Mapping the Intellectual Structure of MIS, 1980–1985: A Co-Citation Analysis

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Abstract

This study is the second of two studies which assess the intellectual development of MIS. The present study documents the current intellectual structure of MIS research based on an author co-citation analysis. Five invisible colleges, or informal clusters of research activity, were identified (foundations; psychological approaches to MIS design and use; MIS management; organizational approaches to MIS design and use; and curriculum). When contrasted with the earlier study, these results suggest that MIS has made significant progress toward a cumulative research tradition.

Introduction

Within the domain of MIS, researchers cluster into informal networks or "invisible colleges" which tend to concentrate on examining common questions in common ways [34]. Research contributions by one member of the network are picked up by another member to be extended, tested, and refined. Through this process, one person's work builds on that of another; theories advance and compete until paradigms emerge. The existence of paradigms is one indication of a discipline's maturity. The history of the exchanges between members of these networks in the field, revealed through patterns of citation, document the intellectual history of the field.

While *doing* research is essential if a field is to establish a cumulative tradition, it is also important to step back periodically and think about the research which constitutes a field. Even new fields like MIS have a sense of history; those which cut themselves off from curiosity and reflection are likely to atrophy [22]. By understanding the intellectual roots of MIS, as represented by citation practices, for example, we can also identify the basic intellectual commitments which serve as the foundations for MIS as it matures. Additionally, publication and citation practices provide an empirical basis for socializing the newest members in the field by transmitting professional norms for scholarship.

This article is the second in a series of studies which investigated the intellectual development of MIS. Both this study and its predecessor [6] use citation analysis to identify the subfields which together comprise the domain of MIS research. By building on the first study, the present article will identify MIS research subspecialties which have emerged between 1980 and mid-1985.

Background

A number of prior studies have reflected on MIS as an academic discipline. Assessment of MIS as a field, from both an historical and a "forward-looking" perspective, served as one important theme for the First International Conference on Information Systems (ICIS) in 1980. This conference and many subsequent studies [17, 18, 19, 31], both conceptual and empirical, have examined the relation-

ship of MIS to its reference disciplines. The approach taken by much of the empirical research in this tradition has been to analyze citations contained in MIS articles published in MIS core journals. These citation counts were then used to measure communication between MIS and its reference disciplines. These studies are reviewed in Culnan [6] and Culnan and Swanson [7].

The present study and its predecessor [6] differ substantially from prior research in that they attempt to develop an intellectual mapping of MIS based on citation patterns. The first study used citations in MIS research published between 1972–1982. As a result, its perspective was essentially historical in nature. The study identified nine informal clusters of research:

- Foundations/Management Theory
- Systems Science
- Computing Impacts/Local Government
- MIS/DSS Implementation
- Individual Differences
- Human Factors
- Computer Conferencing
- two other clusters were unnamed

The first four clusters appeared to represent early MIS research themes which remained popular into the early 1980's.

This first citation analysis was intended as a benchmark for future research. The current study builds on that benchmark study and attempts to provide a current assessment of the structure of MIS research by focusing on research published between 1980 and mid-1985. The study will identify changes in MIS research interests by addressing the research question, "What intellectual subfields characterize *current* MIS research?" In addition, the study will compare the results of this study to those of the previous study in order to assess the progress MIS has made toward establishing a cumulative research tradition [22].

Research of this type has important implications for both academics and practitioners. First, the research can provide a vehicle for promoting communication between academics and practitioners. Given the applied nature of MIS, some academic MIS research should address issues of concern to MIS practitioners. This research identifies current MIS research themes and provides an oppor-

tunity for both practitioners and academics to assess the extent to which academic research is keeping pace with the issues identified here and elsewhere as being of concern to MIS management [3, 5, 13, 20]. The structure of MIS academic research will also influence the issues being taught to future MIS managers in graduate and undergraduate programs as academics bring their research interests into the classroom. As will be shown subsequently, curriculum issues have emerged as a distinct theme.

This type of research also has important implications which are solely academic. Given the changing nature of information technology and the youthful state of MIS as an academic discipline, it is important to track the state of our development on an ongoing basis. This tracking provides a better understanding of the relationship of MIS to its reference disciplines, as well as to understand how our research reflects changes in the ways organizations interact with the technology. Research such as the present study serves an especially important function in providing a guide to scholarship in MIS for doctoral students and researchers in other fields. Furthermore, studies of this type demonstrate that the conventional wisdom about the structure of MIS is not necessarily supported by empirical evidence.

Methodology

This research was conducted as a co-citation study. Co-citation analysis is a form of bibliometrics or quantitative bibliography [35]. Bibliometrics generally involves counting citations to other publications in a body of literature and using these counts to develop statistical distributions. The utility of bibliometrics as a research methodology is predicated on the assumption that bibliographic citations are an acceptable surrogate for the actual influence of various information sources on a research project. In fact, much that is read is not cited, and citation behavior can be biased by the accessibility or nonaccessibility of a particular item. Nonetheless, citations are a measure of scholarly dependence upon previous work. As a form of measurement, bibliometrics is attractive because it is unobtrusive [15]. Analysis always occurs after a paper has been published and without any direct contact with the author.

The development of the specific methodology employed by this study is described in detail in White and Griffith [41]. Co-citation analysis is a form of document coupling which measures the number of documents that have cited any given pair of documents [37]. The co-citation of authors results when a researcher cites any work of any given author along with the work of any other author in a new document. Authors whose works are generally seen to be related and are repeatedly cited together in subsequent publications tend to cluster together when mapped, while authors who are rarely or never cited together do not. It should be emphasized that this mapping is based on the composite judgement of hundreds of citers, rather than on the judgement of a small group of experts. It is, therefore, *the field's view of itself*. Co-citation analyses are dynamic over time as co-citation frequencies to particular works change with shifts in the focus of research efforts in a field.

Co-citation analysis has the potential to yield three insights concerning MIS. First, prior work has indicated that the clusters formed by "this particular type of citation analysis . . . provides(s) a usefully accurate picture of the intellectual nature of the speciality, the rate and direction of its evolution, and the number and identity of its key people" [15, p. 134]. Second, co-citation analysis may be used to document the development of paradigms. Where a paradigm exists, ideological consensus should also be found as documented by widespread citation to the key theoretical works underlying the paradigm [39]. Third, changes in co-citation patterns over time may be used to document the scientific revolution that precedes the emergence of a new paradigm [24].

This study uses sets of documents associated with the names of 42 MIS researchers who are either first or single authors as the unit of analysis. The study, then, is a co-cited author analysis based on citation counts appearing during the period 1980 through mid-1985. This five year period represents an important time in the relatively brief history of MIS, even though there is a small degree of overlap between the data for this study and the first study [5]. The first International Conference on Information Systems (ICIS) was held in 1980. Because the 1980 ICIS was the first academic conference devoted solely to MIS

research, it represents an important milestone in the field's progress toward becoming a mature academic discipline.

Here, as in the prior study, "author" refers to *a body of writings* by a person, not to an individual. Individuals, then, are used as surrogates for the ideas represented by their publications. Citation of an individual is, in reality, citation to the ideas contained in the author's publications [38].

Data were collected from the online *Social Sciences Citation Index* (*SSCI*) database. Unlike some prior studies, data were not drawn from a sample of journals chosen by the researcher. Instead, the entire SSCI database served as the universe for conducting the co-citation analysis. Rather than being limited only to journals known to regularly publish MIS research, the data include citations to MIS research published in a wide range of journals. It should be noted that the *SSCI* is created by indexing references to publications by year in which the citation *appeared*, independent of the year that the cited work was *published*.

The *SSCI* includes citations published in over 4,000 journals, providing full coverage of over 1,400 social science journals and selective coverage of over 3,200 technical journals. Which technical articles are selected for inclusion is determined by the citation patterns of the respective articles. For example, the SSCI provides selective coverage of eight journals published by the ACM, and 25 journals published by the IEEE.

If any type of literature is underrepresented in the *SSCI*, it is literature devoted solely to MIS, as four of the MIS publications identified by Hamilton and Ives [18,19] are not covered (*Data Management*, *Data Base* (*ACM*), *Infosystems* and *Information and Management*). The *MIS Quarterly*, *Datamation* and the *Journal of Systems Management* are fully covered by the *SSCI*.

The sample of authors used in the study was developed from two sources. In the prior study, the findings included identifying authors whose work continued to be cited after 1980 (For more detailed information, the reader is referred to Table 5 in the prior study). Based on actual citations, it was believed that these authors continued to repre-

Table 1. MIS Authors by Sub-Field, 1972–1982

Factor 1 Foundations/ Mgmt Theory	Factor 2 Systems Science	Factor 3 Computing Impacts	Factor 4 MIS/DSS Implement.	Factor 5 Individuals Differences
Nolan	Mitroff	Kraemer	Alter	Mock
Anthony	Mason	Dutton	Ginzberg	Chervany
Dearden	Ackoff	Danziger	Carlson	Dickson
Ein Dor	Churchman	Kling	Keen	Davis
Kriebel	McKenney	Whisler	Zand	
Davis	Hoos		Robey	
Couger	Howard		Swanson	
King, W.	Lucas		Lucas	
Withington	King			
Rockart				
Gorry				
Lucas				
Hax				
Swanson				

Note: Results based on a varimax rotation 9-factor analysis. Subsequent analysis determined that these 5 factors best reflected the early roots of MIS. These factors subsequently provided the starting point for designing the sample for this study. The factor loadings for the individual authors and the Eigenvalue and percentage of variance accounted for by factor are available in Culnan [6].

sent current MIS research topics, and these authors then provided a starting point for drawing the sample for the current study (authors are shown in Table 1). Next, the author index of the second edition of Davis and Olson [12] was examined, as "textbooks expound the body of accepted theory" in a field [24]. All authors receiving five or more references in the author index to this book were added to the list. Other MIS texts were examined, but none contained an author or name index.

Finally, this new list was sent to a number of leading MIS researchers representing different research interests who were asked to modify the list through deletions or additions so that the resulting list would be representative of current MIS research issues. Their suggestions are reflected in the final list which is shown in Table 2. The *pool of ideas* represented by the authors in Table 2 is representative of the MIS field for the time period of the study. This is particularly true because this study, unlike its predecessor, includes a number of the "younger" researchers who began publishing in the late 1970's. Individuals who do not find their names listed in Table 2 should nonetheless find that the ideas repre-

sented by their work are reflected in this study through their co-citation of the individuals in the sample.

Table 2. Authors Selected for Co-cited Author Analysis

Ackoff, R.	Konsynski, B.
Alter, S.	Kraemer, K.
Anthony, R.	Kriebel, C.
Benbasat, I.	Lucas, H.
Boland, R.	McFarlan, F.W.
Carlson, E.	McKenney, J.
Chen, P.	Markus, M.L.
Chervany, N.	Mason, R.
Couger, J.D.	Mumford, E.
Davis, G.	Munro, M.
Dickson, G.	Nolan, R.
Ein Dor, P.	Nunamaker, J.
Ginzberg, M.	Olson, M.
Gorry, G.A.	Robey, D.
Huber, G.	Rockart, J.
Ives, B.	Sprague, R.
Jenkins, A.M.	Swanson, E.B.
Keen, P.	Weber, R.
King, J.	Wetherbe, J.
King, W.	Whinston, A.
Kling, R.	Zmud, R.

Each of the 42 authors in Table 2 were paired with each other and the co-citation frequency of each pair was computed from the online *SSCI*. For example, searching the database for papers citing Alter and Benbasat would yield the number of articles in the *SSCI* database which cited at least one work by Alter and at least one work by Benbasat. There were two exceptions to the procedure. In the case of Anthony and Ackoff, only citations to a single work by each author were counted [1,2].

The works of Anthony and Ackoff provided a foundation for much of the contemporary MIS theory and continue to be cited [6]. It is therefore important that they be included to maintain a sense of continuity with the past. However, because MIS is not the home discipline for these individuals who publish extensively and are widely cited, it was feared that including all of their work could potentially skew the results of the study. This was the case in the prior study.

The notation used to retrieve a citation to a specific paper in the *SSCI* makes it difficult to ensure the accuracy of such a search for all but the most heavily cited works. Specific works are indexed by publication year and journal code, and variously the volume number and specific page cited. In addition to the problems involved in selecting an initial pool of important documents which accurately represent the MIS field, the technical issues associated with document searching make it very difficult to insure that all citations to a particular paper will be retrieved. Further, it is likely that recent papers by younger authors will have received so few citations (due to publication lags), that these papers will fail to load when mapped. Hence, the document co-citation method was only used for two authors, Anthony and Ackoff, for the reasons stated above.

The result of the *SSCI* search was a 42 x 42 matrix of co-citation counts. The diagonals were computed by taking the three highest intersections for each author and dividing by two, thereby indicating, in a general way, the relative importance of a particular author within the field [41]. This matrix was used for subsequent statistical analysis and is shown in the Appendix.

Results

The matrix of raw co-citation counts was factor analyzed using a varimax rotation and these results are shown in Table 3. Based on a scree test, five factors resulted. These five factors account for 70.8% of the variance. Five authors loaded on three factors (Alter, EinDor, Ginzberg, Mason and Robey) and nineteen authors loaded on two factors.

Three authors (Kriebel, Weber and Whinston) failed on load on any of the five factors. This is attributed, in part, to weak co-citation links with the other authors in the sample. In a prior study on macroeconomics, all 41 authors had mean co-citation rates of 5.0 or greater [29]. Here, these three authors had co-citation rates of 1.0 or less. The indexing techniques employed by the SSCI may have contributed to these results as the SSCI only indexes multi-authored articles by first author. If these individuals publish primarily as a second author, these citations will not be retrieved unless the search is conducted using the first authors' names. It should be noted, however, that in the default 9-factor solution, these three authors each loaded unambiguously on three different factors (Kriebel with McFarlan and Nolan; Weber with Benbasat, Chervany, Dickson, Davis and Zmud; Whinston with Dickson and Chervany) suggesting that the *ideas* represented by these individuals' publications are nonetheless represented by the study.

For each of the five factors, a bibliography of source papers was compiled from the online *SSCI*. This was accomplished by retrieving all articles for each factor which co-cited at least two of the authors for a given factor. For example, for Factor 1, any published article citing one work by Sprague and one work by Keen would be included. For each source article, the complete bibliographic citation for the *citing* article as well as a list of *all works cited by* the source article was printed. The results from this procedure were five bibliographies, one for each factor. The format of the bibliographies corresponds to the Source Index of the printed *SSCI*. The five bibliographies included a grand total of 281 source articles. These 281 articles were published in a wide range of journals. *MIS Quarterly*, *Communications of the ACM*, and *Management Science*, accounted for 21% of the source articles. The

Table 3. Author Factor Loadings (Varimax Rotation) at .40 or Higher

Factor 1 Foundations		Factor 2 Individual (Micro) Approaches to MIS Design & Use		Factor 3 MIS Management		Factor 4 Organizational (Macro) Approaches to MIS Design & Use		Factor 5 MIS Curriculum	
Sprague	.82	Ives	.87	Rockart	.82	Kling	.89	Nunamaker	.85
Keen	.79	Swanson	.85	Murno	.79	Kraemer	.87	Couger	.80
Carlson	.73	Zmud	.78	Chen	.74	King, J.	.86	Wetherbe	.52
Alter	.72	Lucas	.76	Nolan	.74	Mumford	.78		
Benbasat	.70	Boland	.71	Konsynski	.68	Markus	.71		
Huber	.69	King, W.	.67	Davis	.67	Olson	.62		
Mason	.69	Robey	.65	Ackoff	.65	Robey	.45		
McKenney	.68	Ginzberg	.62	Anthony	.64				
Dickson	.65	Dickson	.68	McFarlan	.49				
Gorry	.65	Ein Dor	.57	Wetherbe	.45				
Chervany	.58	Benbasat	.56						
Zmud	.58	Jenkins	.50						
Ginzberg	.50	Mason	.49						
Konsynski	.46	Chervany	.47						
Davis	.46	Markus	.40						
Lucas	.44								
Robey	.42								
Anthony	.41								
Ein Dor	.40								
Eigenv.	15.43		5.80		3.81		2.77		1.93
% Var.	36.7		13.8		9.1		6.6		4.6

source articles were also drawn from ten other computer science/engineering publications, including four journals published by the IEEE, and nine other journals which publish management science research.

As would be expected, a wide range of management, behavioral science and other social science journals are also represented. Nearly half of these papers co-cited two or more authors from more than one factor (papers co-citing one factor (n = 149), two factors (n = 88), three factors (n = 37), four factors (n = 7)). The Appendix to this paper contains references to all *co-cited* works which were cited ten or more times by factor.

The factors in Table 3 were named by the researcher based upon a general assessment of the research areas represented collectively by the individuals loading on each factor, as well as the topics of the co-cited papers included in the Appendix. After this was com-

pleted, a senior MIS researcher at another institution who had participated in the sample design was asked to name the factors using Table 3 without factor headings. There was complete agreement between the author and the second individual for all five factors.

The first factor in Table 3 appears to define the foundations of current MIS research with a strong DSS focus, as the factor is defined by Sprague, Keen, Carlson and Alter. Three MIS frameworks (Anthony, Gorry & Scott Morton, and Mason & Mitroff) and research on MIS implementation also load on this factor, as well as a classic MIS text by Davis [10].

Factor 2 is defined by Ives, Swanson, Zmud and Lucas, and appears to represent behavioral research on MIS design, implementation and use. Many of the highly cited papers in this factor are characterized by a "micro" perspective on MIS, focusing on individual differences.

Factor 3 represents MIS management, as well as a more technical approach to MIS, as this factor is defined by Rockart, Munro, Chen and Nolan. Factor 4 includes research on the social and organizational aspects of MIS design, implementation and use, and is defined by three scholars from the same institution (Kling, Kraemer and J. King, all of the University of California, Irvine). While there is some overlap between Factors 2 and 4, Factor 4 appears to represent a more "macro" approach to MIS. It does not include any experimental MIS research or the research on individual differences. Factor 5 represents MIS curriculum issues.

Discussion

The primary goal of this study was to provide an understanding of the current intellectual structure of MIS. Because this study updates a prior study, these results taken together provide a unique opportunity to assess the extent to which MIS has matured as an academic field since it was established in the late 1960's.

Progress toward a paradigm for MIS?

The results of this study suggest that while MIS is still pre-paradigmatic, it has made progress (if one accepts the argument that MIS, like all social sciences, is a multiple paradigm discipline) [25, 36]. Ritzer [36], for example, defines sociology in terms of three basic competing approaches to research, each approach characterized by an exemplar or defining work, images of the subject matter, theories and methods. In MIS, Factor 2 (behavioral approaches) and Factor 4 (computing impacts) appear to represent the use of alternative levels of analysis by focusing on the individual (micro) versus the organizational (macro) approaches to IS design and implementation respectively. These approaches parallel alternative approaches to research in organizational theory and behavior [32]. Further, each of these factors represents a consolidation of two factors from the prior study.

Since MIS may be defined in terms of an organizational subsystem [12, 21], it may be unrealistic to ever expect MIS to resemble the natural sciences as long as the focus of our inquiry consists of ill-structured phenomena. This study, like a previous study of organizational behavior [8], provides some empirical support for Martin's garbage can model of organizational research characterized by a "loose collection of ideas, rather than a coherent structure having a shared intellectual paradigm" [27, p. 22]. Research in this tradition is likely to deal with messy problems, requiring complex models and greater language variety than research in more highly structured, technical fields [9, 27]. This would seem to be an appropriate characterization of MIS research as well, given that here even research on information technology (Factor 3) has an organizational focus.

Comparisons with the prior study

Comparing these results to the results of the prior study provides another way of measuring the progress MIS has made toward intellectual maturity. Factor 1 continues to represent the foundations of MIS research for the time period covered by the study, bringing together managerial, behavioral and technical approaches to MIS, as well as the important MIS frameworks (Gorry & Scott Morton [16]; Anthony, [2]; Mason & Mitroff, [28]). Management of MIS emerges here as a separate factor (Factor 3) while in the first study, it was combined with Factor 1. MIS/DSS implementation existed as a separate factor in the first study. Here, this research has merged with other factors. Factor 1 (MIS Foundations) is dominated by DSS research (Sprague, Keen, Carlson and Alter), providing empirical support for current definitions of MIS in terms of providing support for decision-making [12].

"Micro" (Factor 2) and "Macro" (Factor 4) approaches to MIS research exist in both studies and also reflect the research of some of the "younger" members of the profession. The curriculum factor is new to this study. Concern with curriculum issues suggests that MIS is moving forward as an independent academic discipline [24]. Finally, it is important to note that none of the factors are defined by "technology." While new technology may have provided the original environment for MIS [13], current MIS research, as represented by this study, has a definite organizational flavor.

When the lists of most cited papers from the two studies are compared, nine papers appear in both studies (Anthony [1], Ackoff [2], Davis [10], Gorry & Scott Morton [15], Keen & Scott Morton [23], Lucas [26], McKenney & Keen [28], Mason & Mitroff [30], Swanson [40]. In addition, the Minnesota Experiments are represented by a different paper in each of the two studies. It is suggested that these works define the modern foundations of MIS. The fact that a core of key papers continues to be cited also suggests that MIS is making progress toward a cumulative research tradition [22].

Where is MIS research published?

Published journal articles represent only one means by which research results are communicated to others in a discipline. (It is important to recall here that the *SSCI* coverage of *citing* publications does not extend to books nor conference proceedings.) Prior research [17] identified 37 major journals in the MIS discipline, including both MIS journals as well as journals from the MIS reference disciplines which publish MIS articles. When the 281 *citing* articles which provide the data for this study are analyzed by journal where the article was published, only 126 (45%) of these articles are published in these 37 core journals. This large degree of scatter may be attributable to several factors.

First, MIS and most of its reference disciplines, such as management and behavioral science, are characterized as "low paradigm" fields [25, 33]. The degree of paradigm development in a field subsequently influences publication practices [4]. Journals in low paradigm fields generally publish fewer, longer articles due to lack of consensus over vocabulary and a greater variance in the ways that a given idea may be expressed. As the MIS field continues to grow and publishing remains a requirement for promotion and tenure, MIS researchers are likely to seek publication outlets beyond the traditional core.

Second, MIS is, by definition, an interdisciplinary field [11]. It is expected that MIS research will continue to appear in journals representing the various MIS reference disciplines. Over time, the maturity of MIS may, in part, be measured by the extent to which this research accumulates [22]. Applied MIS

research also has relevance for practice in a wide variety of field, and this use for MIS research is also reflected in the journals where MIS research is co-cited. For example, articles on DSS appear in journals on the subjects of program evaluation, higher education management, and nursing administration, to name just a few. This raises the issue of where MIS research will be based in the future. It has been suggested that MIS may be emerging from its reference disciplines into an independent, coherent field, based on citations to both the MIS literature and the reference disciplines [7]. Whether this trend continues is a question for future research. Given changes in the ways that organizations apply information technology (e.g. end-user computing, MIS for competitive advantage), MIS may continue to emerge as an independent field, or we may see MIS concepts being diffused back to and integrated with the various management and related disciplines.

Conclusion

The results of this study have implications for both academics and practitioners. The emergence of MIS management issues (Factor 3) as a distinct research sub-field should encourage MIS practitioners that these important issues have come to represent a major thrust of MIS research. The growing interest in competitive information systems within the academic community, and the fact that aligning MIS with an organization's business goals has emerged as a top MIS management issue in two recent surveys published in the *MIS Quarterly* [5, 20] suggest that it is reasonable to expect future MIS research to continue to address important managerial issues.

The results of this study also provide some counter-intuitive findings regarding the role of technically oriented research and theory within MIS. In this study, no factors are defined by technical research, despite the fact that technical journals are well-represented both in the *SSCI* and in the pool of source articles for the study. While technology and technical issues may have once been central to MIS, the empirical evidence provided by this study suggests that current MIS research has a strong organizational and managerial focus. A similar comment also applies to some individual publications. While people may have assumed that a given publication is influential,

this assumption is not always supported by actual citation patterns. The challenge in designing future research will be to accurately capture the changing mix of research areas and scholars that comprise the interdisciplinary, ever-changing field of MIS at any given point in time.

References

1. Ackoff, R.L. "Management Misinformation Systems." *Management Science*, Volume 14, Number 4, December 1967, pp. B147–156.
2. Anthony, R.N. *Planning and Control Systems: A Framework for Analysis*. Harvard University Press, Cambridge, Massachusetts, 1965.
3. Ball, L. and Harris, R. "SMIS Members: A Membership Analysis," *MIS Quarterly*, Volume 6, Number 1, March 1982, pp. 19–38.
4. Beyer, J.M. "Editorial Policies and Practices Among Leading Journals in Four Scientific Fields," *Sociological Quarterly*, Volume 19, Winter 1978, p. 68–88.
5. Brancheau, J. and Wetherbe, J.C. "Key Issues in Information Systems — 1986," *MIS Quarterly*, Volume 11, Number 1, March 1987, pp. 23–45.
6. Culnan, M.J. "The Intellectual Structure of Management Information Systems, 1972–1982: A Co-citation Analysis," *Management Science*, Volume 32, Number 2, February 1986, pp. 156–172.
7. Culnan, M.J. and Swanson, E.B. "Research in Management Information Systems, 1980–84: Points of Work and Reference," *MIS Quarterly*, Volume 10, Number 3, September 1986, pp. 289–301.
8. Culnan, M.J., O'Reilly, C.A. and Chatman, J.A. "Mapping the Intellectual Structure of Organization Behavior, 1972–1984: A Co-citation Analysis," Presented at the Academy of Management National Meeting, Chicago, Illinois, August 1986.
9. Daft, R.L. "The Evolution of Organizational Analysis in *ASQ*, 1959–1979," *Administrative Science Quarterly*, Volume 25, Number 4, December 1980, pp. 623–636.
10. Davis, G.B. *Management Information Systems: Conceptual Foundations, Structure and Development*. McGraw Hill, New York, New York, 1974.
11. Davis, G.B. "The Knowledge and Skill Requirements for the Doctorate in MIS," *Proceedings of the First International Conference on Information Systems*, Philadelphia, Pennsylvania, December 1980, pp. 174–186.
12. Davis, G.B. and Olson, M.H. *Management Information Systems: Conceptual Foundations, Structure and Development*, 2nd Ed. McGraw Hill, New York, New York, 1985.
13. Dickson, G.W. "Management Information Systems: Evolution and Status." *Advances in Computers*, Volume 20, Academic Press, New York, 1981, pp. 1–37.
14. Dickson, G.W., Leitheiser, R.L., Wetherbe, J.C. and Nechis, M. "Key Information Systems Issues for the 1980's," *MIS Quarterly*, Volume 8, Number 3, September 1984, pp. 135–160.
15. Garfield, E. *Citation Indexing*, Wiley, New York, New York, 1979.
16. Gorry, G.A. and Scott-Morton, M. "A Framework for Management Information Systems," *Sloan Management Review*, Volume 13, Number 1, Fall 1971, pp. 55–70.
17. Hamilton, S. and Ives, B. "Communication of MIS Research: An Analysis of Journal Stratification," *Proceedings of the First International Conference on Information Systems*, Philadelphia, Pennsylvania, December 1980, pp. 220–232.
18. Hamilton, S. and Ives, B. "Knowledge Utilization Among MIS Researchers," *MIS Quarterly*, Volume 6, Number 4, December 1982, pp. 61–77.
19. Hamilton, S. and Ives, B. "The Journal Communication System for MIS Research," *Data Base*, Volume 14, Number 2, Winter 1983, pp. 3–14.
20. Hartog, C. and Herbert, M. "1985 Opinion Survey of MIS Managers: Key Issues," *MIS Quarterly*, Volume 10, Number 4, December 1986, pp. 351–362.
21. Ives, B., Hamilton, S. and Davis, G.B. "A Framework for Research in Computer-based Management Information Systems." *Management Science*, Volume 26, Number 9, September 1980, pp. 910–934.
22. Keen, P.G.W. "MIS Research: Reference Disciplines and Cumulative Tradition,"

Proceedings of the First International Conference on Information Systems, Philadelphia, Pennsylvania, December 1980, pp. 9–18.

23. Keen, P.G.W. and Scott-Morton, M. *Decision Support Systems: An Organizational Perspective*. Addison Wesley, Reading, Massachusetts, 1978.

24. Kuhn, T.S. *The Structure of Scientific Revolutions*, 2nd Ed., University of Chicago Press, Chicago, Illinois, 1970.

25. Lohdal, J.B. and Gordon, G. "The Structure of Scientific Fields and the Functioning of University Graduate Departments," *American Sociological Review*, Volume 37, Number 1, February 1972, pp. 57–72.

26. Lucas, H.C. *Why Information Systems Fail*. Columbia University Press, New York, New York, 1975.

27. Martin, J. "A Garbage Can Model of the Research Process," in *Judgment Calls in Research*, J.E. McGrath, J. Martin and R.A. Kulka, (eds.), Sage, Beverly Hills, California, 1982.

28. Mason, R.O. and Mitroff, I.I. "A Program for Research on Management Information Systems," *Management Science*, Volume 19, Number 5, January 1973, pp. 475–487.

29. McCain, K.W. "Longitudinal Author Cocitation Mapping: The Changing Structure of Macroeconomics," *Journal of the American Society for Information Science*, Volume 35, Number 2, March 1984, pp. 351–359.

30. McKenney, J.L. and Keen, P.G.W. "How Managers' Minds Work." *Harvard Business Review*, Volume 52, May–June 1970, pp. 79–90.

31. McLean, E.R. (ed.) "Information Systems and Its Underlying Disciplines," *Data Base*, Volume 14, Number 1, Fall 1982, pp. 3–59.

32. Pfeffer, J. *Organizations and Organization Theory*. Pitman Publishing Inc., Marshfield, Massachusetts, 1982.

33. Pfeffer, J., Leong, A. and Strehl, K. "Paradigm Development and Particularism: Journal Publication in Three Scientific Disciplines," *Social Forces*, Volume 55, Number 4, June 1977, pp. 938–951.

34. Price, D. *Big Science, Little Science*. Columbia University Press, New York, New York, 1963.

35. Pritchard, A. "Statistical Bibliography or Bibliometrics?" *Journal of Documenta-* *tion*, Volume 24, Number 4, December 1969, pp. 348–349.

36. Ritzer, G. *Sociology: A Multiple Paradigm Science*, Allyn and Bacon, Boston, Massachusetts, 1975.

37. Small, H. "Co-citation in the Scientific Literature: A New Measure of the Relationship between Two Documents," *Journal of the American Society for Information Science*, Volume 24, Number 4, July–August 1973, pp. 265–269.

38. Small, H. "Cited Documents as Concept Symbols," *Social Studies of Science*, Volume 8, Number 3, August 1978, pp. 327–340.

39. Small, H. "Co-citation Context Analysis and the Structure of Paradigms," *Journal of Documentation*, Volume 36, Number 3, September 1980, pp. 183–195.

40. Swanson, E.B. "Management Information Systems: Appreciation and Involvement." *Management Science*, Volume 21, Number 2, October 1974, pp. 178–188.

41. White, H.D. and Griffith, B.C. "Author Cocitation: A Literature Measure of Intellectual Structure," *Journal of the American Society for Information Science*, Volume 32, Number 3, May 1982, pp. 163–171.

About the Author

Mary J. Culnan is an Associate Professor at the Kogod College of Business Administration, The American University, Washington, D.C. where she is Director of the MIS program. She is a member of the Advisory Board for the Capital Area Chapter of SIM, and also serves as a consultant to the office of U.S. Senator Joseph R. Biden, Jr. (D-Del). Her current research focuses on decision making and information processing activities in U.S. Senate offices. Professor Culnan received her Ph.D. in Computers and Information Systems from the Graduate School of Management, UCLA. Prior to her present position, she held faculty positions at the University of Virginia and the University of California, Berkeley. Her previous research has been published in the *MIS Quarterly, Management Science, Decision Sciences,* and the *ACM Transactions on Office Information Systems.*

Appendix

Publications Receiving Ten or More Citations by Co-citing Factor

FACTOR 1: MIS Foundations

Alter, S. *Decision Support Systems: Current Practice and Continuing Challenges*, Addison-Wesley, Reading, Massachusetts, 1980. (27 citations)

Anthony, R.N. *Planning and Control Systems: A Framework for Analysis*, Harvard University Press, Boston, Massachusetts, 1965. (21 citations)

Benbasat, I. and Schroeder, R.G. "An Experimental Investigation of Some MIS Design Variables," *MIS Quarterly*, Volume 2, Number 2, June 1978, pp. 43–54. (15 citations)

Benbasat, I.W. and Dexter, A.S. "Value and Events Approaches to Accounting: An Experimental Evaluation," *Accounting Review*, Volume 54, Number 4, October 1979, pp. 735–749. (12 citations)

Davis, G.B. *Management Information Systems: Conceptual Foundations, Structure and Development*, First Ed., McGraw Hill, New York, New York, 1974. (15 citations)

Dickson, G.W., Senn, J.A. and Chervany, N.L. "Research in Management Information Systems: The Minnesota Experiments," *Management Science*, Volume 23, Number 9, May 1977, pp. 913–923. (18 citations)

Ein Dor, P. and Segev, E. "Organizational Context and the Success of Management Information Systems," *Management Science*, Volume 24, Number 10, June 1978, pp. 1067–1077. (13 citations)

Ginzberg, M.J. "Steps Toward More Effective Implementation of MS and MIS," *Interfaces*, Volume 8, Number 3, May 1978, pp. 57–63. (16 citations)

Ginzberg, M.J. *A Process Approach to Management Science Implementation*, Unpublished Ph.D. dissertation, Massachusetts Institute of Technology, Cambridge, Massachusetts, 1975. (10 citations)

Gorry, G.A. and Scott Morton, M.S. "A Framework for Management Information Systems," *Sloan Management Review*, Volume 12, Number 1, Fall 1971, pp. 55–70. (23 citations)

Keen, P.G.W. "Information Systems and Organizational Change," *Communications of the ACM*, Volume 24, Number 1, January 1983, pp. 24–33. (11 citations)

Keen, P.G.W. and Scott Morton, M.S. *Decision Support Systems: An Organizational Perspective*, Addison-Wesley, Reading, Massachusetts, 1978. (81 citations)

King, W.R. "Strategic Planning for Management Information Systems," *MIS Quarterly*, Volume 2, Number 1, March 1978, pp. 27–37. (16 citations)

Lucas, H.C. *Why Information Systems Fail*, Columbia University Press, New York, New York, 1975. (30 citations)

Mason, R.O. and Mitroff, I.I. "A Program for Research on Management Information Systems," *Management Science*, Volume 19, Number 5, January 1973, pp. 475–487. (34 citations)

Mason, R.O. and Mitroff, I.I. *Challenging Strategic Planning Assumptions*, John Wiley, New York, New York, 1981 (11 citations)

McKenney, J.L. and Keen, P.G.W. "How Managers' Minds Work." *Harvard Business Review*, Volume 52, Number 3, May–June 1974, pp. 79–90. (20 citations)

Sprague, R.H. and Carlson, E.D. *Building Effective Decision Support Systems*, Prentice Hall, Englewood Cliffs, New Jersey, 1982. (19 citations)

Sprague, R.H. "A Framework for the Development of Decision Support Systems," *MIS Quarterly*, Volume 4, Number 4, December 1980, pp. 1–26. (16 citations)

Zmud, R.W. "An Empirical Investigation of the Dimensionality of the Concept of Information." *Decision Sciences* Volume 9, Number 2, April 1978, pp. 187–196. (13 citations)

Zmud, R.W. "Individual Differences and MIS Success: A Review of the Empirical Literature," *Management Science*, Volume 25,

Number 2, February 1979, pp. 966–979. (21 citations)

FACTOR 2: Individual (Micro) Approaches.

Benbasat, I.W. and Dexter, A.S. "Value and Events Approaches to Accounting: An Experimental Evaluation," *Accounting Review*, Volume 54, Number 4, October 1979, pp. 735–749. (12 citations).

Benbasat, I. "An Experimental Investigation of Some MIS Design Variables," *MIS Quarterly*, Volume 1, Number 1, March 1977, pp. 37–50. (12 citations)

Dickson, G.W., Senn, J.A. and Chervany, N.L. "Research in Management Information Systems: The Minnesota Experiments," *Management Science*, Volume 23, Number 9, May 1977, pp. 913–923. (18 citations)

Davis, G.B. *Management Information Systems: Conceptual Foundations, Structure and Development*. First Ed., McGraw Hill, New York, New York, 1974. (15 citations).

Lucas, H.C. *Why Information Systems Fail*, Columbia University Press, New York, New York, 1975. (19 citations).

Mason, R.O. and Mitroff, I.I. "A Program for Research on Management Information Systems," *Management Science*, Volume 19, Number 5, January 1973, pp. 475–487. (34 citations).

Swanson, E.B. "Management Information Systems: Appreciation and Involvement," *Management Science* Volume 20, Number 2, October 1974, pp. 178–188. (16 citations)

Zmud, R.W. "An Empirical Investigation of the Dimensionality of the Concept of Information," *Decision Sciences* Volume 9, Number 2, April 1978, pp. 187–196. (14 citations)

Zmud, R.W. "Individual Differences and MIS Success: A Review of the Empirical Literature," *Management Science*, Volume 25, Number 10, October 1979, pp. 966–979. (21 citations)

FACTOR 3, MIS Management

Ackoff, R.L. "Management Misinformation Systems," *Management Science*, Volume 14, Number 4, December 1967, pp. B147–156. (23 citations)

Anthony, R.N. *Planning and Control systems: A Framework for Analysis*, Harvard University Press, Boston, Massachusetts, 1965. (17 citations).

Nolan, R.L. "Managing the Crises in Data Processing," *Harvard Business Review* Volume 57, Number 2, March–April 1979, pp. 115–126. (11 citations).

Rockart, J.F. "Chief Executives Define their Own Data Needs," *Harvard Business Review*, Volume 57, Number 2, March–April 1979, pp. 81–91. (12 citations)

FACTOR 4: Organizational (Macro) Approaches

Kling, R. "Social Analyses of Computing," *Computing Surveys*, Volume 12, Number 1, March 1980, pp. 61–108. (20 citations)

Lucas, H.C. *Why Information Systems Fail*. Columbia University Press, New York, New York, 1975. (11 citations)

FACTOR 5: MIS Curriculum

None.

Raw Co-Citation Matrix

Author	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42
1 Ackoff	17																																									
2 Alter	4	38																																								
3 Anthony	3	6	12																																							
4 Benbasat	3	6	0	31																																						
5 Boland	2	4	2	3	11																																					
6 Carlson	2	10	3	5	1	15																																				
7 Chen	3	2	3	1	1	3	6																																			
8 Chervany	3	5	2	1	3	2	1	20																																		
9 Couger	2	2	2	2	1	1	4	0	11																																	
10 Davis	5	5	4	5	2	2	4	3	4	16																																
11 Dickson	3	13	1	22	2	4	4	1	5	7	29																															
12 Eindor	5	5	3	5	5	8	0	17	1	3	3	12																														
13 Ginzberg	5	12	3	8	8	0	0	1	3	4	8	4	24																													
14 Gorry	4	12	4	0	3	4	2	3	2	7	9	3	5	20																												
15 Huber	5	5	3	6	2	4	3	0	1	5	8	4	5	4	17																											
16 Ives	0	2	0	3	5	0	1	3	0	3	3	5	1	1	0	12																										
17 Jenkins	1	2	0	1	2	0	0	0	0	0	1	3	3	2	0	2	4																									
18 Keen	12	47	12	21	9	15	3	9	5	14	17	9	22	20	15	5	3	56																								
19 King, J.	1	5	1	1	0	1	1	1	1	3	1	2	3	0	1	0	0	7	11																							
20 King, W.	11	11	4	7	8	3	5	3	3	7	6	7	10	5	5	5	2	18	1	21																						
21 Kling	3	8	2	4	6	6	1	3	6	3	5	2	8	2	2	4	1	22	10	6	31																					
22 Konsynski	2	3	1	2	4	4	1	2	1	3	2	1	1	1	0	1	0	10	0	3	3	18																				
23 Kraemer	1	4	1	1	1	1	1	0	1	1	3	1	1	1	0	0	0	4	9	0	1	0	3																			
24 Kriebel	0	2	0	2	2	1	0	2	0	2	0	0	0	0	0	0	0	8	1	9	19	5	5	6																		
25 Lucas	7	15	3	18	10	9	1	13	5	7	20	12	20	8	5	11	3	35	3	17	21	2	0	3	37																	
26 McFarlan	1	5	2	0	0	15	1	1	1	3	1	2	2	2	4	0	2	6	0	2	1	2	0	0	7	10																
27 McKenney	5	5	6	0	3	3	1	5	3	7	6	7	7	2	5	1	1	15	0	3	1	1	1	0	9	11	11															
28 Markus	0	5	6	2	2	2	1	1	1	0	2	2	2	2	1	1	0	9	3	3	2	2	2	0	8	4	4	16														
29 Mason	9	7	4	16	7	7	1	8	8	8	14	7	7	9	3	3	1	30	4	15	10	1	3	0	18	7	4	4	31													
30 Mumford	3	3	2	0	2	2	1	0	1	1	3	1	1	2	2	3	1	9	1	3	3	1	0	0	8	2	4	1	1	13												
31 Munro	4	2	3	2	2	2	1	3	2	6	1	6	1	3	3	1	1	5	0	8	1	1	1	0	3	2	4	0	3	2	9											
32 Nolan	5	4	7	1	3	5	1	1	3	3	3	2	2	2	3	1	0	15	2	11	3	1	1	1	18	7	3	3	5	3	5	22										
33 Nunamaker	1	1	1	0	1	1	1	0	1	1	1	0	1	1	1	0	2	2	0	4	3	4	0	0	3	2	2	1	1	1	1	2	6									
34 Olson	2	4	1	1	3	3	0	2	3	3	3	2	2	2	3	3	0	5	0	4	1	1	1	0	0	2	3	0	3	3	2	4	1	10								
35 Robey	2	7	0	9	5	9	0	3	1	1	5	4	5	3	6	1	2	20	7	11	7	3	2	1	7	3	3	3	6	6	5	4	0	6	20							
36 Rockart	11	4	5	3	2	1	3	0	2	2	2	2	1	4	1	0	1	13	4	3	2	0	1	0	4	4	4	4	5	5	2	13	1	2	4	18						
37 Sprague	3	14	3	10	3	3	2	0	4	6	4	5	2	11	0	6	2	37	8	8	4	1	2	1	8	2	4	1	11	2	3	3	1	6	8	8	31					
38 Swanson	1	4	0	0	2	2	0	0	1	1	4	3	5	1	1	0	0	6	1	1	0	2	0	0	13	2	2	2	4	4	0	4	1	6	6	1	0	14				
39 Weber	1	0	1	0	0	1	0	1	1	1	2	0	0	1	0	6	0	2	0	1	1	0	1	0	0	0	1	0	2	0	0	0	0	0	6	0	0	0	6			
40 Wetherbe	1	0	1	6	0	1	1	0	0	2	0	2	0	1	0	1	0	1	0	3	0	0	0	0	3	2	2	0	2	1	1	3	2	1	5	2	0	0	0	5		
41 Whinston	0	0	0	1	0	0	0	0	0	2	0	1	1	1	0	0	0	2	1	0	3	1	0	0	1	2	2	0	1	0	0	1	1	0	0	0	0	0	0	1	2	
42 Zmud	4	7	3	19	6	1	1	8	2	5	13	6	17	6	7	8	2	20	16	5	2	1	0	2	20	4	10	3	16	3	3	6	3	12	12	4	12	1	1	0	0	29