The Convergence of Information Science and Communication: A Bibliometric Analysis

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This study asks whether the disciplines of information science and communication are converging, as indicated by a bibliometric study of all core journals of both disciplines in the *Social Sciences Citation Index (SSCI®)* for the period 1977 to 1987. Results show very little convergence between these disciplines, at least on the basis of cross-disciplinary journal citation patterns, although the number of journals involved has increased slightly over time. A few journals are mainly responsible for the cross-disciplinary citing, and they are primarily information science journals citing communication journals. The results may be of interest to those studying scholarly communication or bibliometrics, to faculty constructing curricula in either of the disciplines, to communication and information science scholars seeking new areas of research, and to collection development librarians in drawing the boundaries of these disciplines.

Introduction

Convergence of Information Science and Communication

Are the disciplines of information science and communication converging or becoming more integrated? Common research topics include scholarly communication, knowledge gaps, invisible colleges, diffusion of innovations, human interaction with communication technologies, information-seeking behavior, information theory, and the information society. Several information science programs, most notably Rutgers, Syracuse, and UCLA, have hired faculty with doctorates in communication in recent years.

Others have speculated on these trends (see Borgman, 1990b; Paisley, 1984, 1986, 1990a; Pemberton & Prentice, 1990; Schement & Ruben, in press). While Paisley provided some cross-sectional bibliometric data assessing convergence trends in these articles, no one has yet gathered sufficient longitudinal data to study whether there is evidence of a trend toward convergence.

The discipline of communication, as defined by Schramm (1971, p. 13), is concerned with "communication [as] the sharing of an orientation toward a set of informational signs. ... Communication is therefore based on a relationship. This relationship may exist between two persons, or between one person and many." Communication typically is divided into the subfields of mass communication and interpersonal communication (Berger & Chaffee, 1988; Reardon & Rogers, 1988), although Paisley (1984) considers information science to be a subset of communication as well.

As a field of study, information science generally is taken to be broader in scope than is library science. Borko (1968, p. 5) is the most commonly cited definition: "[Information science] is an interdisciplinary science that investigates the properties and behavior of information, the forces that govern the flow and use of information, and the techniques, both manual and mechanical, of processing information for optimal storage, retrieval, and dissemination." Schools of library and information science have tended to treat information science as a subset of their course offerings and declared faculty specialties, while acknowledging that information science research is pursued in other academic departments as well (Hayes, 1969, 1983). The term "information" has achieved increasing prominence in the names of these programs, such as "information and library studies," or "School of Information Studies," suggesting that information science is becoming more fully integrated into the curricula.

Paisley (1984) considers both communication and information science to be "variable fields," ones that fo-

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cus on a theoretical variable—communication and information, respectively—rather than "level fields," ones that focus on a level of analysis—the individual or group, as in most behavioral and social sciences.

This article considers these two disciplines in this broader context, as defined by the 1985 lists of core journals in "communication" and "information and library science" from the *Social Sciences Citation Index* (*SSCI*®). It is a broad-ranging list, from *Central States Speech Journal* to *Telecommunications Policy* in communication and from *College and Research Libraries* to the *Annual Review of Information Science and Technology* in information and library science. For simplicity, we will refer to the two disciplines as "communication," abbreviated "COMM" in tables and "information science," abbreviated "IS" in tables throughout this article.

Why might we care whether these disciplines are converging? The results could have implications for both scholarship and training in these two disciplines. If information science and communication are converging, scholars in each discipline need to be incorporating a wider range of literature in both their scholarship and teaching if they are to reflect the true state of the field. Faculty search committees might use these data in considering whether to recruit a new faculty member from the complementary discipline to their staff; similarly, graduates of either program might find that they can expand their base of employment possibilities. Collection development librarians might use these data in selection decisions that determine the operational scope of these disciplines. Similarly, editors of abstracting and indexing journals might draw their boundaries differently, depending upon these results. At a more theoretical level, we can apply these results in assessing the maturity of these disciplines.

Scholarly Communication and Bibliometrics

As the amount and type of data available from the scholarly record increases, we are becoming increasingly sophisticated in applying bibliometric techniques to the study of scholarly communication (Borgman, 1989, 1990a; Paisley, 1989, 1990b). Bibliometrics—the application of mathematics and statistical methods to books and other media of communication (Pritchard, 1969)—have been used to study such issues as scholarly communities and networks, the growth and evolution of fields, the diffusion of research topics, and the influence and importance of individual authors or institutions (Borgman, 1989, 1990a).

Bibliometric data are particularly useful for studying longitudinal trends in scholarly disciplines because of the massive datasets that can be utilized. Virtually no other method provides as comprehensive coverage of a topic in scholarly communication. Bibliometrics, and citation analysis in particular, are most useful for achieving a macro perspective on scholarly communication processes. Bibliometric studies are reliable, in that the data are collected unobtrusively, from the published record, and can be easily replicated by others. They are valid, to the extent that we accept the aggregation of citations to represent the "importance" of links between citing and cited documents (White, 1990).

Prior Research

Bibliometric studies have been performed on the disciplines of information science and communication, using a range of methods. A few have studied how these two disciplines relate to the larger context of the social sciences. Here we review these studies and related methodological issues, concentrating on works that have used journals as the level of analysis and that have sought to characterize either or both of these disciplines.

Core Journal Lists

Bibliometric studies assessing the growth or evolution of a discipline usually begin with some core set of journals, articles, authors, or key terms and use these to generate links or clusters. The choice of the unit of analysis and of the initial set has a strong influence on the measures and results of any bibliometric study. Generally speaking, authors are used when the study focuses on the influence of individuals, articles used to study the influence of a particular idea (as embodied in the article), key terms to follow an idea over time as it crosses disciplines, and journals when the study focuses on the institutional embodiment of a discipline. Studies to characterize scholarly communities statically or over time generally use either journals or co-citations as the unit of analysis (Borgman, 1990a). Co-citation analysis begins with a set of articles (Small, 1973) or a set of authors (White, 1990) to define a discipline, while journal studies generally begin with a disciplinary "core list."

Diverse approaches to identifying a "core list" have been used in bibliometric research, including journals read by those surveyed (Coblans, 1972; Dansey, 1973; Hansen & Tilbury, 1963; Swisher & Smith, 1982), a survey of authors publishing in one journal of where else they publish (Meadow & Zaborowski, 1979), faculty consensus (Hayes, 1983; Meadow & Zaborowski, 1979; Reeves & Borgman, 1983), a consensus of a set of expert researchers (Doreian, 1985; Doreian & Fararo, 1985), and a random sample of articles from two journals, clustering the sources cited (Eisenhardt, 1979; Wellisch, 1980).

The *Science Citation Index, SSCI*®, and the *Arts & Humanities Citation Index* produced by the Institute for Scientific Information (ISI) are commonly used for bibliometric studies because they are very large datasets, multidisciplinary, and are available online from several vendors as well as in print. The ISI databases are not

without their measurement problems (Moed & Vriens, 1989; Rice, Borgman, Bednarski, & Hart, 1989), but they are manageable problems.[1]

An important advantage of the ISI databases is that they cover individual journals in their entirety by editorial policy, while many, if not most, abstracting and indexing services selectively index individual articles from journals they cover. LaRose (1989), for example, searched the authors of all articles in two years' issues (1985–1986) of 12 communication journals through eight indexing and abstracting services, finding that only 8.3% to 50% of the articles were indexed in any particular source.

The ISI databases include specific lists of journals that the editors consider to be the core journals of each discipline covered. The core lists change annually, as does the set of journals indexed (Moed & Vriens, 1989). Often researchers accept the ISI lists as a utilitarian approach to estalishing a core (as have we), while others choose a core through some form of consensus, or simply focus on one or two journals and avoid defining a core.

[1]The data-collection and data-correction methods are described only briefly here, as they are reported in detail in Rice et al. (1989), as are associated reliability and validity issues.

The data collection was on the 1985 *SSCI*® core lists so that there would be a common matrix for the 11 years of data collection. The data collection process compensated for the annual changes in core lists by picking up prior and subsequent journal titles and variant forms of entry. Even so, 1985 is the only year for which a complete census of all titles is available from the *JCR*. Thus, it is possible that some of the shift during the middle of the 11-year period could be attributed to the increasingly cohesive dataset.

The dataset is undoubtedly skewed toward a Western view of both of these disciplines, given the coverage of the ISI indexes. Citation data are not available from any other indexing source, so a study incorporating journals outside the ISI databases would require manual collection of citations from the journals themselves, a prohibitively labor-intensive task. As the full text of journals increasingly becomes available online, the situation may change.

One additional necessary correction involved the communication journal titled *Communication*. At least through 1991, ISI has coded all references to "communication"—such as "personal communication" or "telephone communication"—simply as "communication," and this is indistinguishable from the journal entitled *Communication*. Thus, there appeared to be considerable and increasing citations of the journal by ISI journals until this coding problem was identified. The only reasonable solution was to drop all the column (cited) entries for this journal. Few of these were in the set of communication journals, and there were no values in the diagonal (*Communication* citing itself), so there is little distortion of the within-communication discipline citations involving the journal *Communication*.

Another additional necessary correction was the inclusion of some cross-disciplinary citations not listed as occurring between two specific journals in the *JCR*. For a journal that cited another specific journal only a very few times, *JCR* typically includes this citation in the "Other" category rather than listing that specific other journal. Thus, for infrequent cross-disciplinary citations, the *JCR* will not always provide information on the specific journals involved. Any additional such citation discovered in our verification process was thus included in the appropriate matrix. The total number of such added cross-disciplinary links (not strengths) was 29.

Bibliometric studies in information science or communication that have been based on the ISI databases include Barnett and Fink (1989); Barnett, Fink, and Debus (1988), Beniger (1988), Cottrill, Rogers, and Mills (1989); Harter and Hooten (1990); Hayes (1983); Lockett and Khawan (1990); Midorikawa (1984); Paisley (1984, 1986, 1990a); Reeves and Borgman (1983); So (1988); Saito (1984); Small (1981); White and Griffith (1982); Rice (1990); Rice, Borgman, and Reeves (1988); and Rice et al. (1989); the latter three articles are based on the same dataset reported here.

Todorov (1982) produced a merged core list of information science journals from what Coblans (1972) and Dansey (1973) considered to be the "big four": *Informatics,* the Soviet journal of abstracts; *Library and Information Science Abstracts* (*LISA*); *Bulletin Signaletique, 101: Sciences de l'Information, Documentation* (*BSI*); and *Information Science Abstracts* (*ISA*), indicating which of these journals were covered by the *Social Sciences Citation Index*. Todorov cites Dansey (1973) for this selection of the "big four" sources in information science, but Dansey (1973, p. 253) attributes it to Coblans (1972). At the time of Coblans' and Danseys' selection of these sources (1972–1973), *SSCI* had just begun (1973), which would explain why they did not include it.

Todorov's merged list includes 85 information science journals, 57 of which were covered by all three of *LISA*, *BSI*, and *ISA* at the time of his study, and 28 of which were covered by *SSCI*®. In comparing these lists, it appears that the *SSCI*® coverage is concentrated in journals originating in the United States, United Kingdom, and Western Europe, with a relatively weaker coverage of journals from the Soviet Union, Eastern Europe, and Japan. Although we do not have a comparable study of communication journal distributions, it seems reasonable to assume that bibliometric studies of either of these disciplines based on the *SSCI*® are likely to be skewed toward a Western perspective in journal content, and that either of these disciplines could be defined more broadly by choosing other or additional data sources.

Bibliometric Studies of Information Science

The literature of information science has received more bibliometric study than has the literature of communication. This is not surprising, given that the methods have arisen largely from the discipline of information science (White & McCain, 1989).

Most of these studies sought to identify a list of core, most-cited, or most-read journal lists of the discipline through varying methods (Coblans, 1972; Dansey, 1973; Donohue, 1972; Hanson & Tilbury, 1963; Lockett & Khawam, 1990; Meadow & Zaborowski, 1979; Midorikawa, 1984; Pope, 1975; Saracevic, 1971; Saracevic & Perk, 1973; Sellen, 1984; Swisher & Smith, 1982; Wellisch, 1980 [translation of Eisenhardt, 1979]). Others, such as Saito (1984), have used author co-citation

analysis to identify disciplinary subspecialties. He found four specialties in 1966–1970 (scientific information and citation study, information retrieval, information dissemination, and specialties in several subjects), and five in 1983 (citation/social studies of science, information retrieval, computers and communication, evaluation of the library, and user studies).

Hayes (1983) analyzed the productivity of faculty of schools of library and information science (L&IS), using data from the *SSCI®*. (The names of these schools range from "library service" to "information studies.") His source for author names and specialties was the *Directory of the Association for Library and Information Science,* a comprehensive listing of faculty that includes self-identified research areas. Hayes normalized publication and citation rates by L&IS specialty for the number of journals covered in the *SSCI®* (e.g., 33 for information science, 20 for communications in his core list). Those specializing in information science had the highest publication rate (14.6) and received the most citations (90.1). The L&IS communications specialty, which is far more narrowly defined than is communication, ranked fourth in publications (8.3) and second in citations (42.0). Thus, the information science and communications specialties appear to be the more publication-active segments of the discipline of L&IS.

Bibliometric Studies of Communication

Only a few bibliometric studies have focused on communication as a discipline. Reeves and Borgman (1983) clustered three years of *SSCI®* data (1977–1979) for eight communication journals plus hand-collected data on *Human Communication Research,* which was not covered by *SSCI®* at the time, showing that the discipline clustered into two subdisciplines of mass communication and interpersonal communication, with the journal *Human Communication Research* bridging the two subdisciplines. These data showed that the discipline was externally oriented, with only 13% of the citations, on average, made to other journals in this core list.

Rice, Borgman, and Reeves (1988) used the complete *SSCI®* 1985 list of 21 core communication journals for the years 1977–1985. Using the same citation strength cutoff as the earlier article, ten of the journals (the same nine as before, plus *Communication Education*) clustered again into two subdisciplines—mass communication and interpersonal—this time with *Human Communication Research* shifting into the interpersonal group and *Journal of Communication* becoming the bridge journal.

So (1988) replicated Reeves and Borgman (1983) with 1983–1985 *SSCI®* data on the same ten journals that Rice et al. (1989) found to cluster. Using a different clustering technique and no cut-off point, So's results show the same five journals in each of the two subdisciplines, although with *Journal of Communication* in the mass communication group and no single bridge journal.

Bibliometric Studies of Communication, Information Science, and the Social Sciences

Peritz (1981) gathered citation data on library science research articles from 39 core journals for the years 1950–1975. While excluding the 44% of her data that were historical articles or "studies unrelated to library science," she still found that 20% of all cites were to disciplines outside librarianship and that 3% of all cites were to psychology, sociology, or communication, as a group.

So (1988) analyzed links between communication and 11 other social science disciplines using 1983–1985 *SSCI®* data. Information science falls below his cutoff for links to the discipline of communication. Information science has a higher impact factor than does communication, however, and shorter half-lives for both citing and cited references, indicating that it is a faster-moving discipline.

Barnett and Fink (1989) analyzed 26 social science disciplines identified in the *SSCI®*, selecting the 25% highest-impact journals and the 25% lowest-impact journals in each discipline, which were combined into a journal-by-journal matrix aggregated by discipline. In grouping all disciplines together, they found that, in both high- and low-impact networks, information science did not receive any citations from outside its own discipline. Sociology, general psychology, and social psychology, all more established disciplines, were most central in both high- and low-impact networks. In the low-impact network, the most peripheral disciplines were social work, transportation, and information science.

Small (1981) set information science in the context of the social sciences using individual journal articles, rather than journal titles, from the 1975–1977 *SSCI®*. Small's data suggest that information science has a weaker structure than more established disciplines such as psychology, sociology, or economics, which emerge as larger and more coherent specialties at this level. Small did find that information science falls between sociology and economics in recency of literature cited, measured either by mean publication date of cited items, or by Price's index (percentage of items which fall within the last five years). He also found that information science clusters contain relatively few books as cited items, about the same as psychology: "[T]his indicates the tendency for important contributions in the discipline to appear in journal article form." (Small, 1981, p. 44).

Parker, Paisley, and Garrett (1967) were the first to apply bibliometrics to the discipline of communication. They did not consider any information science journals in their 1950 data, but did include *American Documentation* (the precursor to *JASIS*) in 1965. They found no

cross-citing between *American Documentation* and the four communication journals analyzed.

Only Paisley has focused directly on comparisons between the journals of these two disciplines. Paisley (1986, 1984) compared 1980 and 1981 *SSCI®* data (respectively) for the eight communication journals from Reeves and Borgman (1983) that were covered by *SSCI®* at the time to three prominent information science journals, *JASIS, Information Processing and Management,* and *Journal of Documentation.* He found no cross-citation in either direction in this limited dataset. Paisley (1986) did find that several concepts originating in communication appeared in journals from information science and elsewhere during the period 1973–1982, based on *SSCI®* data (Paisley, 1984, 1986). He reports similar data in Paisley (1990a), with further discussion.

Research Questions

The present research seeks preliminary answers to two sets of research questions that address the speculated convergence of the disciplines of information science and communication—(1) trends over time in the structures of these disciplines, and (2) links between these two disciplines. These are questions that can be addressed by using a set of core journals from each of the two disciplines, and by making the assumption that these journals represent an institutional form of these disciplines.

Methods and Data

This study analyzes journal citation data obtained from the *Journal Citation Reports* (*JCR*) of the *Social Sciences Citation Index* (*SSCI®*) for each of the 11 years from 1977–1987. The data include citations among the 77 journals in the core lists entitled "communication" and "information and library science" in the 1985 *JCR* volume (Table 1). The 1985 list of journals was the basis for the longitudinal analyses as it was the latest list at the time of the initial data collection; 1986 and 1987 data were collected later to expand the set. The resulting dataset was a square matrix (77 × 77) of citing and cited data for each year, consisting of 20 communication and 57 information and library science journals.

The dataset was also extended by picking up aberrant forms of abbreviation, title changes, and citations made to journals listed in the 1985 core list that were not in the core list of that year (Table 2), thus ameliorating some of the problems created by the changing journal coverage. Some data were lost due to grouping of small numbers of cites under "all other" and due to the above characteristics of the *SSCI* data collection (see footnote 1). Thus, these data will tend to underestimate, rather than overestimate, the amount of citation between journals.

The analyses take a network analysis approach, looking at the structure of these sets of journals and the relationships among them (Rice, 1990; Rice & Richards, 1985; Richards & Rice, 1981).

Results

We present our results by research question, (1) trends over time and (2) links between the disciplines. Briefly, our analyses find that the journal–journal matrices are generally stable over time, suggesting some cohesiveness within these young disciplines, yet becoming slightly more open over time. Cross-citation between the two disciplines increases slightly over time, and is generally associated with a few specific journals.

Trends Over Time

- Does the citation network exhibit stability, an overall trend or process of change, or specific periods of change?

Structural Results. One measure of network structure is the ratio of the number of transitive relations (triangular citing patterns) that exist to how many would be expected given the total number of journals and the total number of citation relations among the journals. The average triangle structure over the 11 years was .32. It was slightly higher (.32 to .36) from 1977 through 1983, and slightly lower from 1983, onward (.26 to .29), providing a slight hint of increasing openness in the journal citation patterns. That is, the tendency toward small sets of journals citing each other declines slightly in the second half of the period.

Another structural measure is density (also known as cohesiveness), defined as the ratio of the actual number of *links* (a citation *link* is defined as the number of other journals cited by the articles of a particular journal) to the maximum possible number of *links* (that is, if all journals cited each other in that year, a maximum of $77 \times 77 = 5929$). The average citation density of .19 shows almost no variation, except for a slight rise to .24 in 1981, over the 11 years. Table 3 provides these measures and the correlations referenced below.

Bi-Yearly Correlation Comparisons. Another measure of structural change is the correlation of the matrix in one year with the matrix in the next year. The approach here is simply to convert one year's 77 × 77 matrix into a single vector, the next year's matrix into another vector, and then correlate the two years' vectors.[2] This process is then conducted for each consecu-

[2]To convert a $N \times N$ matrix into a N^2 vector (as used here), simply take each column of the matrix and add on the next column to the end of the prior column. The diagonals of the matrix may be dropped, creating a $N(-1)$ vector. Or, if the original matrix is symmetric, the diagonals and upper triangle may be dropped, creating a $[N(-1)]/2$ vector. Two such vectors may then be correlated to measure the strength of the similarity in patterns between the two original matrices.

TABLE 1. "Core" communication journals and information and library science journals included in the 1985 *Journal Citation Report.*

Abbreviation	
Communication journals:	
CenSt	Central States Speech Journal
ColJR	Columbia Journalism Review
Commu	Communication
CommE	Communication Education
CommM	Communication Monographs
CommR	Communication Research
ECTJ	Educational Communication and Technology Research
HumCo	Human Communication Research
JBroa	Journal of Broadcasting and Electronic Media
JComm	Journal of Communication
JTech	Journal of Technical Writing and Communication
JQuar	Journalism Quarterly
Lang&	Language and Communication
Media	Media, Culture and Society
PubOp	Public Opinion Quarterly
PubRe	Public Relations Review
QJSpc	Quarterly Journal of Speech
SpchC	Speech Communication
TeleP	Telecommunications Policy
WritC	Written Communication
Information and library science journals:	
AmArc	American Archivist
ARIST	Annual Review of Information Science and Technology
ASLIB	ASLIB Proceedings
BehSS	Behavioral and Social Sciences Librarian
BMedL	Bulletin of the Medical Library Association
CanJI	Canadian Journal of Information Science
CanLi	Canadian Library Journal
CRL	College Research Libraries
Dbase	Database
Drexe	Drexel Library Quarterly
EdFor	Education for Information
ElecL	Electronic Library
GovIn	Government Information Quarterly
GovPu	Government Publications Review
IFLA	IFLA Journal
InfoA	Information Age
InfPr	Information Processing and Management
InfTl	Information Technology and Libraries
InfTe	Information Technology—Research Development Applications
Inter	Interlending and Document Supply
Intcl	International Classification
IntFo	International Forum on Information and Documentation
IntLi	International Library Review
JAcam	Journal of Academic Librarianship
JDocu	Journal of Documentation
JEdLi	Journal of Education for Library and Information Science
JofIS	Journal of Information Science
JLibs	Journal of Librarianship
JLibH	Journal of Library History Philosophy and Comparative Librarianship
JASIS	Journal of the American Society for Information Science
LawLi	Law Library Journal
L&ISR	Library and Information Science Research
LibAc	Library Acquisitions—Practice and Theory
L&IS	Library and Information Science
LibJ	Library Journal
LibQ	Library Quarterly
LibR&	Library Resources and Technical Services
LibTr	Library Trends
Libri	Libri
NachD	Nachrichten fur Dokumentation
Naucl	Nauchno-Tekhnicheskaya Informatsiya Seriya 1

TABLE 1. (continued).

Abbreviation	
Nauc2	Nauchno-Tekhnicheskaya Informatsiya Seriya 2
Onlin	Online
OnliR	Online Review
ProAS	Proceedings, American Society for Information Science
ProgA	Program-Automated Library and Information Systems
RevPu	Review of Public Data Use
RQ	RQ
Schol	Scholarly Publishing
Scien	Scientometrics
Seria	Serials Librarian
SoSci	Social Science Information
SoScS	Social Science Information Studies
SpecL	Special Libraries
Wilso	Wilson Library Bulletin
ZeitB	Zeitschrift fur Bibliothekswesen und Bibliographie
ZentB	Zentralblatt fur Bibliothekswesen

TABLE 2. Number of journals listed in *SSCI*'s 1985 *JCR* "fully covered source journals," with improved totals.

Number of titles within category "Communication"	21
Number of titles within category "Information Science and Library Science"	56
Number of titles duplicated by "Communication" and "Information Science and Library Science" lists	−1
Number of titles listed by *JCR* but not actually covered in the *JCR* listings	−1
Total number of unique "Communication" and "Information Science and Library Science" journals covered and listed by *JCR*	76
Number of title changes identified for these 76 journals	19
Total number of journal titles used in 1977–1985 *JCR*	95

tive pair of years. Overall, the average correlation between the 77 × 77 raw citation matrix of one year and the next is $r = .60$ ($p > .001$), with a range of r = .47 between 1978 and 1979, to $r = .70$ between 1983 and 1984. In other words, on average, the journal-to-journal citation pattern in one year shares slightly over a third (36%) of its variance with the pattern in the subsequent year; however, the overall structure, based upon year-to-year correlations, became slightly more stable between 1983–1985.

The above comparisons are limited to consecutive year pairs. As the number of years increases, the correlation betwen any given year and any other later year declines considerably (from the $r = .70$ in 1983–1984 to $r = .36$ for eight- to nine-year differences). That is, very little variance in the pattern of the citation matrix is shared over the long term; the overall patterns of citations change, due mostly to the entry of new journals. Using the 1987 citation matrix as the comparison point, this effect seems greatest for the four following years, with a jump from correlations of about .4 with the years before 1982, and correlations of about .6 to .7 with the years from 1983 on.

Thus, the data indicate an equally dense, slightly less transitive, and slightly more stable, journal-to-journal citation pattern in the second half of the 1977–1987 period.

TABLE 3. Pearson correlations between yearly journal-to-journal citation matrices and matrix density and structure, 1977–1987.

	Correlations between yearly matrices											
Year	'77	'78	'79	'80	'81	'82	'83	'84	'85	'86	Citation density	Matrix structure
1977	0										.18	.32
1978	.57	0									.21	.35
1979	.53	.47	0								.19	.34
1980	.52	.50	.66	0							.19	.34
1981	.55	.57	.60	.61	0						.24	.38
1982	.51	.50	.55	.56	.57	0					.20	.35
1983	.48	.45	.54	.54	.57	.61	0				.19	.31
1984	.46	.46	.49	.49	.49	.54	.70	0			.19	.26
1985	.44	.43	.50	.47	.48	.61	.69	.67	0		.17	.28
1986	.41	.47	.42	.44	.50	.58	.61	.57	.60	0	.18	.29
1987	.36	.36	.42	.42	.39	.51	.66	.67	.69	.59	.20	.29

Within-Discipline Relations

- Has there been overall growth in the journals involved in citing within and across the two disciplines?

As Table 4 indicates, there was a slight and varying growth in the total number of journals involved in citing within their respective disciplines (ranging from 10 journals in 1977 to 18 in 1987 in communication, with a peak of 19 journals in 1985 and 1986; and from 40 journals in 1977 to 48 in 1987 in information science, with a peak of 55 in 1984), and the total number of communication or information science journals citing journals within *both* of the two disciplines (from 49 links in 1977 to 84 in 1987 for communication, peaking at 92 in 1983; and from 266 links in 1977 to 534 in 1987 for information science, with a 1983 peak of 553). The average number of journals within these two disciplines cited by communication journals remained around 4.6, but there was considerable growth by information science journals (from 6.7 in 1977 to 11.1 in 1987). Thus, there is an overall growth in these journals' citing of articles in other journals, especially for information science journals.

Cross-Discipline Relations

- Has the relationship between communication journals and information science journals changed during this 11-year period, as measured by the number and strength of citations overall and between these disciplines?
- If the relationship between communication journals and information science journals has changed, which if either discipline is the primary source of these changes?

TABLE 4. Overall number, percent and mean of journal citation linkage, for communication and for library and information science journals.

Year	Disc.	No. journals	Percent journals with links	No. links	No. links/journal
1977	Comm	12	23	49	4.1
	IS	40	77	266	6.7
1978	Comm	10	19	53	5.3
	IS	43	81	317	7.4
1979	Comm	13	21	62	4.8
	IS	48	79	392	8.2
1980	Comm	14	23	65	4.6
	IS	48	77	440	9.2
1981	Comm	13	22	62	4.8
	IS	45	78	422	9.4
1982	Comm	15	23	69	4.6
	IS	49	77	481	9.8
1983	Comm	17	26	92	5.4
	IS	49	74	511	10.4
1984	Comm	16	23	83	5.2
	IS	55	77	544	9.9
1985	Comm	19	28	83	4.4
	IS	50	73	538	10.8
1986	Comm	19	27	89	4.7
	IS	52	73	553	10.6
1987	Comm	18	27	84	4.7
	IS	48	73	534	11.1

The term citation *strength* will be used to indicate the total number of citations involved in that relationship; citation *link* is defined as above. Thus, a journal may have an article that makes six citations (strength = 6) to one other journal (link = 1).

As Table 5 shows, from 1977–1987 citation *strength* for communication journals to information science journals varied between 0 to 2, with 12 in 1987 (as a percent of all the communication journals' citation strength, these figures vary between 0% and .2%, with a rise to .7% in 1987). The number of *links* from journals in the communication set to journals in the information science was similar, varying between 0 and 2, and with 4 in 1987. Mean citation strength for communication journals citing information science journals was mostly 0 or 1, with 2 in 1983 and 3 in 1987.

For information science journals to communication journals, citation *strength* rose from 0 in 1977 to peaks of 35 in 1980, 25 in 1982, and 37 in 1986, and back down to 19 in 1987 (the percentage rose from 0% in 1977 to a peak of .98% in 1980, and back to .5% in 1987), and *links* rose from 0 to 7 in 1982 and 1985, with a peak of 14 in 1986, and back down to 4 in 1987. Mean citation *strength* for information science journals citing communication science journals was between 2 and 4, except for a peak of 8.8 in 1980.

Based upon the link and strength results, there was more cross-disciplinary citation by information science to communication journals, and a proportionately greater activity by information science journals in the most recent years of the period studied.

Sources of Cross-Citation

- Over time, which journals in each discipline are the primary sources and receivers of these changes?

Table 6 lists those journals involved in cross-disciplinary citations between communication and information science. A total of 25 of the 57 (43.8%) information science journals and 14 of 20 (70%) of the communication journals were involved in cross-disciplinary citations. The communication journals that most frequently had articles *citing* articles in information science journals were *Journalism Quarterly* (total of 6 links, 8 citations; i.e., *strength* = 8) and *Communication Research* (4, 12). The three communication journals most *cited* by information science journals were *Telecommunications Policy* (13, 65), *Journal of Communication* (14, 65), and *Communication Education* (4, 7). *Telecommunications Policy* is the one journal that appeared in both lists;

TABLE 5. Strength and number of citation links made, within and across communication and library and information science disciplines, 1977–1987.

	Year										
	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
Citation strength											
Comm-Comm	1208	1041	1292	1214	1243	1343	1896	1930	1705	1660	1794
Comm-IS	2	2	1	0	1	0	2	1	1	2	12
IS-IS	2899	2605	3012	3543	3538	3563	3944	3794	4799	4699	4046
IS-Comm	0	11	6	35	6	25	14	4	17	37	19
Percent of citation strength											
Comm-Comm	99.0	99.8	99.9	100	99.9	100	99.9	100	99.9	99.9	99.3
Comm-IS	0.2	0.2	0.1	0	0.1	0	0.1	0	0.1	0.1	0.7
IS-IS	100	99.6	99.8	99.0	99.8	99.3	99.6	99.9	99.6	99.2	99.5
IS-Comm	0	0.4	0.2	1.0	0.2	0.7	0.4	0.1	0.4	0.8	0.5
Mean strength per citation link											
Comm-Comm	25.7	20.4	21.2	18.7	20.4	19.5	20.8	23.5	20.8	19.1	22.4
Comm-IS	1	1	1	0	1	0	2	1	1	1	3
IS-IS	10.9	8.3	7.7	8.1	8.5	7.5	7.8	7	9.1	8.7	7.6
IS-Comm	0	3.7	3	8.8	1.5	3.6	3.5	1.3	2.1	2.6	4.8
Citation links											
Comm-Comm	47	51	61	65	61	69	91	82	82	87	80
Comm-IS	2	2	1	0	1	0	1	1	1	2	4
IS-IS	266	314	390	436	418	474	507	541	530	539	530
IS-Comm	0	3	2	4	4	7	4	3	8	14	4
Percent of citation links											
Comm-Comm	95.9	96.2	98.4	100	98.4	100	98.9	98.8	98.8	97.8	95.2
Comm-IS	4.1	3.8	1.6	0	1.6	0	1.1	1.2	1.2	2.2	4.8
IS-IS	100	99	99.5	99.1	99	98.5	99.2	99.4	98.5	97.8	99.2
IS-Comm	0	1	0.5	0.9	1	1.5	0.8	0.6	1.5	2.2	0.8

TABLE 6. Journals involved in cross-disciplinary citing, with citation direction and strength, 1977–1987.

Year	Library and information science	Citation direction	Communication	No. of citations
1977	AmArc	Cited by	JQuar	1
	LibJ	Cited by	JQuar	1
1978	InfPr	Cites	JComm	6
	LibQ	Cites	JBroa	2
	LibQ	Cites	JComm	3
	RQ	Cited by	JQuar	1
	SpecL	Cited by	JQuar	1
1979	GovPu	Cites	ColJR	1
	JLibs	Cites	ECTJ	5
	Wilso	Cited by	ECTJ	1
1980	ARIST	Cites	JBroa	1
	ARIST	Cites	JComm	9
	ARIST	Cites	TeleP	22
	InfoA	Cites	TeleP	3
1981	ARIST	Cites	JBroa	1
	ARIST	Cites	TeleP	2
	InfTL	Cited by	JQuar	1
	LibJ	Cites	ColJR	2
	LibQ	Cites	PubOp	1
1982	ARIST	Cites	JComm	12
	ARIST	Cites	JQuar	1
	ARIST	Cites	TeleP	2
	BehSS	Cites	HumCo	1
	BehSS	Cites	CenSt	1
	InfoA	Cites	TeleP	5
	JofIS	Cites	TeleP	3
1983	InfPr	Cites	ECTJ	1
	IFLA	Cites	JComm	5

TABLE 6. (continued).

Year	Library and information science	Citation direction	Communication	No. of citations
	JASIS	Cites	JComm	1
	JASIS	Cited by	JComm	2
	JASIS	Cites	TeleP	7
1984	AmArc	Cites	CommE	1
	InfoA	Cited by	Media	1
	Scien	Cites	HumCo	1
	SoSci	Cites	TeleP	2
1985	CRL	Cites	CommE	3
	CRL	Cites	JComm	1
	CRL	Cites	JQuar	2
	Libri	Cites	CommR	1
	Libri	Cites	JComm	4
	Libri	Cites	PubOp	1
	NachD	Cited by	Media	1
	ProAS	Cites	JComm	
	ProAS	Cites	TeleP	
1986	ARIST	Cites	CommR	1
	ARIST	Cites	JBroa	1
	ARIST	Cites	JComm	1
	ARIST	Cites	PubOp	1
	ARIST	Cites	PubRe	1
	ARIST	Cites	TeleP	7
	Dbase	Cites	JComm	4
	GovPu	Cites	JComm	1
	GovPu	Cites	PubRe	1
	GovPu	Cites	QJSpc	7
	GovPu	Cites	TeleP	3
	JLibH	Cited by	CommR	1
	LibQ	Cited by	HumCo	1
	ProAS	Cites	JComm	2
	ProAS	Cites	TeleP	5
	RQ	Cites	CommE	2
1987	ARIST	Cited by	CommR	6
	InfPr	Cited by	CommR	1
	InfPr	Cites	JComm	13
	InfPr	Cites	TeleP	2
	JASIS	Cited by	CommR	4
	LibQ	Cites	CommE	1
	LibQ	Cited by	JQuar	3

we have considered it a communication journal in our analysis, due to the common usage in the discipline and because of the "communications" in the journal title.

The information science journals with the most *citing* to communication were *ARIST* (total of 14 links, 62 citations), *Information Processing & Management* (4, 22), *ASIS Proceedings* (4, 12), and *Government Publications Review* (4, 12). The only information science journals cited by more than one communication journal were *JASIS* (2, 6) and *Library Quarterly* (3, 7).

Thus, the primary "users" of cross-disciplinary communication-information science journal information—that is, those journals that most frequently cite the other discipline's journals—are *Communication Research* and *Journalism Quarterly* in the communication discipline, and *ARIST* and *Information Processing & Management* in the information science discipline. The primary "sources" of cross-disciplinary citations—those that are cited by the other discipline's journals—are *Telecommunications Policy* and *Journal of Communication.*

Integrativeness of Journals in Citation Network. Another network concept potentially useful to bibliometric studies is integrativeness. In the present context, *integrativeness* is the extent to which the other journals with which one journal exchanges citations also exchange citations among themselves. According to diffusion theory, social structures with high integrativeness (interlocking networks) are less likely to be exposed to new information than ones with low integrativeness (radial networks), because their local network is too tightly interconnected to let in much new information (here, citations from other disciplines or subdisciplines). On the other hand, citations relevant to an interlocking network are likely to be shared easily among those journals.

Table 7 lists the integrativeness values for each journal by year. Looking only at the journals that most frequently bridge the disciplines, *Journal of Communication* has a mean integrativeness value of .438; *Communication Research,* .624; *Journalism Quarterly,* .536; *Telecommunications Policy,* .822; *Annual Review of In-*

TABLE 7. Yearly and mean network integrativeness of communication and information and library science journals, 1977–1987.

Journal	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	Means*
Communication journals:												
CenSt	524	762	700	667	733	607	800	667	1000	467	700	693
ColJR	1000	0	333	600	500	667	0	1000	0	500	1000	700
Commu	0	0	900	700	1000	0	1000	0	667	0	0	853
CommE	1000	833	1000	800	900	1000	533	500	393	321	429	701
CommM	533	867	429	700	571	867	857	679	500	700	476	653
CommR	900	1000	800	533	700	528	778	556	400	327	345	624
ECTJ	0	0	0	0	0	0	0	0	0	333	0	333
HumCo	0	0	0	0	700	643	564	528	436	417	472	537
JBroa	800	536	700	524	600	643	952	800	667	364	1000	690
JComm	667	528	467	333	436	556	455	455	318	238	364	438
JTech	0	0	0	1000	0	0	0	500	1000	333	667	700
JQuar	429	571	524	667	429	464	778	619	422	533	464	536
Lang&	0	0	0	0	0	0	0	0	333	833	0	583
Media	0	0	0	1000	0	667	0	500	333	333	1000	639
PubOp	800	867	800	571	476	536	857	643	1000	900	900	759
PubRe	0	0	0	0	0	1000	1000	1000	667	200	0	773
QJSpc	1000	800	467	571	800	750	667	733	571	429	524	665
SpchC	0	0	0	0	0	0	1000	0	1000	500	1000	875
TeleP	0	0	0	1000	0	333	1000	0	1000	600	1000	822
WritC	0	0	0	0	0	0	0	0	500	0	667	584
Information and library science journals:												
AmArc	400	667	691	700	800	667	464	308	306	571	389	542
ARIST	300	413	364	286	455	346	561	317	382	290	308	366
ASLIB	511	362	395	476	509	451	363	359	362	382	484	423
BehSS	0	0	564	0	0	361	536	333	417	1000	333	506
BMedL	470	549	486	566	544	536	400	342	456	474	444	479
CanJI	0	576	0	533	333	1000	333	0	0	583	321	526
CanLi	571	576	381	533	686	596	500	403	348	341	457	490
CRL	374	428	591	449	495	562	435	403	338	387	434	445
Dbase	0	0	857	806	619	711	618	361	571	545	371	607
Drexe	379	462	485	527	578	490	517	407	305	576	606	485
EdFor	0	0	0	0	0	0	0	470	324	333	393	380
ElecL	0	0	0	0	0	0	0	0	700	462	440	534
GovIn	0	0	0	0	0	0	0	867	500	700	0	689
GovPu	600	545	530	733	582	462	464	314	218	284	373	464
IFLA	800	381	333	417	600	321	419	368	476	470	390	452
InfoA	0	0	0	1000	0	0	0	0	333	0	0	667
InfPr	333	533	515	712	520	636	408	470	412	458	257	478
InfTl	556	385	404	457	536	629	441	500	444	762	694	528
InfTe	0	0	0	0	0	0	607	733	491	516	0	587
Inter	0	0	0	667	0	0	308	444	607	353	333	452
Intcl	321	1000	464	577	393	474	400	500	778	527	436	534
IntFo	1000	400	476	800	700	394	486	145	458	462	571	536
IntLi	448	475	438	410	514	543	420	416	419	468	495	459
JAcam	1000	833	545	652	614	523	495	526	453	395	407	586
JDocu	417	367	333	448	497	391	354	298	386	471	438	400
JEdLi	500	654	583	549	792	522	569	500	463	552	634	574
JofIS	536	0	655	366	682	441	379	353	492	517	405	483
JLibs	491	472	404	398	583	505	449	476	362	464	495	464
JLibH	571	800	652	722	727	576	418	399	392	425	652	576
JASIS	392	444	377	384	461	396	318	325	339	373	357	379
LawLi	867	524	444	476	600	733	500	417	571	457	689	571
L&ISR	0	0	0	0	0	0	0	523	500	509	543	519
LibAc	0	0	1000	667	600	611	528	514	641	667	575	645
L&IS	600	0	0	0	0	0	462	359	374	429	604	471
LibJ	571	603	481	462	660	596	458	420	550	450	379	512
LibQ	515	571	560	658	642	529	575	500	571	515	490	557
LibR&	444	450	407	359	428	432	382	421	474	346	464	419
LibTr	433	582	558	528	473	430	412	443	361	451	386	460
Libri	358	325	395	458	400	593	338	399	304	468	409	404
NachD	286	417	321	410	487	412	438	346	397	412	394	393
Naucl	167	1000	667	476	333	533	429	333	667	429	800	530

TABLE 7. (continued).

Journal	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	Means*
Nauc2	321	400	500	1000	667	500	643	533	400	500	306	525
Onlin	0	1000	600	549	636	590	606	551	451	503	456	594
OnliR	489	1000	439	467	438	567	379	495	433	493	417	511
ProAS	0	643	500	392	591	428	429	434	293	441	583	473
ProgA	0	500	583	606	615	606	409	269	462	385	564	500
RevPu	0	0	0	0	0	1000	0	0	0	0	0	1000
RQ	361	453	342	448	731	532	505	470	345	406	421	456
Schol	0	0	333	533	300	429	429	500	533	533	600	466
Scien	0	0	667	528	422	381	353	221	327	333	300	392
Seria	1000	429	429	1000	0	475	611	410	439	485	517	580
SoSci	0	0	0	0	0	333	1000	833	667	1000	1000	806
SoScS	0	0	0	0	0	667	750	389	429	0	0	559
SpecL	448	497	514	533	480	489	411	403	451	471	500	472
Wilso	583	591	576	636	629	756	483	564	560	667	495	595
ZeitB	333	167	0	500	300	333	500	306	361	467	474	374
ZentB	333	500	1000	667	0	500	476	485	300	464	381	511

*To control for the effect on integrativeness of those years in which a journal made or received no citations, the mean integrativeness is based upon only nonzero values.

formation Science and Technology (*ARIST*), .366; *Information Processing & Management,* .478; and *Libri,* .404. Thus, because of their cross-disciplinary citations and their lower integrativeness scores, *Journal of Communication, ARIST,* and *Information Processing & Management* are the primary potential (though still small) sources for scientific information about relevant theories, methods, results, and issues of concern to the two disciplines. In addition to being the most-cited communication journal by information science journals, the *Journal of Communication* is also a key bridge journal within communication (Paisley, 1984, 1986; Reeves & Borgman, 1983; Rice, Borgman, & Reeves, 1987; So, 1988). *Telecommunications Policy* is more frequently cited by information science journals, but has a relatively high integrativeness score. *ARIST* is an annual review series, as the title indicates, that covers a broadly defined scope of information science. Each *ARIST* chapter has an extensive reference list, so it is a likely source of cross-citation as well as a visible recipient for citations.

In summary, the combination of the three measures of citation—links, citation strength, and integrativeness—indicate that the *Journal of Communication, Telecommunications Policy, ARIST,* and *Information Processing & Management* are the most influential journals at the nexus of information science and communication. These data confirm the placement of *Telecommunications Policy* in both *SSCI®* core lists. In terms of number of citations, information science journals are considerably more active in using communication sources than vice-versa, while a higher proportion of the communication journals (14 of 20; 70%) are involved in cross-disciplinary citation than are the information science journals (25 of 57; 43.8%).

Discussion

Our results show that we were not able to identify as much evidence of convergence between the disciplines of information science and communication as we expected, as indicated by citation patterns among the 77 journals of those two disciplines from 1977–1987, although there are some slight trends. These results are based, of course, on the data that can be gleaned from the *SSCI®Journal Citation Reports,* which necessarily underestimate the true amount of citation among a set of journals. Many citation data are unavailable due to the varying year-by-year coverage of journals over such a long study, and to the aggregation of journals making small numbers of citations into the "other" category (see footnote 1). The numbers of citations between the two disciplines are relatively small, and results are thus more susceptible to measurement problems caused by the aggregation of citations. Stronger trends may exist than can be identified by the available data collection methods.

The data show that the matrices are fairly stable from 1977–1987, suggesting that these are maturing disciplines that are settling into some patterns. The correlation measures exhibit about a two-thirds change in variance from one year to the next, indicating that change is occurring. While there are periods of higher correlations (stability in patterns of citation flows), the patterns in subsequent years become increasingly different from the 1977 pattern, and the years in the last half of the period seem more similar to each other than to the years in the first half of the period.

The number of journals involved in cross-disciplinary citing between communication and information science stayed nearly constant, with a small growth in

1986 and 1987. There is considerably more cross-disciplinary citing originating in information science journals in terms of numbers of citations, though fewer in terms of proportion of journals participating. The links can be traced to a few journals in each discipline, with an increasing number over time. The primary journals involved in citing and being cited across disciplines include *Journal of Communication, Telecommunications Policy, Annual Review of Information Science and Technology,* and *Information Processing & Management.*

Some portion of the citations from information science to communication may be due to information science faculty holding communication doctorates and publishing in both literatures. Another explanation is that each of the two disciplines has a number of specialties within it (Hayes, 1983; Reeves & Borgman, 1983; Rice, Borgman, & Reeves, 1988; Saito, 1984; So, 1988), and citation patterns may vary within each (Barnett & Fink, 1989; Hayes, 1983). A more microlevel analysis of citation patterns within these disciplines may identify clusters both within and across specialties, and from certain specialties outward. When scholars branch out for a citation, it may only be from one specialty to another within the same field. Hayes' (1983) finding that L&IS faculty claiming information science specialties had the highest publication and citation rates in the field indicates that there is more activity here, and is likely the specialty contributing the most to citation across the two disciplines.

As a test of awareness of publications of interest to both disciplines, we ran an *SSCI®* citation search on a bibliometric study appearing in a communication journal. Our test case was Reeves and Borgman (1983), the first bibliometric study of communication known to appear in the communication literature since Parker, Paisley, and Garrett (1967). As of the 1990 *SSCI®* cumulation (covering journals through 1989), there were 23 citations to Reeves and Borgman (1983), 20 of which were in communication or advertising journals, one in a management journal, one a 1984 entry in a bibliography of bibliometric studies published in *Scientometrics,* a core information science journal, and one in the 1989 *ARIST,* an annual review series. Thus, this work has come to the attention of communication researchers, but has been little used (based upon the formal indicator of being cited) by those in information science, who are far more active in bibliometric research.

In comparing the present results to those of the earlier studies that did not identify cross-citation between communication and information science (Barnett & Fink, 1989; Paisley, 1984, 1986, 1990a; So, 1988) note that all of them used much smaller datasets, typically from one to three years of data, and that all except So (1988) utilized data prior to the time (1983) when the small changes in yearly patterns identified here began to occur. Paisley (1986) found several concepts originating in communication appearing in information science journals in 1973–1982, but his dataset was too sparse to identify the citation patterns that supported the transfer. Our data may begin to shed light on the paths these ideas have taken in moving from one discipline to the other.

Conclusions

Some citation relations between the disciplines of communication and information science do occur, and they seem to be increasing slightly over the 1977–1987 period. There is also a slight shift to a less transitive (or more open) structure, and a consistently small but increasing pattern of citation from information science to communication, as identified with conservative data collection methods. We note also that a larger proportion of communication than information science journals is involved in citations between these two disciplines.

While we found less evidence of cross-citation between communication and information science than we had expected, given the ideas and scholars crossing between them, we are encouraged by the positive direction of the trend. Large-sample bibliometric studies such as this one are dependent upon the available body of *SSCI®* citation data, which is designed more for identifying large trends rather than subtle ones. Given that we were able to identify fairly subtle trends with the available data, we expect that more activity exists between these disciplines than can be exposed by these methods. We encourage others to pursue these research questions through bibliometric and other techniques and follow the path of what may be a most interesting convergence of two fields, as they have much to offer each other as sources of new ideas and new scholars.

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