPDC Focus Workshop on Multimedia and Collaborative Environments, part of Fifth IEEE Int. Symp. on High Performance Distributed Computing (HPDC-5), Aug. 6-9, 1996, Syracuse, NY
214. 1995-96 Program committee member for Multimedia Computing and Networking 1996 - part of the IS&T/SPIE Symposium on Electronic Imaging Science and Technology, Jan. 29-31, 1996, San Jose, CA
215. 1995-96 Program committee member, Pacific Workshop on Distributed Multimedia Systems, DMS'96, June 25-28, 1996, Hong Kong
216. 1995 Steering committee member, NSF-sponsored 37th Allerton Institute, "How We Do User-Centered Design and Evaluation of Digital Libraries: A Methodological Forum," 10/29-31/95, Monticello, IL
217. 1995 Program committee member, Curriculum Development in Computer Information Science: A Framework for Developing a New Curriculum in IR, workshop following ACM SIGIR'95, July 13, 1995, Seattle, WA
218. 1995 Invited participant, ARPA sponsored HPCC/IITA DigLib Workshop, May 18-19, 1995, Tysons Corner, VA.
219. 1995 Organizing Committee, NSF hosted workshop on Computer Science Technical Reports, NSF, Arlington, VA, April 7-8, 1995
220. 1994-96 Program committee member, ISMIS'96, organized with the assistance of the Polish Academy of Sciences, 6/10-13/96, Zakopane, Poland
221. 1994-95 Senior Member of the Program Committee, member of conference executive committee, ACM Multimedia '95, Third ACM International Conference on Multimedia, Nov. 5-9, 1995, San Francisco, CA
222. 1994-95 Program committee member, CIKM 95, Fourth International Conference on Information and Knowledge Management, Nov. 28 - Dec. 2, 1995, Baltimore, MD
223. 1994-95 Organizing Committee Member, Digital Libraries '95, June 11-13, 1995, Austin, TX
224. 1994-95 Program committee member, Electronic Publishing and the Information Superhighway, DAGS'95 (Dartmouth Institute for Advanced Graduate Studies 4th Annual Summer Meeting), May 31- June 2, Boston
225. 1994-95 Program committee member, 1995 Pacific Workshop on Distributed Multimedia Systems, March 30-31, 1995, Honolulu, Hawaii
226. 1994-95 Member, IBM Digital Library Council
227. 1994 Participant, Oct. 31, 1994 NSF Workshop on World-Wide Web in support of Computer Science Research and as a Means for NSF to Disseminate Information, NSF Headquarters, Arlington, VA

228. 1994 Assoc. Program Chair, Digital Libraries '94, June 19-21, 1994, College Station, TX.
229. 1994 Session Chair on Architectures, EG-MM '94, Eurographics Symposium and Workshop on Multimedia: Multimedia/Hypermedia in Open Distributed Environments, June 6-9, 1994, Graz, Austria. Also, invited workshop participant.
230. 1994 Member, ACM Electronic Membership Directory task force
231. 1994 NSF Instrumentation and Laboratory Improvement Program panel, Jan. 19-22, 1994.
232. 1994 NSF Database and Expert Systems panel, March 29-30.
233. 1993-94 Program vice-chair, CIKM 94, Third International Conference on Information and Knowledge Management, Nov. 29-Dec. 2, 1994, NIST, Gaithersburg, MD
234. 1993-94 Program and conference executive committees member, ACM Multimedia 94, Second ACM International Conference on Multimedia, Oct. 15-20, 1994, San Francisco, CA
235. 1993-94 Program committee member, 2nd International Workshop on Advanced Teleservices and High-Speed Communication Architectures (IWACA), Sept. 26-28, 1994, Heidelberg, Germany
236. 1993-94 Member, NSF Information Engineering Task Force, initial meeting Nov. 4-6, 1993, Alexandria, VA, preparing NSF Task Force Report on Developing a Framework for Academic Programs in Informatics: Educating the Next Generation of Information Specialists
237. 1993-94 Organizing committee member, Workshop on Intelligent Access to On-line Digital Libraries, in connection with IEEE CAIA '94, San Antonio, TX, March 1, 1994
238. 1993 NSF panels on Jan. 7-8, March 19, April 15, May 7, June 21-22, 1993
239. 1993 NIH RADIX review panel, March 26, Bethesda, MD
240. 1992-94 Program committee member, 17th Intern'l Conf. on R & D in Information Retrieval, SIGIR '94, Dublin, Ireland, July, 1994
241. 1992-94 Program committee member, IS&T/SPIE Symposium on Electronic Imaging Science and Technology --- two workshops: 1) Digital Video Compression and Processing on Personal Computers: Algorithms and Technologies, 2) High-Speed Networking and Multimedia Computing (and session chair). Feb. 6-10, 1994, San Jose, CA
242. 1992-94 Member, ACM Electronic Publishing Volunteer Advisory Committee
243. 1992-93 Member, Design Team, The Capture and Storage of Electronic Theses and Dissertations, sponsored by Coalition for Networked Information (CNI), VPI&SU, Council of Graduate Schools, and University Microfilms Int., including Information Technology group leader for 11 Oct. 1992 Design Meeting, Washington, D.C., speaker at 2 sessions of the CNI 1993 Spring Meeting, March, San Francisco.
244. 1992-93 Program committee member, ACM Multimedia '93, First ACM International Conference on Multimedia, Aug. 2-6, 1993, Anaheim, CA
245. 1992-93 Editorial board, NSF funded SCID3B (Scientific Database Bulletin Board)
246. 1992 Steering committee member, Hyperbases workshop, sponsored by the National Science Foundation and Texas A&M, 15-16 Oct., 1992, Washington, D.C.

247. 1992 Invited member, NSF Workshop on Visual Information Management Systems, org. by U. of Mich. and IBM Almaden Res. Cntr., 24-24 Feb. 1992, San Francisco.
248. 1992 Review panel member, NSF CISE Education Infrastructure Program
249. 1991-95 Jury, ASIS (Amer. Soc. for Inf. Science) Award for Research in Information Science: member 1991-93, chair 1994, member 1995
250. 1991-92 Program comm. member, 1992 Symposium on Applied Computing (SAC '92)
251. 1991 Review panel member, NSF Research Initiation Awards
252. 1991 Steering committee member, "Emerging Technologies" panel chair: Directions in Text Analysis, Retrieval and Understanding workshop, sponsored by the National Science Foundation and U. Nebraska, 11-12 Oct., 1991, Chicago IL.
253. 1991 Invited workshop member, "User Interfaces for Online Public Access Catalogs" Invitational Research Workshop, sponsored by the U. of Maryland Human-Computer Interaction Lab. and the Library of Congress Information Technology Office, Nov. 1, 1991, Library of Congress, Washington, D.C.
254. 1990-93 Member, Chemical Abstracts Service Research Council
255. 1990-92 Program committee member, 15th Intern'l Conf. on R & D in Information Retrieval, SIGIR '92, June 21-24, 1992, Copenhagen, Denmark
256. 1990-92 Member, Working Group on Hypermedia, Text Encoding Initiative
257. 1990-91 Member, Editorial Board, Applied Computing Review
258. 1990-91 Member, ACM Press CD-ROM Advisory Panel
259. 1990-91 Program committee member, publicity chair, 14th Intern'l Conf. on R & D in Information Retrieval, SIGIR '91, October 13-16, 1991, Chicago
260. 1990-91 Organizing committee member, AAAI-91 Workshop on Natural Language Text Retrieval, July 15, 1991, Anaheim, CA
261. 1990-91 Program committee member, RIAO (Recherche d'Informations Assistee par Ordinateur) 91, April 2-5, 1991, University Autonoma of Barcelona
262. 1990 Invited participant at Scientific Database Workshop, sponsored by NSF and Univ. of Virginia Dept. of Comp. Sci., Charlottesville VA, Mar. 12-13, 1990.
263. 1990 Organizer and chairman of planning meeting on Electronic Submissions at ACM Computer Science Conference, Feb. 20, 1990, Washington, D.C.
264. 1989-91 Member of ad hoc committee of the ACL: ACL Data Collection Initiative
265. 1989-91 Program comm. member, International Conference on Multimedia Information Systems, Singapore, Jan. 16-18, 1991
266. 1989-91 Member, Research Committee, American Society for Information Science
267. 1988-90 Technical program comm. member, The Fifth Annual AI Systems in Gov. Conf., May, 1990, Washington, D.C.
268. 1988-90 Member Advisory Board, Lexical Research Program, Applied Information Technologies Research Center, Columbus, Ohio
269. 1988-90 Program committee member, 13th Intern'l Conf. on R & D in Information Retrieval, Sept. 5-7, 1990, Brussels, Belgium. Access Methods session chair.
270. 1988-89 Technical program comm. member, Intelligent Systems - Realizing the Payoff, AI Systems in Gov. Conf., March 27-31, 1989, Washington, D.C.

271. 1988 Invited participant in AITRC sponsored workshop on lexicons and text collections, April 20, 1988, Dublin, Ohio
272. 1988 Review panel member, NSF Science & Tech. Research Centers
273. 1987-94 Editorial board, CD-ROM Professional(formerly Laserdisc Professional)
274. 1987-89 Publicity chairman, program committee member, 1989 ACM SIGIR Intern'l Conf. on R & D in Information Retrieval, June 25-27, 1989, Cambridge, MA
275. 1987-88 Program committee, hypertext session chair: RIAO (Recherche d'Informations Assistee par Ordinateur) 88: User-Oriented Text and Image Handling, March 21-24, 1988, Cambridge, MA.
276. 1987 Invited participant in AAP/UMI Workshop on Dissertation Markup, April 15, 1987, Ann Arbor, MI
277. 1986-87 Planning committee for Workshop on Distributed Expert-Based Information Systems, March 5-7, 1987, New Brunswick, NJ
278. 1985 Conference Committee, Virginia Networking and Telecommunications Planning Conference, Oct. 15 -16, 1985, Fredericksburg, VA

UNIVERSITY SERVICE:

CURRENT:

1. 2016- Member, College of Engineering Commencement Committee
2. 2015- Faculty Affiliate, Virginia Tech Center for Autism Research (VTCAR)
3. 2015- Affiliated Faculty Member, Global Change Center (GCC)
4. 2014- University Libraries' Dean's Advisory Committee (DAC)
5. 2013- College of Engineering Faculty Organization Executive Committee, Member, and President 2015-2016
6. 2012- CS Mentoring Program Coordinator
7. 2009- Member, Search Committee(s), Dept. of Computer Science
8. 1998- Director, Digital Library Research Laboratory, www.dlib.vt.edu

PRIOR:

1. 2007-2014 Faculty Advisor to Information Technology, special staff member reporting to VP for Information Technology
2. 2009-2012 Member, Personnel Committee, Dept. of Computer Science
3. 2007-2010 Member, Commission on Undergraduate Studies and Policies (CUSP)
4. 2007-2010 Member, Committee on Undergraduate Curricula (CUC)
5. 2007-2010 Member, College of Engineering Undergraduate Curricular Committee
6. 2003-2009 Chair, Undergraduate Program Committee, Dept. of Computer Science
7. 2007-2008 Chair, Search Committee for next Head of Dept. of Computer Science
8. 2005-2007 Member, Personnel Committee, Dept. of Computer Science
9. 2005 Member, Review Committee for Dean of the College of Business
10. 2003-2004 Member, College of Engineering Undergraduate Curriculum Committee
11. 2002-2004 Member, Information Sciences and Technology Advisory Committee of the Administrative Coordinating Council for Engineering, Physical Sciences, and Information Sciences and Technology (ACCEPSIST)

12. 1998-2005 Director, Internet Technology Innovation Center at Virginia Tech (a University Center), http://fox.cs.vt.edu/itic/, www.internettic.org
13. 1996-2003 Member, Electronic Thesis and Dissertation Advisory Committee
14. 2003-2004 Member, College of Engineering Executive Committee
15. 2000-2003 Member, Undergraduate Program Committee, Dept. of Computer Science
16. 2001-2002 Member, University Council
17. 2000-2001 Fellow, Institute for the Social Assessment of Information Technology (ISAIT). Virginia Tech, http://www.uap.vt.edu/classes/uap3344/ISAITInfo/
18. 1996-2002 Chair, Commission on University Support (2001-2002, Vice chair 2001, member in previous years)
19. 2001 Member, Technical Advisory Group for WPI, meeting 1/19/2001
20. 1999-00 Member, Review Committee for Center for Wireless Telecommunications (CWT)
21. 1997- Member, Personnel Committee of Dept. of Computer Science
22. 1995-99 Member, University Computing and Communications Resources Committee (chair for AY 1995-1996)
23. 1995-99 Coordinator, College of Arts and Sciences, Advanced Communication and Information Technology Center (ACITC)
24. 1997-98 Member, University Libraries Serials Collection Committee
25. 1996-98 Member, Steering Committee, University Self Study
26. 1996-98 Member, 125th Anniversary Steering Committee
27. 1996-98 Chair, Traditional Students Subcommittee, University Self Study
28. 1995-97 Member, Computing Resources Committee of Dept. of Computer Science
29. 1994-97 Member, Faculty Senate (and chair, 1995-96, of working group on distance learning)
30. 1994-95 Member, University Research Computing Advisory Group
31. 1994-95 Member, Blacksburg Electronic Village Research Advisory Group
32. 1992-95 Member, Executive Committee of Department of Computer Science
33. 1992-93 Faculty advisor, Organization for Student Computing
34. 1991-93 Chair, Search Committee, for Head of Department of Computer Science
35. 1991 Member, Search Committee for Asst. Dean for Engineering Computing
36. 1991 Member, Planning Comm. for 2nd Annual University/Industry Cooperation Conf.
37. 1991 Member, Task Group for Innovations in Teaching: The Information Resources
38. 1990-94 Member (for Arts & Sciences), University's Library Committee
39. 1990-92 Chair, Arts & Sciences' Ad Hoc College Library Committee
40. 1989-93 Member, Scholarly Publications Project subcommittee
41. 1989-92 Chair, Dept. of Computer Science's Computing Resources Committee
42. 1988-95 Member (for Arts & Sciences), University's Communications Resources Committee
43. 1988-89 Member, Dept. of Comp. Science's Graduate Program & Research Activities Comm.
44. 1987-91 Departmental representative, Sigma Xi
45. 1987-90 Member, Arts & Sciences' Ad Hoc College Library Committee
46. 1987-88 Member, PC Selection Committee (selecting CS computer system for requirement)
47. 1987-88 Faculty Counselor for University's Honor System

48. 1983-89 Member, Dept. of Computer Science's Computing Resources Committee, wrote first draft of request for proposal leading to 1985 UNIX requirement for CS students
49. 1986-87 Member, LRC Teaching Learning Grant Committee
50. 1986-87 Member, Computing and Information Services Committee of University Self Study (serving on 2 of the 4 task forces, responsible for helping prepare final report)
51. 1986 Member, review team, CNS Single System Image project
52. 1986 Member, Task Force, Library's role in relation to other units in an electronic campus
53. 1985 Member, Ad Hoc Committee on Library Futures
54. 1983-87 Technical liason for Virginia Tech to CSNET (proposed joining the Computer Science Network, and coordinated this effort that was taken over in 1987 by CNS, leading to university Internet connection)

SELECTED COURSES TAUGHT:

- **Regular:** Data Structures; Information Storage and Retrieval; Information Systems Project; Intro. to Artificial Intelligence; Intro. to Computer Science; Intro. to Data Base Management Systems, Intro. to LIKES (Living In the KnowlEdge Society), Intro. to Networked Information (team); Multimedia, Hypertext and Information Access; Multimedia Technology and Projects (team)
- **Special Topics:** CD-ROM Publishing and Access, Computational Linguistics, Digital Libraries, Intelligent Multimedia, Information Systems, Interactive Accessibility, Natural Language Processing, Office Information Systems, UNIX/C