# The Shift Towards Multi-Disciplinarity in Information Science

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**This article analyzes the collaboration trends, authorship and keywords of all research articles published in the Journal of American Society for Information Science and Technology (JASIST). Comparing the articles between two 10-year periods, namely, 1988–1997 and 1998–2007, the three-fold objectives are to analyze the shifts in (a) authors' collaboration trends (b) top authors, their affiliations as well as the pattern of coauthorship among them, and (c) top keywords and the subdisciplines from which they emerge. The findings reveal a distinct tendency towards collaboration among authors, with external collaborations becoming more prevalent. Top authors have grown in diversity from those being affiliated predominantly with library/information-related departments to include those from information systems management, information technology, businesss, and the humanities. Amid heterogeneous clusters of collaboration among top authors, strongly connected cross-disciplinary coauthor pairs have become more prevalent. Correspondingly, the distribution of top keywords' occurrences that leans heavily on core information science has shifted towards other subdisciplines such as information technology and sociobehavioral science.**

## Introduction

Information science has its roots as far back in history as 1000 BC, but it only became a term commonly used in the academia after World War II. Centered on the representation, storage, transmission, and use of information and messages, it has since grown beyond its traditional confines of library studies into areas as diverse as the sciences, humanities, law, and medicine. This phenomenon is fueled, in part, by the need to understand the contextual, institutional, methodological, technological, and theoretical aspects of information (Buckland & Liu, 1995). As information science literature evolves dynamically and proliferates in diverging research directions, the task of drawing a definitive perimeter around the field becomes increasingly challenging.

For the past few decades, many researchers have attempted to chart the boundaries of information science. For example, White and McCain (1998) analyze the specialties of authors and their collaboration patterns in leading information science journals. The findings revealed two major subdisciplines within information science: one focuses on the design and evaluation of document retrieval systems while the other is concerned with the interconnectedness of scholarly literature through citation analysis. Lipetz (1999) investigates information science research and authorship over five decades and uncovered several trends, including the exponential growth of information science literature, the increasing instances of multiple authors per paper, and the tendency for individual authors to produce multiple papers.

In a parallel line of inquiry, Diener (1989) argues that information science cannot be understood as summarization of its building block, but it must be treated as a distinct discipline of science that studies information. Responding to Diener's (1989) call, Hjorland and Albrechtsen (1995) suggest a domain-based perspective to define the discipline. More recently, Zins (2007) proposes six models of information science to reflect the different knowledge domains it embodies. They are the hi-tech, technology, culture, human world, living world, and living and physical world models. Zhang and Benjamin (2007) further seek to integrate various information related fields by way of an I-model comprising four components, namely, information, technology, people, organization, and society.

To better understand how information science has shifted towards multi-disciplinarity over the two most-recent decades, this article analyzes the collaboration trends, authorship, and keywords of all research articles published in the Journal of American Society for Information Science and Technology (JASIST), a leading academic journal in information science. Influenced by Lipetz (1999) who used a 10-year

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period as the unit of analysis, this article compares the articles between two 10-year periods, namely, 1988 to 1997 and 1998 to 2007, and its three-fold objectives are to analyze the shifts in (a) authors' collaboration trends (b) top authors, their affiliations and the pattern of coauthorship among them, as well as (c) top keywords and the subdisciplines from which they emerge.

This article is significant on two counts. First, it appears that the scholarly efforts that review information science and its development involve either the analyses of authors' profiles and citations (for example, Ellis, Allen, & Wilson, 1999) or the construction of domain-based maps based on the literature (for example, Zins, 2007). This article adopts an integrated approach by combining both authorship and domain-based analyses. Second, a number of bibliometric studies on information science literature have already become dated. For example, in White and McCain's (1998) work, data from 1972 to 1995 were collected and those collected in Lipetz's (1999) work were from 1955 to 1995. This article therefore serves as a timely update on the study of information science.

The organization of the rest of the article is as follows. The next section outlines the methodology used. Drawn from the metadata of some 1,825 research articles published from 1988 to 2007 in JASIST, details such as authors, authors' affiliations, and keywords were captured. The schema for classifying authors' departments and that for classifying keywords are explained thereafter. Following that, the Results section presents authors' collaboration trends, the top authors and their affiliations, the top keywords used, and the subdisciplines from which top keywords emerge. The major findings and some limitations of this paper are highlighted in the Discussion section. Finally, the Conclusion section offers a few implications for educators and researchers in the information science community.

## Methodology

### *Journal Selection*

There are some 53 journals classified under "Information Science & Library Science" in the Journal Citation Report (Social Science Edition 2006) in ISI Web of Knowledge. However, far from being homogeneous, each journal differs in aspects such as its inception date, target audience, publication frequency, and editorial quality. To better serve the purpose of this paper, the scope is confined to a single journal. JASIST was chosen due to three compelling factors. First, the journal has been consistently ranked among the top-tier journals in information science for the past 8 years in terms of total cites, impact factor, and immediacy index. It therefore stands as an authoritative source of information science literature. Second, affiliated with the American Society for Information Science and Technology (ASIST), JASIST represents an important knowledge base for information professionals for nearly six decades. Third, unlike other journals which lean obliquely towards narrowly-defined areas such as systems development or library science education, the scope of JASIST encompasses a broad array of topics within information science.

### *Data Collection*

Mentioned earlier, a number of bibliometric studies on information science were completed in the mid 1990s (for example, Lipetz, 1999; White & McCain, 1998). Any trend that emerges from the literature published thereafter has yet to be analyzed. Given that this article seeks to examine the shifts in information science, an effort that necessarily entails collecting data from a timeframe of considerable length, articles from the most-recent decade and the one preceding it were collected. The period between 1988 to 2007 not only subsumes a substantial volume of recent information science literature but also offers a vantage point to observe the possible influences of technological advances on the development of the field, given that the journal's current name was coined after the term "technology" was appended to what was previously known as the Journal of the American Society for Information Science (JASIS) in 2000.

Each JASIST/JASIS (henceforth simply identified as JASIST) issue features a number of different types of publication including research articles, editorials, brief communications, book reviews, and letters to the editor. In this study, only full-length research articles were collected for analysis. Using Wiley InterScience database, the following details were extracted from each article: publication information (including year, issue, volume, start and end pages), authors' names, authors' affiliations, and keywords. A total of 1,825 distinct articles have been collected from Volumes 39–58, comprising 234 issues of the journal.

It is necessary to highlight a few imperfections in the data collected. Of all articles collected, 57 (3.1%) do not have any keyword specified. Fortuitously, these articles are distributed fairly evenly over the two 10-year periods: 25 articles (1.4%) from 1988 to 1997 and 32 articles (1.8%) from 1998 to 2007. Next, authors' names have not always been consistently rendered even though they may belong to the same person (for example, Félix de Moya-Anegón and Félix Moya Anegón). Such anomalies were manually resolved. In cases where names are given as an initial followed by the last name and at other times given in full (for example, L. Egghe and Leo Egghe; Shan L. Pan and Shan-Ling Pan), the two names were considered as belonging to the same author if the initial matches with the first letter in the full name and if the authors' affiliations, where given, are identical.

### *Data Analysis*

JASIST articles published between 1988 and 2007 were divided into two equal 10-year periods and were analyzed in terms of authorship and keywords. Authorship analysis involved studying authors' collaboration trends, identifying top authors, and analyzing coauthorship among top authors. To achieve the first objective (authors' collaboration trends), single-authored articles were separated from coauthored


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ones. Coauthored articles were further divided into those written by authors with the same affiliation and those by authors among whom at least two are with different affiliations. Thereafter, statistics such as coauthorship ratios (number of coauthored articles divided by the total number of articles), internal collaboration ratios (number of articles written by authors with the same affiliation divided by the total number of articles), and external collaboration ratios (number of articles written by authors with different affiliations divided by the total number of articles) were computed and compared across the two time periods. Median rather than mean values were used as they are less easily swung by extreme data points and hence better suited to study trends.

To achieve the second objective (identifying top authors), all authors were ranked according to the number of articles they have contributed over the two 10-year periods. Similar to the approach of sampling only the most prolific authors adopted in previous studies (for example, White & McCain, 1998; Palvia & Panjani, 2007), the top 10% of all authors measured in terms of their publication productivity (henceforth simply identified as top authors) in each time period were creamed off for analysis. The rationale behind analyzing top authors was based on the assumption that these highly research-intensive individuals are thought leaders who have made significant contribution to the field of information science by pushing its frontiers and redefining its boundaries. Using either the department, division, faculty, center, or school as a proxy for the discipline to which an author is affiliated, the top authors' smallest available sub-organizational units (henceforth simply identified as departments) were captured and coded into four categories, namely, core information science, information systems management, information technology, and others, on the basis of the departments' names as shown in Table 1. Adapted from Summers, Oppenheim, Meadows, McKnight, and Kinnel (1999), this coding scheme was used because it gives a pragmatic perspective of information science and aptly reflects how departments are usually structured in universities.

Where top authors' affiliations either omit department names or include equivocal department names that could not be readily coded, checks were made via the Internet on the departments' missions and foci to determine the most appropriate category assignment. For example, the Department of Computer and Information Science in University of Michigan was coded as "information technology" due to its IT-related slant in its program offerings and its faculty profile in general.

Some top authors have been affiliated with more than one department over time due to internal transfers or career movements. For example, Detmar Straub was affiliated with the Information and Decision Sciences Department in 1991 but was affiliated with Computer Information Systems in 1997. For expediency reasons, only the most recent department was admitted for coding.

The top authors' departments ($N = 62$ for the first 10-year period and $N = 153$ for the second 10-year period) were coded independently by three research assistants who were graduate students in the Division of Information Studies at the Nanyang Technology University. The pairwise average inter-coder reliability was found to be 0.79, indicating a strong non-chanced agreement.

Delving deeper into the extent to which collaboration among top authors straddle across different disciplines, coauthor analysis that involved four steps was carried out for each of the time period. First, all instances of coauthorship among top authors were identified. Next, the strength of collaboration between each coauthor pair was computed by subtracting one from the total number of authors of a given article, and then taking the reciprocal of the result (Newman, 2004). Because two top authors may have coauthored multiple articles, the total strength of collaboration between them was derived by summing the strength computed from the above for all articles they have coauthored. This measurement is therefore a function of both the frequency of collaboration between the two top authors as well as the number of collaborators in the articles. In gist, the strength of collaboration between a coauthor pair positively correlates to the frequency of collaboration and negatively correlates to the number of collaborators in those coauthored articles. Third, the total number of publications of each top author was recorded. Fourth, network diagrams depicting the collaboration patterns among top authors were constructed, one for each time period. Major clusters in the network were then analyzed in terms of the number of disciplines represented. Strong coauthor pairs in the clusters were also studied. It must be noted that centrality measurements, such as closeness and betweenness, were not examined because the intention was not to analyze individuals' positions in the networks.

To achieve the third objective (analyzing coauthorship among top authors), keywords were extracted from all articles and were sorted in descending order of their number of occurrences. For parsimonious reasons as well as to reduce noise, only the top 10% of the most commonly used keywords

TABLE 1. Coding scheme for top authors' departments (adapted from Summers, et al., 1999).

| Categories | Terms appearing in department names | Examples |
|---|---|---|
| Core Information Science | Library, Information Science, Information Studies | School of Information and Library Science |
| Information Systems Management | Information systems, Management | Management Information Systems Department; |
| Information Technology | Information Technology, Science & Technology, Computer Science, Systems Engineering | School of Computing and Information Technology |
| Others | [None of the terms specified above] | School of Journalism; Psychology Department |


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TABLE 2. Coding scheme for keywords (Adapted from Hawkins, 2001).

| Subdisciplines | Related areas | Examples |
|---|---|---|
| Core Information Science | Information access and retrieval; knowledge organization; publishing; information economics; online searching | End user searching; information needs; information retrieval; |
| Computing Technology | Software; hardware; storage; electronic mail; multimedia; security; hypertext; fuzzy logic, Internet | CD-ROM; databases; World Wide Web |
| Law & Government | Copyright; privacy; contracts | Legal aspects |
| Communication | Speech; text; video; visualization; scholarly and organizational communication | Organizational communication |
| Sociobehavioral Science | Ergonomics; human-computer interface; human factors; psychology; collaboration; politics | Social aspects; usage studies; political aspects |
| Librarianship | Types of libraries; educations/training; digital libraries; library management and operations | Academic libraries; reader services |
| Statistics | Bibliometrics; scientometrics; citation analysis | Cluster analysis; citation analysis |
| Others | Terms not specified above | Medical science; cost analysis |

(henceforth simply identified as top keywords) in each time period were admitted for analysis. The approach of analyzing only the top keywords has been similarly used in previous studies (for example, Claver, Gonzalez, & Llopis 2000; Palvia & Panjani, 2007). Top keywords were coded into eight subdisciplines as shown in Table 2. Adapted from Hawkins (2001), such a coding scheme was used because it not only encompasses many of the conceptual models of information science proposed hitherto (for example, Haythornthwaite, Bowker, Jenkins, & Rayward, 1999; Zins, 2007; Zhang & Benjamin, 2007) but also offers sufficient theoretical breath to capture a wide range of keywords.

All top keywords (N = 70 for the first 10-year period and N = 93 for the next 10-year period) were coded independently by the three research assistants mentioned earlier. Where a given top keyword cannot be coded owing to the lack of contextual information (for example, "analytic models," "evaluation"), all the source articles from which it had been extracted were retrieved. The dominant theme among these articles was then used as the basis to code that keyword. The pair-wise average inter-coder reliability was found to be 0.71, indicating a strong non-chanced agreement.

## Results

### *Authors' Collaboration*

Table 3 shows the total number of articles, sole-authored articles, and coauthored articles collected. In the first decade, 52.6% (327) of all articles are single-authored while the remaining 47.4% (295) are coauthored. However, in the second decade, the percentage of single-authored articles dips to 39% (469) while that of coauthored articles surges to 61% (734). In particular, the number of internal collaborations as a percentage of all coauthored articles decreases from 54.2% to 50.4% while that of external collaborations increases from 45.8% to 49.6%. In other words, amid the tendency towards collaboration among authors across the two decades, external collaborations seem to grow in prevalence.

To provide a more granular perspective, the data, which had been captured on a yearly basis, were disaggregated and expressed in ratios with respect to the total articles published each year, as shown in Figure 1. This allows the ratios of sole-authored articles to be compared to those of coauthored articles annually for two decades. The ratios of coauthored articles were further broken down into those involving internal collaboration and those involving external collaboration.

From Figure 1, it can be observed that sole-authored articles dominate the period between 1988 and 1992. However, from 1995 through 2007, coauthored articles become predominant. Over the 20-year period, the median ratio of coauthored articles grows by 78.8% from 0.33 in the first decade to 0.59 in the second. Conversely, the median ratio of sole-authored articles declines by 38.8% from 0.67 to 0.41. This indicates a distinct shift towards collaboration in authorship. Delving into the nature of collaboration, between 1988 and 1997, the median ratios of internal collaboration and external collaboration are 0.26 and 0.2 respectively. However,

TABLE 3. Overview of authors' collaboration.

| | First decade: 1988–1997 | | Second decade: 1998–2007 | |
|---|---|---|---|---|
| No. of articles | 622 (100%) | | 1203 (100%) | |
| No. of sole-authored articles | 327 (52.6%) | | 469 (39%) | |
| No. of coauthored articles | 295 (47.4%) | Int. collab. = 160 (54.2% of coauthored) | 734 (61%) | Int. collab. = 370 (50.4% of coauthored) |
| | | Ext. collab. = 135 (45.8% of coauthored) | | Ext. collab. = 364 (49.6% of coauthored) |


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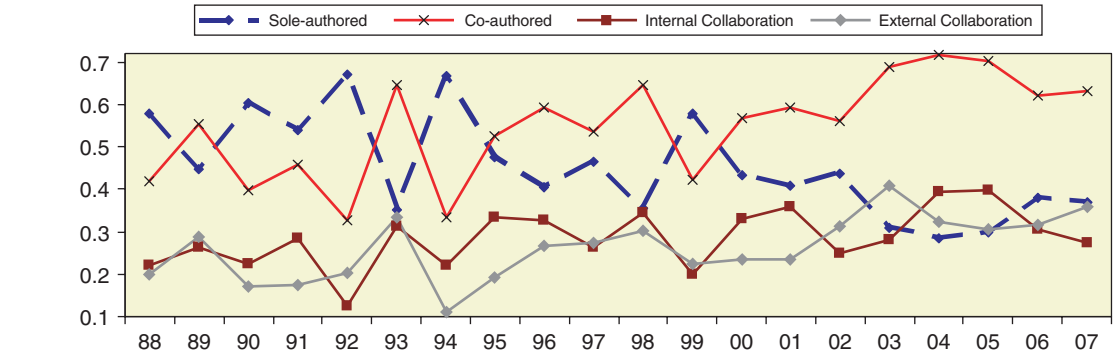


| | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 00 | 01 | 02 | 03 | 04 | 05 | 06 | 07 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sole-authored | 0.58 | 0.45 | 0.60 | 0.54 | 0.67 | 0.35 | 0.67 | 0.48 | 0.41 | 0.47 | 0.35 | 0.58 | 0.43 | 0.41 | 0.44 | 0.31 | 0.28 | 0.30 | 0.38 | 0.37 |
| Co-authored | 0.42 | 0.55 | 0.40 | 0.46 | 0.33 | 0.65 | 0.33 | 0.52 | 0.59 | 0.53 | 0.65 | 0.42 | 0.57 | 0.59 | 0.56 | 0.69 | 0.72 | 0.70 | 0.62 | 0.63 |
| Internal Collab. | 0.22 | 0.26 | 0.22 | 0.28 | 0.13 | 0.31 | 0.22 | 0.33 | 0.33 | 0.26 | 0.34 | 0.20 | 0.33 | 0.36 | 0.25 | 0.28 | 0.39 | 0.40 | 0.30 | 0.27 |
| External Collab. | 0.20 | 0.29 | 0.17 | 0.18 | 0.20 | 0.33 | 0.11 | 0.19 | 0.27 | 0.27 | 0.30 | 0.22 | 0.24 | 0.23 | 0.31 | 0.41 | 0.32 | 0.31 | 0.32 | 0.36 |

FIG. 1. Authors' collaboration ratios by year.

between 1998 and 2007, the median ratio of internal collaboration rises marginally to 0.3 (an increase of 15.4%) but that of external collaboration jumps to 0.31 (an increase of 55%). Hence, over the two decades, the trend towards collaboration stems more from external rather than internal collaboration. Here lies a possible clue on how information science research in JASIST has become more multi-disciplinary.

*Top Authors Analysis*

The total number of distinct authors from 1988 to 1997 is 792. The top 10% of all authors works out to be approximately 79. Because the 63rd author through the 162nd author contributed two articles each, the list of top authors was cut off after the 62nd position. This means top authors list comprises 62 individuals, each of whom had contributed three or more articles. For the next 10-year period, the total number of distinct authors is 1,823. The top 10% of all authors works out to be approximately 182. Because the 154th author through the 368th author contributed two articles each, the list of top authors was cut off after 153rd position. Thus, the top authors list for 1998 to 2007 comprises 153 individuals, each of whom had also contributed three or more articles. The lists of all top authors are given in Appendix A.

Authorship analysis invariably entails the study of authors' affiliations (for example, White & McCain, 1998; Lipetz, 1999) because affiliations serve as proxies to authors' disciplinary paradigms. Hence, the departments of top authors were coded using the scheme described earlier in Table 1. The result, tabulated in Table 4, shows a marked decline in the proportion of top authors from the core information science discipline from 61.3% in the first decade to 47.7% in the second decade. Conversely, the proportion of top authors from the IT discipline has increased from 16.1% to 24.8% over the two periods. This could be a reflection of JASIST's success in attracting authors from the IT discipline after JASIS expanded its scope to include technology in 2000. It may also mean that technology has indeed become a mainstream concern within information science. While the percentages of top authors from the information systems management and others disciplines see only a marginal increase, the departments to which top authors are affiliated are more varied in the second decade. They include Division of Humanities, Department of Psychiatry, Psychology Department, School of Business, School of Communication, and School of Journalism. In other words, top authors of JASIST have now become more diverse.

TABLE 4. Distribution of authors' disciplines over two 10-year periods.

| Top authors' disciplines | 1988–1997 | 1998–2007 |
|---|---|---|
| Core Information Science | 38 (61.3%) | 73 (47.7%) |
| Information System Management | 4 (6.5%) | 13 (8.5%) |
| Information Technology | 10 (16.1%) | 38 (24.8%) |
| Others | 10 (16.1%) | 29 (19%) |
| Total | 62 (100%) | 153 (100%) |

To further study the collaboration patterns among top authors, coauthor analysis was conducted. Figures 2 and 3 show clusters of top authors that are connected by a size of three or more from 1988 to 1997 and 1998 to 2007, respectively. The size and color of a node signify the top author's productivity and discipline respectively, while the thickness of an edge denotes the strength of collaboration between two top authors.

Shown in Figure 2, there are a total of four clusters in the first decade. In particular, two clusters comprise top authors exclusively from core information science. One comprises top authors from both core information science and others, while the other one features top authors from core information science, information systems management, IT, and others. Furthermore, a majority of the strongly connected coauthor pairs are confined to those belonging to the same discipline, namely, core information science. Examples of such pairings are Kantor-Saracevic, Branin-D'Elia, Abels-Liebscher, and Bolan-Rohde.

While the number of clusters has grown to 11 in the second decade, the dominance of top authors from core information science has somewhat diminished, as shown in


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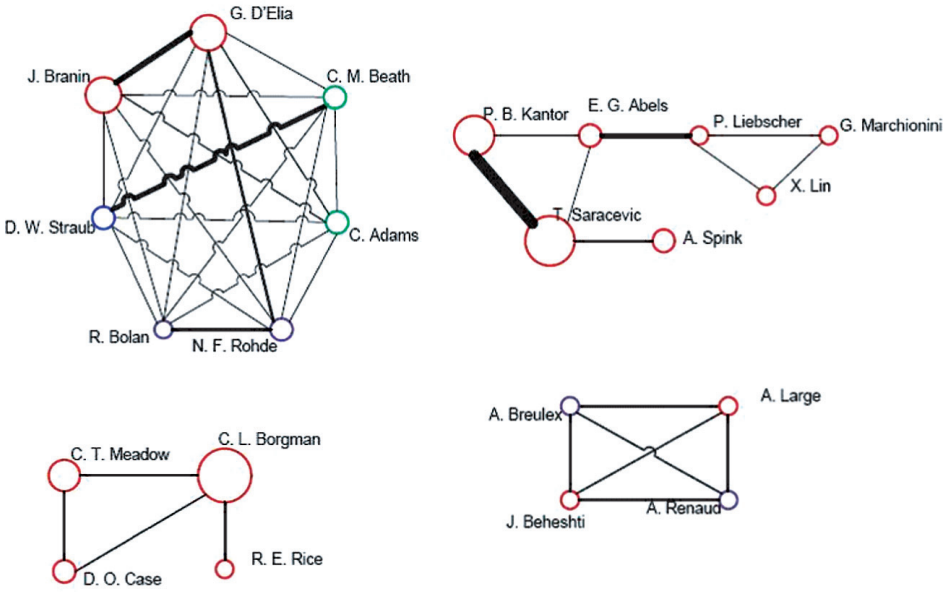


FIG. 2. Coauthorship analysis of top authors from 1988–1997.

Figure 3. Of the 11 clusters, only two comprise top authors exclusively from core information science. We found it interesting that three clusters (two exclusively from IT and one exclusively from information system management) are without any representation from core information science. The remaining six feature top authors from heterogeneous disciplines. Four clusters comprise top authors from core information science, IT, and others; one straddles between core information science and IT while another is between information system management and IT. Compared to that in the first decade, the number of strongly connected pairs, which can be observed in clusters with heterogeneous disciplines, has seen a marked increase. Furthermore, among strongly connected pairs, there appear to be a growing sign of cross-disciplinary collaborations such as those found between Spink-Cole, Shapira-Kantor, Chen-Chau, Thelwall-Vaughan, and Egghe-Rousseau. The growth of cross-disciplinary coauthor pairs could be attributed either to the movement of top authors from one discipline to another or simply a natural realization of fit between top authors from disparate disciplines. For example, in 1997, Armanda Spink was affiliated with the School of Library and Information Sciences (core information science) but was affiliated with the Faculty of Information Technology (IT) in 2007. On the other hand, Mike Thelwall and Liwen Vaughan were persistently affiliated with the School of Computing and Information Technology (IT) and the Faculty of Information and Media Studies (core information science) respectively. In any case, the shift from homogeneous to heterogeneous collaborative research efforts is apparent across the two decades.

### *Top Keywords Analysis*

There are 766 distinct keywords (total keyword entries = 3,235) and 974 distinct keywords (total keyword entries = 5,968) from 1988 to 1997 and 1998 to 2007, respectively. The top 10% of the distinct keywords therefore translates into some 77 distinct keywords from the first decade and 97 distinct keywords from the second decade. The keywords were ordered by the number of their occurrences. As with the approach described earlier to delimit the top authors' list, the top keywords' lists were cut off after the 70th and 93rd position from the two 10-year periods, respectively. In so doing, each top keyword occurs at least 11 times from 1988 to 1997 and 16 times from 1998 to 2007. The total number of occurrences of these top keywords accounts for 41% (1326 out of 3235) and 46% (2746 out of 5968) of all keyword entries of the two time periods, respectively, and are not insignificant representation of the entire data set. The list of all top keywords is given in Appendix B.

For the purpose of detecting the shifts in the distribution of the eight subdisciplines over the two 10-year periods, the top keywords were first coded using the scheme presented earlier in Table 2. Thereafter, the occurrences of each top keyword coded in the same subdisciplines were summed. The result, which is tabulated in Table 5, shows the frequency distribution of the top keywords across the eight subdisciplines.

While core information science stands as the most conspicuous subdiscipline, its importance measured in terms of frequency distribution of top keywords' occurrences has diminished from 63.2% to 40%. Librarianship also suffers a drop in distribution from 8.1% to 4.3%. Others subdiscipline drops from 3.2% to 0.9%. Conversely, computing technology has grown most significantly in distribution (from 6.4% to 22.1%), followed by sociobehavioral science (from 9.2% to 17.1%), communication (from 2.1% to 4.2%), statistics (from 7.8% to 10.7%), and law & government (from 0 to 0.6%). In essence, top keywords from core information science, librarianship, and others have their presence reduced while those from the rest


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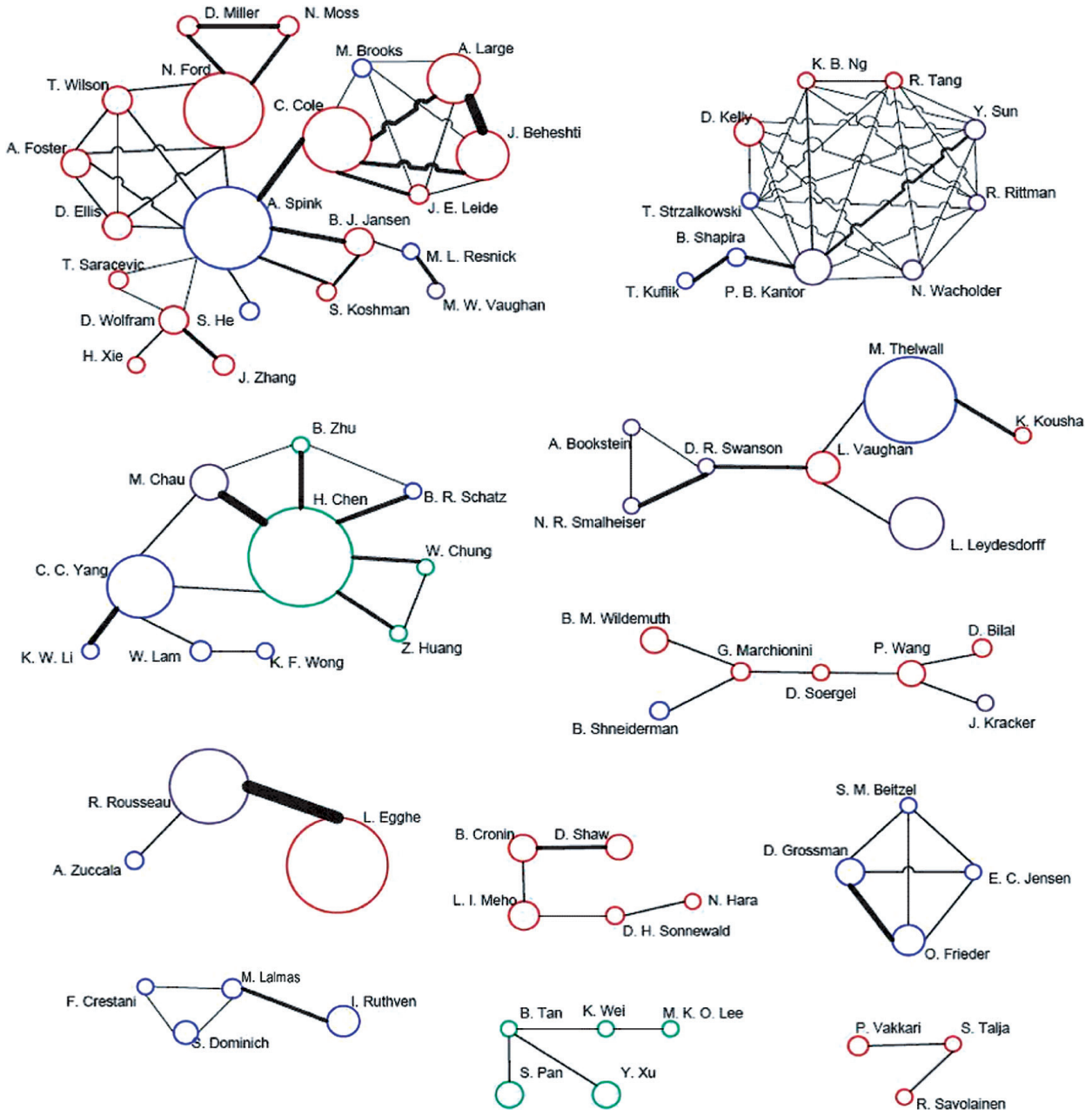


FIG. 3. Coauthorship analysis of top authors from 1998–2007.

TABLE 5. Frequency distribution of top keywords' occurrences across the eight subdisciplines.

| | 1988–1997 | | 1998–2007 | |
|---|---|---|---|---|
| Subdisciplines | Top keywords | Occurrences | Top keywords | Occurrences |
| Core Information Science | 42 | 837 (63.2%) | 33 | 1098 (40%) |
| Computing Technology | 5 | 85 (6.4%) | 23 | 608 (22.1%) |
| Law & Government | 0 | 0 | 1 | 17 (0.6%) |
| Communication | 2 | 28 (2.1%) | 4 | 116 (4.2%) |
| Sociobehavioral Science | 8 | 122 (9.2%) | 17 | 470 (17.1%) |
| Librarianship | 5 | 107 (8.1%) | 4 | 119 (4.3%) |
| Statistics | 6 | 103 (7.8%) | 10 | 294 (10.7%) |
| Others | 2 | 44 (3.2%) | 1 | 24 (0.9%) |
| Total | 70 | 1326 (100%) | 93 | 2746 (100%) |


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TABLE 6. Common and exclusive top keywords' occurrences by time period.

| Subdiscipline | Top keywords occurrences | | |
|---|---|---|---|
| | In both time periods | Exclusively in 1988–1997 | Exclusively in 1998–2007 |
| Core Information Science | 21 | 21 | 12 |
| Computing Technology | 2 | 3 | 21 |
| Law & Government | 0 | 0 | 1 |
| Communication | 1 | 1 | 3 |
| Sociobehavioral Science | 7 | 1 | 10 |
| Librarianship | 1 | 4 | 3 |
| Statistics | 5 | 1 | 5 |
| Other subject disciplines | 0 | 2 | 1 |

of the subdisciplines are increasingly being featured over the years.

Top keywords were further segregated into those that occur persistently in both time periods and those that occur exclusively in each time period, as shown in Table 6.

Within core information science, 21 top keywords including "document retrieval," "end user searching," and "information retrieval" remain persistent for two decades. This is a substantial figure in relation to the number of top keywords that occur exclusively in each time period, and it indicates that information science does have a set of matured themes that continually attract research attention. Shifting from top keywords such as "Boolean searching" and "full text searching" that occur in the first decade, extant research in core information science is characterized by top keywords such as information architecture, information seeking, and knowledge management.

Within computing technology, there are only two persistent top keywords but 21 top keywords occur exclusively in the second decade, reflecting the fast-changing nature of this subdiscipline. Top keywords such as "CD-ROM" and "databases" found in the first decade are supplanted by "data mining," "fuzzy retrieval systems," and "World Wide Web" in the second.

Within law & government and communication, top keywords feature minimally in the first decade but are making in-roads as "legal aspects," "communication patterns," and "visualization."

Within sociobehavioral science, examples of persistent top keywords include "social aspects," "usability," and "user behavior." Top keywords that occur exclusively in the second decade include "user models," "user preferences," and "social networking." Overall, the increase in top keywords related to sociobehavioral science points to the growing recognition of the importance of the humanistic and softer aspects of information science.

Top keywords related to librarianship such as "libraries" and "OPAC" found in the first decade morph into "digital libraries" and "electronic journals" in the next, likely a result of relentless technological advancement. Another research trend in librarianship seems to be a growing focus on "children."

Statistics remains an integral subdiscipline within information science with top keywords such as "bibliographic citations," "citation analysis," and "cluster analysis" occurring in both decades. Judging from the top keywords that occur exclusively in the second decade including "impact factor," "ranking," and "author productivity," there appears to be a budding interest on the measurement of research output.

Top keywords in the others subdiscipline are "medical science" and "cost analysis" in the first decade and "research methods" in the second.

## Discussion

On the basis of analyzing the metadata of all research articles published from 1988 to 2007 in JASIST, four main findings emerged. First, major trends in information science research from 1955 to 1995 uncovered by Lipetz (1999) continue to persist in the two most-recent decades. Specifically, the exponential growth of information science literature, the increasing instances of coauthored papers, and the tendency for individual authors to produce multiple papers have been borne out in this study. Across the two 10-year periods, the number of articles published has surged by 90.5% from 622 to 1203. The median ratio of coauthored papers has risen from 0.33 to 0.59. No author had published 10 or more papers in the first decade but 9 had done so in the second decade. Collectively, these trends suggest that the field of information science is thriving. There should be no lack of researchable areas for information science scholars to either deepen existing research threads or open up new frontiers of inquiry.

Second, there is a distinct shift towards collaboration among authors both internally and externally, with the latter becoming more prevalent than the former. Across the two 10-year periods, the median ratio of internal collaboration rises marginally from 0.26 to 0.3 but that of external collaboration jumps from 0.2 to 0.31. As connectedness among authors increases, there appears to be the realization that individuals with complimentary expertise and skills who reside outside one's organization represent immense opportunities for collaboration. Furthermore, the advent of the internet and ubiquitous communication technologies may also have significantly lowered the barrier of collaboration that transcends geographical boundaries. In fact, far from being peculiar to information science, the trend towards external and even international collaboration is also observable in recent years in fields such as nano-technology (Schummer, 2004), molecular biology (Ma & Guan, 2005), science (Wagnera & Leydesdorff, 2005), and earth sciences (Jesus & Maria Jose, 2004). This spells the era in which expertise is becoming less of an exclusive asset contained within an organization or a country but more of a shared asset held by teams of like-minded researchers both nationally and internationally.

Third, top authors' departments, which were predominantly library/information-related, have grown in diversity


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to include those related to information systems management, information technology, business, and the humanities. The percentage of top authors from core information science drops from 61.3% to 47.7% across the two decades while those from information system management, information technology, and others rise unanimously. From another angle of inquiry, coauthor analysis also reveals a reduced representation of core information science discipline in the clusters of collaboration among top authors. Unseen in the first decade, clusters formed exclusively by top authors from IT and information system management emerge in the second decade. Not only have strongly connected coauthor pairs increased in number, cross-disciplinary ones have become more prevalent. These phenomena could be a result of the enlargement of JASIST's scope or a heightened interest in information science research among authors from different departments. It could also mean that the community of information science authors has become so diffused that they can be located in various departments. In any case, the increasing diversity of top authors' disciplines, the emergence of non core information science clusters of collaborative research efforts and the growth in strongly connected cross-disciplinary coauthor pairs point to the blurring boundaries of information science.

Fourth, the distribution of top keywords' occurrences that leans heavily on core information science has shifted towards other subdisciplines such as information technology and sociobehavioral science. Core information science accounts for 63.2% of all top keywords' occurrences from 1988 to 1997 but its proportion is reduced to 40% from 1998 to 2007. Conversely, across the two decades, keywords' occurrences of information technology and sociobehavioral science grow from 6.4% to 22.1% and 9.2% to 17.1%, respectively. The fear that information science may be veering too much on systems and losing sight on humans aspects (Saracevic, 1999) turns out to be unfounded hitherto, at least. With the exception of librarianship and others, the rest of the subdisciplines including law & government, communication, and statistics have all posted an increase. The trend towards a broadened coverage of keywords beyond core information science mirrors the growth in the diversity of top authors and is likewise vestige of the multi-disciplinary nature of information science.

However, these findings should be viewed as indicative rather than authoritative in light of three main limitations. First, the scope of the data collected was confined to JASIST for reasons explained earlier. Detailed results of the collaboration patterns, top authorship and keywords' occurrences must therefore be interpreted with caution. For example, prolific information science scholars who contributed to journals other than JASIST in the two most-recent decades would not be featured in the lists of top authors. Second, the analyses of this paper did not include article titles and abstracts but were based only on the quantitative evidence of authorship and keywords. Hence, all keywords bearing equal significance and that they aptly reflect the content of the articles had to be assumed. Also, there could be multi-authored articles that were not actually contributed evenly by all their purported authors. The precise extent of collaboration could not possibly be established. Third, even though they were parsimonious and theoretically grounded, the two classification schemes used in this article may not sufficiently discriminate amongst the array of specialties of information science. Furthermore, the approach of using departments as proxies to authors' primary disciplines is expedient but not without flaws. One possibility is to enlist the help of a panel of experts to develop the categories and the coding schemes. The publication records of each author can also be examined exhaustively to help determine where their main research foci lie.

## Conclusion

As information science evolves dynamically, any attempt to trace the trajectory of its development is inevitably fraught with challenges. For one, conceptions of information science are aplenty and new frameworks to define its perimeter constantly emerge. Amid the ongoing effort to elucidate the field lies a generally acknowledged but not commonly expounded issue: the multi-disciplinarity of information science. As a modest attempt to study how information science has shifted towards multi-disciplinarity, this article examines the collaboration trends, authorship, and keywords of all research articles published in JASIST over the two most recent decades.

From 1988 to 2007, there is a distinct tendency towards collaboration among authors, with external collaborations becoming more prevalent. Top authors have grown in diversity from those being affiliated predominantly with library/information-related departments to include those from information systems management, information technology, business, and the humanities. Amid heterogeneous clusters of collaboration among top authors, strongly connected cross-disciplinary coauthor pairs have become more prevalent. Correspondingly, the distribution of top keywords' occurrences that leans heavily on core information science has shifted towards other subdisciplines such as information technology and sociobehavioral science.

Like adjacent jigsaw pieces that fit snuggly, these findings, when juxtaposed, do appear to reveal parts of the picture in the puzzle. Information science is indeed becoming multi-disciplinary and this trend may be related reciprocally to the external collaboration and contribution of authors from diverse perspectives. The multi-disciplinarity of the field presents complex problems that demand collaborative efforts among authors with different expertise. The blend of various perspectives in turn drives the field towards multi-disciplinarity.

For educators, this article is a call for information science curriculum to be designed with a multi-disciplinary flavor. It would be interesting to structure learning activities that help reinforce the pertinence of information-related issues in various subdisciplines within information science. For researchers, this article serves as an affirmation of the


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significance of scholarly collaboration. For in the intersection of different disciplinary paradigms lies the potential to frame old problems in new angles and tackle new problems with novel approaches.

## References


Buckland, M., & Liu, Z. (1995). History of information science. Annual Review of Information Science and Technology, 30, 385–416.

Claver, E., Gonzalez R., & Llopis, J. (2000). An analysis of research in information systems, Information and Management, 37(4), 181–195.

Diener, R. (1989). Information science: What is it?... What should It be. Bulletin of the American Society for Information Science, 15(5), 17.

Ellis, D., Allen, D., & Wilson, T. (1999). Information science and information systems: conjunct subjects disjunct disciplines. Journal of the American Society for Information Science, 50(12), 1095–1107.

Hawkins, D.T. (2001). Information science abstract: Tracking the literature of information science. Part 1: Definition and map. Journal of the American Society for Information Science and Technology, 52(1), 44–53.

Haythornthwaite, C., Bowker, G., Jenkins, C., & Rayward, W.B. (1999). Mapping the dimensions of a dynamic field. Journal of the American Society for Information Science. 50(12), 1092–1094.

Hjorland, B., & Albrechtsen, H. (1995). Toward a new horizon in information science: Domain-analysis. Journal of the American Society for Information Science, 46(6), 400–425.

Jesus, R.R., & Maria Jose, M.S. (2004). Patterns of the foreign contributions in some domestic vs. international journals on Earth Sciences, Scientometrics, 59(1), 95–115.

Lipetz, B. (1999). Aspects of JASIS authorship through five decades. Journal of the American Society for Information Science, 50(11), 994–1003.

Ma, N., & Guan, J.C (2005). An exploratory study on collaboration profiles of Chinese publications in molecular biology. Scientometrics, 65(3), 343–355.

Newman, M.E.J. (2004). Coauthorship networks and patterns of scientific collaboration. Proceedings of the National Academy of Sciences, 101. Suppl 1, 5200–5205.

Palvia, P., & Pinjani, P. (2007). A profile of information systems research published in information & management. Information & Management, 44, 1–11.

Saracevic, T. (1999). Information science. Journal of the American Society for Information Science, 50(12), 1051–1063.

Schummer, J. (2004). Multidisciplinarity, interdisciplinarity, and patterns of research collaboration in nanoscience and nanotechnology. Scientometrics, 59(3), 425–465.

Summers, R., Oppenheim, C., Meadows, J, McKnight, C., & Kinnel, M. (1999). Information science in 2010: A Loughborough University view. Journal of the American Society for Information Science. 50, 1153 –1162.

Wagnera, C.S., & Leydesdorff, L. (2005). Network structure, self-organization, and the growth of international collaboration in science. Research Policy, 34(10), 1608–1618.

White, H.D., & McCain, K. W. (1998). Visualizing a discipline: An author co-citation analysis of information science, 1972–1995. Journal of the American Society for Information Science, 49(4), 327–355.

Zins, C. (2007). Conceptions of information science. Journal of the American Society for Information Science and Technology, 58(3), 335–350.

Zhang, P., & Benjamin, R.I., (2007). Understanding information related fields: A conceptual framework. Journal of the American Society for Information Science and Technology, 58(13), 1934–1947.


## Appendix A

*Full Listing of Top Authors: Number of Articles Contributed, Affiliations and Disciplines Coded*

**1988–1997**

| | | | |
|---|---|---|---|
| 9 | Christine L. Borgman | Department of Library and Information Science | Core |
| 8 | Leo Egghe | Limburgs Univesitaire Centrum | Core |
| 8 | Michael K. Buckland | School of Library and Information Studies | Core |
| 8 | Tefko Saracevic | School of Communication, Information and Library Studies | Core |
| 7 | Paul B. Kantor | School of Communication, Information and Library Studies | Core |
| 7 | Ronald Rousseau | Speciale Licentie Informatie-en Bibliotheekwetenschap | Core |
| 7 | Stephen P. Harter | School of Library and Information Science | Core |
| 6 | George D'Elia | Center for Applied Research in Library and Information Science | Core |
| 6 | Joseph Branin | University Libraries | Core |
| 6 | Robert M. Losee Jr. | School of Information and Library Science | Core |
| 6 | Y. Y. Yao | Department of Mathematical Sciences | Oth |
| 5 | A. Bookstein | Center for Information and Language Studies | Core |
| 5 | Charles T. Meadow | Faculty of Information Studies | Core |
| 5 | MaryEllen C. Sievert | School of Library and Informational Science | Core |
| 5 | Michael D. Gordon | Computer and Information Systems | IT |
| 5 | S. K. M. Wong | Department of Computer Science | IT |
| 5 | Stephanie W. Haas | School of Information and Library Science | Core |
| 5 | Terrence A. Brooks | Graduate School of Library and Information Science | Core |
| 4 | Amanda Spink | School of Library and Information Sciences | Core |
| 4 | Bryce Allen | School of Library and Informational Science | Core |
| 4 | Carl Adams | Information and DeCoreion Sciences Department | MIS |
| 4 | Clifford A. Lynch | Division of Library Automation | Core |
| 4 | Cynthia Mathis Beath | Information & DeCoreion Sciences Department | MIS |
| 4 | Detmar W. Straub | Computer Information Systems | IT |
| 4 | Donald O. Case | Graduate School of Library and Information Science | Core |
| 4 | Eileen G. Abels | College of Library & Information Services | Core |
| 4 | Hsinchun Chen | Management Information Systems Department | MIS |
| 4 | Justin Zobel | Department of Computer Science | IT |

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**Appendix A** (*Continued*)

| | | | |
|---|---|---|---|
| 4 | Katherine W. McCain | College of Information Studies | Core |
| 4 | Marion J. Ball | Information Resources Management Division | Core |
| 4 | Nancy Freeman Rohde | College of Liberal Arts | Oth |
| 4 | Paul Solomon | School of Information and Library Science | Core |
| 4 | Peter Willett | Department of Information Studies | Core |
| 4 | Ray R. Larson | School of Information Management and Systems | Core |
| 4 | Raya Fidel | Graduate School of Library and Information Science | Core |
| 4 | Valery I. Frants | Department of Computer and Information Science | IT |
| 3 | A. F. J. van Raan | Centre for Science and Technology Studies | IT |
| 3 | Abbe Mowshowitz | Rotterdam School of Management | Oth |
| 3 | Alain Breuleux | Department of Educational and Counseling Psychology | Oth |
| 3 | Alistair Moffat | Department of Computer Science | IT |
| 3 | Andre Renaud | Department of Educational and Counseling Psychology | Oth |
| 3 | Andrew Large | Graduate School of Library and Information Studies | Core |
| 3 | David H. Hickam | Portland VA Medical Center | Oth |
| 3 | Donna Harman | NIL | Oth |
| 3 | Gary Marchionini | College of Library and Information Services | Core |
| 3 | Gwyneth Tseng | Department of Information and Library Studies | Core |
| 3 | Jacob Shapiro | Department of Statistics and Computer Information Systems | IT |
| 3 | Jamshid Beheshti | Graduate School of Library and Information Studies | Core |
| 3 | Jean Tague-Sutcliffe | Graduate School of Library and Information Science | Core |
| 3 | Judith V. Douglas | Information Resources Management Division | Core |
| 3 | Laurence B. Heilprin | College of Library and Information Services | Core |
| 3 | Mark T. Kinnucan | Graduate School of Library and Information Science, Elborn College | Core |
| 3 | Martha Evens | Computer Science Department | IT |
| 3 | Peter Liebscher | Palmer School of Library & Information Science | Core |
| 3 | Quentin L. Burrell | Statistical Laboratory, Department of Mathematics | Oth |
| 3 | Richard Bolan | Hubert H. Humphrey Institute of Public Affairs | Oth |
| 3 | Ronald E. Rice | School of Communication, Information and Library Studies | Core |
| 3 | Roy Rada | Department of Computer Science | IT |
| 3 | William R. Hersh | Biomedical Information Communication Center | Oth |
| 3 | Xia Lin | School of Library and Information Science | Core |
| 3 | Zimin Wu | Elinor Electronic Library Research Group, Information Centre | Core |
| 3 | Ziming Liu | School of Information Management and Systems | MIS |

**1998–2007**

| | | | |
|---|---|---|---|
| 19 | Hsinchun Chen | Department of Management Information Systems | MIS |
| 19 | Leo Egghe | Limburgs Univesitaire Centrum | Core |
| 17 | Mike Thelwall | School of Computing and Information Technology | IT |
| 16 | Amanda Spink | Faculty of Information Technology | IT |
| 15 | Ronald Rousseau | Department Industrial Sciences and Technology | Oth |
| 14 | Nigel Ford | Department of Information Studies | Core |
| 13 | Charles Cole | Graduate School of Library and Information Studies | Core |
| 12 | Christopher C. Yang | Department of Systems Engineering and Engineering Management | IT |
| 10 | Loet Leydesdorff | Amsterdam School of Communications Research (ASCoR) | Oth |
| 9 | Andrew Large | Graduate School of Library and Information Studies | Core |
| 9 | Howard D. White | College of Information Science and Technology | Core |
| 9 | Jamshid Beheshti | Graduate School of Library and Information Studies | Core |
| 8 | David Bodoff | Graduate School of Business | Oth |
| 7 | Bernard J. Jansen | College of Information Sciences and Technology | Core |
| 7 | Michael Chau | School of Business | Oth |
| 7 | Paul B. Kantor | School of Communication | Oth |
| 7 | Rob Kling | Center for Social Informatics | Oth |
| 6 | Blaise Cronin | School of Library and Information Science | Core |
| 6 | Chaomei Chen | College of Information Science and Technology | Core |
| 6 | Ian Ruthven | Department of Computer and Information Sciences | IT |
| 6 | Judit Bar-Ilan | Department of Information Science | Core |
| 6 | Julian Warner | School of Management and Economics | Oth |
| 6 | Kalervo Järvelin | Department of Information Studies | Core |
| 6 | Liwen Vaughan | Faculty of Information & Media Studies | Core |
| 6 | Lokman I. Meho | School of Library and Information Science | Core |
| 6 | Ophir Frieder | Department of Computer Science | IT |
| 6 | Ronald E. Day | School of Library and Information Science | Core |

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**Appendix A** (*Continued*)

| | | | |
|---|---|---|---|
| 5 | Allen Foster | Department of Information Studies | Core |
| 5 | Barbara M. Wildemuth | School of Information and Library Science | Core |
| 5 | Carolyn Watters | Faculty of Computer Science | IT |
| 5 | Chaim Zins | NIL | Oth |
| 5 | David Ellis | Department of Information and Library Studies | Core |
| 5 | David Grossman | Department of Computer Science | IT |
| 5 | Debora Shaw | School of Library and Information Science | Core |
| 5 | Diane Kelly | School of Information and Library Science | Core |
| 5 | Dietmar Wolfram | School of Information Studies | Core |
| 5 | Eugene Garfield | Institute for Scientific Information | Oth |
| 5 | Félix de Moya-Anegón | Library and Information Science Faculty | Core |
| 5 | Jane Greenberg | School of Information and Library Science | Core |
| 5 | Justin Zobel | School of Computer Science and Information Technology | IT |
| 5 | Michael D. Cooper | School of Information Management and Systems | MIS |
| 5 | Peiling Wang | School of Information Sciences | Core |
| 5 | Sandor Dominich | Department of Computer Science | IT |
| 5 | Shan-Ling Pan | School of Computing | MIS |
| 5 | Shoichi Taniguchi | Graduate School of Library | Core |
| 5 | T.D. Wilson | Department of Information Studies | Core |
| 5 | Yunjie Xu | School of Computing | MIS |
| 4 | Ben Shneiderman | Department of Computer Science | IT |
| 4 | Bracha Shapira | Department of Information Systems Engineering | IT |
| 4 | Cecelia Brown | School of Library and Information Studies | Core |
| 4 | Corinne Jörgensen | College of Information | Core |
| 4 | Dania Bilal | School of Information Sciences | Core |
| 4 | David Miller | Department of Information Studies | Core |
| 4 | Denise E. Agosto | College of Information Science & Technology | Core |
| 4 | Diane H. Sonnenwald | School of Information and Library Science | Core |
| 4 | Endre Száva-Kováts | NIL | Oth |
| 4 | Frederick G. Kilgour | School of Information and Library Science | Core |
| 4 | Gary Marchionini | School of Information and Library Science | Core |
| 4 | Gonzalo Navarro | Department of Computer Science | IT |
| 4 | Henk F. Moed | Centre for Science and Technology Studies | IT |
| 4 | Jin Zhang | School of Information Studies | Core |
| 4 | John E. Leide | Graduate School of Library and Information Studies | Core |
| 4 | Katherine W. McCain | College of Information Science & Technology | Core |
| 4 | Lee-Feng Chien | Institute of Information Science | Core |
| 4 | Marcia J. Bates | Department of Information Studies | Core |
| 4 | Mark Rorvig | School of Library and Information Sciences | Core |
| 4 | Mounia Lalmas | Department of Computer Science | IT |
| 4 | Nicola Moss | Department of Information Studies | Core |
| 4 | Nina Wacholder | School of Communication | Oth |
| 4 | Pertti Vakkari | Department of Information Science | Core |
| 4 | Philip M. Davis | Albert R. Mann Library | Core |
| 4 | Pia Borlund | Department of Information Studies | Core |
| 4 | Quentin L. Burrell | Business | Oth |
| 4 | Scott Nicholson | School of Information Studies | Core |
| 4 | Sherry Koshman | School of Information Sciences | Core |
| 4 | Tefko Saracevic | School of Communication, Information and Library Studies | Core |
| 4 | Wai Lam | Department of Systems Engineering and Engineering Management | IT |
| 4 | Ying Sun | School of Communication | Oth |
| 3 | A. Bookstein | Center for Information and Language Studies | Oth |
| 3 | Abby A. Goodrum | School of Journalism | Oth |
| 3 | Ajit Kambil | NIL | Oth |
| 3 | Alesia Zuccala | School of Computing and Information Technology | IT |
| 3 | Alton Y.K. Chua | Division of Information Studies | Core |
| 3 | Anita Coleman | School of Information Resources & Library Science | Core |
| 3 | Bernard C.Y. Tan | School of Computing | MIS |
| 3 | Berthier Ribeiro-Neto | Department of Computer Science | IT |
| 3 | Bin Zhu | Department of Management Information Systems | MIS |
| 3 | Bradley M. Hemminger | School of Information and Library Science | Core |
| 3 | Bruce R. Schatz | Digital Library Research Program | IT |
| 3 | Carole L. Palmer | Graduate School of Library and Information Science | Core |
| 3 | Caroline Haythornthwaite | Graduate School of Library and Information Science | Core |

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**Appendix A** (*Continued*)

| | | | |
|---|---|---|---|
| 3 | Concepción S. Wilson | School of Information Systems, Technology and Management | MIS |
| 3 | Craig Locatis | NIL | Oth |
| 3 | Dagobert Soergel | College of Information Studies | Core |
| 3 | Debra J. Slone | School of Library & Information Science | Core |
| 3 | Don R. Swanson | Division of the Humanities | Oth |
| 3 | Ee-Peng Lim | School of Computer Engineering | IT |
| 3 | Elaine G. Toms | Faculty of Information Studies | Core |
| 3 | Eric C. Jensen | Department of Computer Science | IT |
| 3 | Fabio Crestani | Department of Computer and Information Sciences | IT |
| 3 | Frederico T. Fonseca | College of Information Sciences and Technology | Core |
| 3 | Geoffrey McKim | Center for Social Informatics | Oth |
| 3 | Gerald Benoit | Graduate School of Library & Information Science | Core |
| 3 | Hajar Sotudeh | Department of Library and Information Science | Core |
| 3 | Hong (Iris) Xie | School of Information Studies | Core |
| 3 | Hsin-Hsi Chen | Department of Computer Science and Information Engineering | IT |
| 3 | Hui-Min Chen | School of Information Management and Systems | MIS |
| 3 | Jacqueline Kracker | Psychology Department | Oth |
| 3 | Jeffrey Pomerantz | School of Information and Library Science | Core |
| 3 | John C. Huber | Institute for Invention and Innovation | Oth |
| 3 | John Carlo Bertot | School of Information Studies | Core |
| 3 | Kam-Fai Wong | Department of Systems Engineering and Engineering Management | IT |
| 3 | Kar Wing Li | Department of Systems Engineering and Engineering Management | IT |
| 3 | Kayvan Kousha | Department of Library and Information Science | Core |
| 3 | Kenneth D. Crews | Copyright Management Center | Oth |
| 3 | Kevin W. Boyack | NIL | Oth |
| 3 | Kwok-Kee Wei | Department of Information Systems | MIS |
| 3 | Kwong Bor Ng | Graduate School of Library and Information Studies, Queens College | Core |
| 3 | Marc L. Resnick | Industrial and Systems Engineering | IT |
| 3 | Mark Sanderson | Department of Information Studies | Core |
| 3 | Martin Brooks | Institute for Information Technology | IT |
| 3 | Massimo Melucci | Department of Information Engineering | IT |
| 3 | Matthew K. O. Lee | Department of Information Systems | MIS |
| 3 | Misha W. Vaughan | Applications User Experience, Oracle Corporation | Oth |
| 3 | Murat Karamuftuoglu | Department of Communication and Design | Oth |
| 3 | Myke Gluck | Department of Math & Computer Science | IT |
| 3 | Neil R. Smalheiser | Department of Psychiatry | Oth |
| 3 | Noriko Hara | School of Library and Information Science | Core |
| 3 | Paul F. Marty | College of Information | Core |
| 3 | Reijo Savolainen | Department of Information Studies | Core |
| 3 | Ricardo Baeza-Yates | Department of Computer Science | IT |
| 3 | Robert M. Losee Jr. | School of Information and Library Science, | Core |
| 3 | Robert Rittman | School of Communication | Oth |
| 3 | Ronald E. Rice | Department of Communication | Oth |
| 3 | Rong Tang | School of Information Science and Policy | Core |
| 3 | Sanna Talja | Department of Information Studies | Core |
| 3 | Shaoyi He | School of Information Sciences and Technology | IT |
| 3 | Sherry Y. Chen | Department of Information Systems & Computing | MIS |
| 3 | Stefano Mizzaro | Department of Mathematics and Computer Science | IT |
| 3 | Stephen J. Bensman | LSU Libraries | Core |
| 3 | Stephen P. Harter | School of Library and Information Science | Core |
| 3 | Steven A. Morris | School of Electrical and Computer Engineering | IT |
| 3 | Steven M. Beitzel | Department of Computer Science | IT |
| 3 | Timo Niemi | Department of Computer Sciences | IT |
| 3 | Tomek Strzalkowski | Department of Computer Science | IT |
| 3 | Tsvi Kuflik | Department of Information Systems Engineering | IT |
| 3 | Vicente P. Guerrero-Bote | Library and Information Science Faculty | Core |
| 3 | Vijay V. Raghavan | Center for Advanced Computer Studies | IT |
| 3 | W. John Wilbur | National Center for Biotechnology Information | Oth |
| 3 | Weiguo Fan | Virginia Polytechnic Institute and State University | IT |
| 3 | Wingyan Chung | Management Information Systems Department | MIS |
| 3 | Wolfgang G. Stock | Department of Information Science | Core |
| 3 | Zan Huang | Department of Management Information Systems | MIS |


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## Appendix B

*Full Listing of Top Keywords: Number of Occurrences and the Subdisciplines Coded*

**1988–1997**

| | | |
|---|---|---|
| 64 | information retrieval | Core |
| 41 | document retrieval | Core |
| 38 | end user searching | Core |
| 37 | Evaluation | Core |
| 35 | Journals | Lib |
| 34 | online searching | Core |
| 33 | biomedical information | Core |
| 33 | Relevance | Core |
| 32 | Medical science | Oth |
| 30 | comparison | Core |
| 30 | academic libraries | Lib |
| 29 | citation analysis | Stats |
| 26 | information technology | IT |
| 25 | Primary literature | Core |
| 24 | Usability | Beh Sci |
| 24 | information needs | Core |
| 24 | information storage and retrieval systems | Core |
| 21 | usage studies | Beh Sci |
| 21 | subject indexing | Core |
| 20 | information use | Core |
| 20 | retrieval effectiveness | Core |
| 20 | bibliographic citations | Stats |
| 19 | Analytic models | Core |
| 19 | full text searching | Core |
| 19 | information science history | Core |
| 18 | user studies | Beh Sci |
| 18 | information dissemination | Core |
| 18 | query formulation | Core |
| 18 | standards | Core |
| 17 | automatic indexing | Core |
| 17 | information science | Core |
| 17 | databases | IT |
| 17 | hypertext | IT |
| 16 | organizational communication | Comm |
| 16 | information science education | Core |
| 15 | colleges and universities | Core |
| 15 | libraries | Lib |
| 15 | cluster analysis | Stats |
| 14 | search strategies | Core |
| 14 | algorithms | IT |
| 14 | OPACs | Lib |
| 14 | bibliometrics | Stats |
| 14 | trends | Stats |
| 13 | social aspects | Beh Sci |
| 13 | user Beh Sciavior | Beh Sci |
| 13 | cognitive models | Core |
| 13 | overlap | Core |
| 13 | performance | Core |
| 13 | recall | Core |
| 13 | scholarly publishing | Core |
| 13 | reader services | Lib |
| 12 | scholarly communication | Comm |
| 12 | data distribution | Core |
| 12 | indexing | Core |
| 12 | information access | Core |
| 12 | information resources management | Core |
| 12 | information seeking | Core |
| 12 | thesauri | Core |
| 12 | cost analysis | Oth |
| 11 | collaboration | Beh Sci |
| 11 | political aspects | Beh Sci |
| 11 | user satisfaction | Beh Sci |
| 11 | authors | Core |
| 11 | Boolean searching | Core |
| 11 | index terms | Core |
| 11 | non English languages | Core |
| 11 | probabilistic retrieval | Core |
| 11 | relevance ranking | Core |
| 11 | CD-ROM | IT |
| 11 | Statsistical methods | Stats |

**1998–2007**

| | | |
|---|---|---|
| 102 | end user searching | Core |
| 93 | information retrieval | Core |
| 86 | online searching | Core |
| 81 | World Wide Web | IT |
| 67 | citation analysis | Stat |
| 55 | information seeking | Core |
| 53 | analytic models | Core |
| 52 | user studies | Beh |
| 46 | evaluation | IT |
| 43 | scholarly publishing | Comm |
| 43 | document retrieval | Core |
| 43 | trends | Stat |
| 42 | collaboration | Beh |
| 42 | search behavior | Beh |
| 42 | relevance | Core |
| 42 | journals | Lib |
| 41 | digital libraries | Lib |
| 40 | biomedical information | Core |
| 40 | query formulation | Core |
| 38 | social aspects | Beh |
| 37 | Internet | IT |
| 36 | interfaces | Beh |
| 35 | information science | Core |
| 35 | search engines | IT |
| 34 | information needs | Core |
| 34 | retrieval effectiveness | Core |
| 34 | web sites | IT |
| 32 | impact factor | Stat |
| 30 | scientific and technical information | Core |
| 30 | bibliometrics | Stat |
| 29 | human computer interaction | Beh |
| 29 | usage studies | Beh |
| 29 | scholarly communication | Comm |
| 29 | search strategies | Core |
| 29 | search terms | Core |
| 29 | similarity | IT |
| 28 | user behavior | Beh |
| 27 | usability | Beh |
| 27 | visualization (electronic) | Comm |
| 27 | comparison | Core |
| 27 | information storage and retrieval systems | IT |
| 27 | information technology | IT |
| 27 | bibliographic citations | Stat |
| 25 | link analysis | IT |
| 24 | information science history | Core |
| 24 | individual differences | IT |
| 24 | research methods | Oth |
| 23 | knowledge management | Core |
| 23 | research and development | IT |
| 22 | user models | Beh |
| 22 | cognitive models | Core |
| 22 | information resources | Core |


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## Appendix B (*Continued*)

**1998–2007** (*Continued*)

| | | | | | |
|---|---|---|---|---|---|
| 21 | authors | Core | 18 | fuzzy logic | IT |
| 21 | algorithms | IT | 18 | pattern recognition | IT |
| 21 | images | IT | 17 | browsing | Beh |
| 21 | co-citation analysis | Stat | 17 | information use | Beh |
| 21 | forecasting | Stat | 17 | communication patterns | Comm |
| 20 | social networking | Beh | 17 | colleges and universities | Core |
| 20 | non English languages | Core | 17 | information architecture | Core |
| 20 | data mining | IT | 17 | legal aspects | Gov |
| 20 | ranking | Stat | 17 | design | IT |
| 19 | end users | Beh | 17 | fuzzy retrieval systems | IT |
| 19 | information access | Core | 17 | links (hypermedia) | IT |
| 19 | non English language materials | Core | 17 | performance | IT |
| 19 | scholars | Core | 17 | electronic journals | Lib |
| 19 | vector space models | Core | 17 | cluster analysis | Stat |
| 19 | image retrieval | IT | 16 | user satisfaction | Beh |
| 19 | query by example | IT | 16 | metadata | Core |
| 19 | children | Lib | 16 | primary literature | Core |
| 18 | user aids | Beh | 16 | user expertise | Core |
| 18 | user preferences | Beh | 16 | web pages | IT |
| 18 | classification | Core | 16 | author productivity | Stat |
| 18 | query refinement | Core | | | |


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