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## Kochen's Influence Examined Bibliometrically

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### ABSTRACT

EXAMINES THE INFLUENCE of Manfred Kochen, who was instrumental in the early planning of this issue off *Library Trends*, through a review of the various publications that have cited his work.

### INTRODUCTION

The idea for this issue of *Library Trends*, dedicated to the memory of Manfred Kochen, originated with the journal editor, F. W. Lancaster, in 1988. He had known Kochen and his work for many years (by reputation since 1963, on a personal basis since the early 1970s), and, once the idea for the issue arose, Kochen seemed an obvious choice to be editor. Kochen accepted the idea enthusiastically and had gone a long way toward planning the content of the issue by the time of his tragic death. When Amy Warner and Miranda Pao graciously agreed to take over as guest editors, they asked Lancaster to prepare a brief biographical tribute to Kochen; thus the present article arose.

Kochen had a long and illustrious career. Although associated most obviously with IBM and the University of Michigan, the diversity of his interests took him, for periods of time, to many other institutions, including the Euratom project in Italy, Harvard, Rockefeller University, the U.S. Senate (as Congressional Fellow), and the Library of Congress. Rather than prepare a conventional

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biography, however, it seemed more appropriate to explore the extent and diversity of his influence through an analysis of how much his work has been cited and in what contexts.

### SUMMARY OF CITATION DATA

Between 1956 and the end of 1990, Kochen earned 456 citations as reflected in the *Science Citation Index* and in the *Social Sciences Citation Index*. This figure excludes duplicate citations (some appear in both citation indexes for the earlier years) but includes self-citation. It underestimates the number of cites Kochen receives because it considers only works for which he is sole author and those in which his name appears in first-author position. While his work has been cited consistently over the years, especially since about 1966, he has been most heavily cited in the period since 1981.

As Table 1 reveals, the citations are not concentrated on a few items, but are scattered over his entire corpus of writings. Note, however, that we have chosen to separate citations to parts of works from citations to the complete works. For example, citations to his chapter in *The Growth of Knowledge* are separated from citations to the entire volume, which he edited.

TABLE 1  
DISTRIBUTION OF CITATIONS OVER KOCHEN WORKS

<i>Publication</i>	<i>Number of citations</i>
<i>Principles of Information Retrieval</i>	33
"Toward a Rational Theory of Decentralization: Some Implications of a Mathematical Approach." <i>American Political Science Review</i> , 63, 1969, pp. 734-749, (written with Karl W. Deutsch)	19
<i>Decentralization: Sketches Toward a Rational Theory</i> (written with Karl W. Deutsch)	16
"Experimental Study of 'Hypothesis Formation' by Computer." <i>Information Theory: 4th London Symposium</i>	13
"Computers and Comprehension" ( <i>The Growth of Knowledge</i> )	13
<i>The Growth of Knowledge: Readings on Organization and Retrieval of Information</i>	12
"Stability in the Growth of Knowledge." <i>American Documentation</i> , 20, 1969, pp. 186-197)	12
2 items with 11 citations each	
2 items with 10 citations each	
2 items with 9 citations each	
3 items with 8 citations each	
5 items with 7 citations each	
5 items with 6 citations each	
4 items with 5 citations each	
5 items with 4 citations each	
9 items with 3 citations each	
25 items with 2 citations each	
72 items with 1 citation each	

Kochen regarded himself as primarily an information scientist (in the very broadest sense of that term), and, thus, it is not surprising that it is in the literature of information science that his citations are most concentrated (see Table 2). Neither Table 1 nor Table 2 give a real appreciation of the diversity of his work and influence. This is revealed more clearly by looking at the various contexts in which he has been cited.

TABLE 2  
SOURCES CITING KOCHEN'S WORK MOST FREQUENTLY

<i>Journal</i>	<i>Number of citations</i>
<i>Annual Review of Information Science and Technology</i>	30
<i>Journal of the American Society for Information Science</i>	26
<i>Information Processing and Management</i>	10
<i>Behavioral Science</i>	9
<i>International Journal of Man-Machine Studies</i>	9
<i>Journal of Documentation</i>	9
<i>Management Science</i>	6
<i>American Society for Information Science Proceedings</i>	6
<i>Scientometrics</i>	6

## CONTEXTUAL ANALYSIS

This analysis will survey the literature that has cited Kochen's work. Not every citation is included; the survey is intended to show the range of his influence rather than to be a comprehensive review.

### *Epistemology and the Growth of Knowledge*

Because Kochen's contributions to this area are closest to the subject of this issue of *Library Trends*, it seems appropriate to begin here. This work has been cited by other literature on epistemology and the growth of knowledge (Deutsch, 1968; Krejč, 1971; Blute, 1972; Harte, 1977; Stephenson, 1985; Nitecki, 1985), on copyright (Henry, 1972, 1974), memory skills (Fraser, 1985), information science education (Harmon, 1976), the dissemination of information (Cosmann, 1977), literature obsolescence (Kuch, 1982), citation analysis (Virgo, 1977), journal coverage (Sapp, 1989), computational linguistics (Salton, 1968), and medical information systems (Swets, 1988).

### *Scientometrics and Bibliometrics*

Kochen's research relating to the selection of journals by authors and the acceptance and rejection of manuscripts has been cited by Juhasz et al. (1975); Narin and Moll (1977); Moll and Narin (1977); Lefrere (1981); Vlachý (1981); Cronin (1981); Kaye (1981); Miller and Serzan (1984); Gordon (1984); Lindsey, (1988, 1989); and Bakanic et al. (1989). Kochen's work on the citation process has been drawn

upon by Smith (1981); Bonzi (1982); Noma (1982, 1984); Tomer (1986); McCain and Turner (1989); White and McCain (1989); Garfield (1990); and Sen (1990).

He also did significant work on the mapping of scholarly fields through conomination analysis. This is discussed in detail by Lenk (1983) and is cited in several other contexts: bibliometric distributions (Sichel, 1985), collection management (Bensman, 1985), library leadership (Gertzog, 1990), and general scientometrics (Szabo, 1985; Vlachý, 1986).

#### *Information Science: Theoretical and Professional Aspects*

Kochen's work has frequently been cited in discussions on the nature of information and "information science" (Shera & McFarland, 1969; Foskett, 1970; Harmon, 1971; Barnes & Petrie, 1976; Fussler & Kocher, 1977; Shera & Cleveland, 1977; Wellisch, 1981; Boyce & Kraft, 1985; Cilliers, 1985; Salton, 1985; Maričič, 1987; Watters, 1989; Van Gigh & Le Moigne, 1989; Buckland, 1990), as well as in articles dealing with education for information science and other professional aspects (Taylor, 1966; Derr, 1983; McGarry, 1983; Lancaster, 1983, 1984).

#### *Information-Seeking Behavior*

In 1983, Kochen authored an article on how clinicians recall experiences. Based on a study of seventeen primary care physicians, he concluded that, in clinical decisions, they rely more on their own direct experience than they do on information from colleagues, meetings, or the literature. Later, in 1985, he co-authored a related paper on the information needs of clinical researchers. These works have been cited in literature relating to information needs and information services in the health sciences—Bohannon and Le Veau (1986), Bohannon and Gibson (1986), Bohannon and Larkin (1986), and Woolf and Benson (1989).

#### *Communications Technology*

In his paper, "Technology and Communication in the Future," published in 1981, Kochen suggested that technology is applied in three stages: (1) to do what we can now do, but to do it cheaper, faster, and better; (2) to do things that we cannot now do; and (3) to change our life-styles. This paper has been influential in several areas: library automation (Lundeen & Davis, 1982; Sandore & Baker, 1986; Crawford et al., 1987); the future of libraries and of publishing (Featheringham, 1981; Braude, 1983; Moran, 1989), and technological forecasting (Klopfenstein, 1989).

#### *Design of Information Systems*

Kochen's articles on directory design for networks of information (1971, 1972), referential consulting networks (1970), and switching

centers for inquiry referral (1970) have been cited in the literature of library and information networks (Olson et al., 1972; Seidman, 1978), library and information center management (Leimkuhler & Billingsley, 1972; Buckland, 1974), bibliographic description (Batten, 1973; Buckland, 1988), and the design of neighborhood information services (Licht, 1976).

In 1972, Kochen wrote an article on a kind of world brain—WISE (a world information synthesis and encyclopedia), a topic dealt with further in a book he edited in 1975. This work has been cited in writings on the social sciences and social science information (Adam, 1975; Ballard et al., 1980; Hogeweg-deHaart, 1984), the planning of information services (Aines & Day, 1975), marketing research (Deshpande & Zaltman, 1982), interactive computer networks (Lederberg, 1978; Lowe, 1985), and the growth of knowledge (Umstätter & Rehm, 1984). Soergel (1977) draws upon Kochen in his own work on an automated encyclopedia.

Other Kochen articles have been cited in literature on the design of libraries and information systems: Miller (1967); Zimmerman (1977); and Allen (1990).

### *Information Retrieval*

The article Kochen published with Tagliacozzo in 1968 on cross-referencing in subject catalogs and indexes, has been cited by Fairthorne (1969), Kilgour (1969), Richmond (1977), Keen (1977), and Ingwersen (1982). Other Kochen works have been cited in theories of indexing (Fugmann, 1980, 1985), in articles on automatic indexing and related techniques (Lancaster, 1964; Meyer-Uhlenreid, 1965; Cooper & Maron, 1978; Yu et al., 1978; Kwok, 1985), in the literature on the evaluation of retrieval systems (Saracevic, 1975; Rorvig, 1990; Schamber et al., 1990), and articles on other aspects of information retrieval and information retrieval systems (McLaughlin, 1964; Baxendale, 1966; Climenson, 1966; Amsden, 1968; Zodrow, 1975; Walker, 1981; Davies, 1983; Radecki, 1988).

### *Economics of Information*

General work on the economics of information is cited by Debons and Montgomery (1974), Kantor (1982), and Lamberton (1984). Specific work on the costs of cataloging in research libraries is cited by Richmond (1971) and Wilson (1972).

### *Social Aspects of Information*

Kochen's chapter, "Information and Society," in the *Annual Review of Information Science and Technology* (1983) has been cited in articles on social measures of information (Menou, 1985), privacy protection (Turn, 1985), information resource management (Lytle,

1986), the social responsibilities of librarians (Stevens, 1989), moral issues in information science (Capurro, 1985), and the impact of computer technology (Weber, 1988).

His book on information for the community, co-edited with Donohue (1976), has been cited in the context of information retrieval (Shroder, 1981), information needs of social change organizations (Macfarlane, 1984), librarians and politics (Birdsall, 1988), and child care information and referral (Bogat & Gensheimer, 1986).

### ARTIFICIAL INTELLIGENCE AND RELATED AREAS

In the early 1960s, Kochen performed influential research on the formation of hypotheses by computer. This has been cited in the literature of artificial intelligence (Hormann, 1964; Solomonoff, 1966; Waterman, 1970; Fikes, 1970; Hayes-Roth, 1976; Cohen & Sammut, 1982; Michalski, 1983), cybernetics (Pask, 1971), information theory (Andrew, 1962), and psychology (Mackworth, 1965; Klix, 1967; Miller, 1971; Uhr, 1978; van der Meer, 1985).

A later report (1964), with several co-authors, on "computers and comprehension" (reprinted in *The Growth of Knowledge*, edited by Kochen in 1967) has been cited in the literature of artificial intelligence (Lea, 1970; Mackay, 1974; Klahr & Waterman, 1986), educational psychology (Bobrow & Bower, 1969; Mistler-Lachman, 1972, 1974; Ross & Ross, 1973, 1978), and information retrieval (Tharp, 1973).

Related works have been cited in writings on artificial intelligence (Towster, 1975; Smith, 1980), man-machine communication (Levien & Maron, 1967; Licklider, 1968), computational linguistics (Simmons, 1965, 1970; Montgomery, 1969), pattern recognition (O'Callaghan, 1970), expert systems (Anderson, 1988), and educational applications of computing (Wrigley, 1957).

#### *Fuzzy Sets*

Kochen's work on fuzzy sets has been cited in the literature of man-machine studies (Gaines, 1976; Gaines & Kohout, 1977; Novak & Pedrycz, 1988; Zwick & Wallsten, 1989), the design of military information systems (Dockery, 1982), quality control and reliability (Wang et al., 1988), sociology (Li, 1989), psychology (Pipino et al., 1981; Smithson, 1982; Leung, 1982; Smithson & Amato, 1982; Kulka & Novak, 1984), engineering mechanics (Souflis & Grivas, 1986), management science (Cooley & Hicks, 1983; Zebda, 1984; Zimmermann & Zysno, 1985), information science (Slamecka & Gehl, 1978), and fuzzy sets in general (e.g., Macvicar-Whelan, 1978; Toth, 1987).

#### *Problem Solving*

In 1958, Kochen co-authored a paper (with E. Galanter) on problem solving. This has been widely cited in the literature of

psychology (Pribram, 1959; Gyr, 1960; Lindsay, 1968; Krause, 1970; Krause & Lohmann, 1977), and that of decision making and decision theory (Feldman & Newell, 1961; Edwards, 1962; Lanzetta & Kanareff, 1962). It has also been cited in the literature of language learning (Smith, 1979).

A later (1974) problem solving paper, co-authored with A. N. Badre, has been cited in psychology (Erickson & Jones, 1978; Striženec, 1989), psycholinguistics (Kearsley, 1976), clinical decision making (Badre & Slamecka, 1976), management science (Cowan, 1990), and information retrieval (Heine, 1984; Horne, 1990).

Related papers by Kochen have been cited in the literature of communication research (Thayer, 1963), psychology (Berkeley & Humphreys, 1982; Hayes et al., 1988), management science (Frese, 1968), and information system design (Baruch, 1966).

#### *Organizational Theory*

Perhaps the most influential of Kochen's publications are those on decentralization and related topics, co-authored with Karl W. Deutsch, or included in a book edited by Deutsch. It is these works that have produced the greatest diversity in citation. They have been cited in the literature of urban planning and regional studies (Young, 1971; Schmandt, 1972; Morrill & Symons, 1977; Johnson, 1977; Reynolds, 1978; Milbrath, 1980; Stevens, 1985; Morrill, 1989), political science and public policy (Levy & Truman, 1971; Beck, 1971; Furniss, 1974, 1975; Park, 1976; Conyers, 1984; Kitschelt, 1985; Page & Goldsmith, 1985; Davies & Rose, 1988), sociology (Alker, 1970), management science (Sharon, 1979; Green et al., 1981; Beckmann, 1982; Manz & Gioia, 1983; Baliga & Jaeger, 1984; Malone, 1987; Leonard-Barton & Deschamps, 1988; Chen & Chung, 1990), the diffusion of innovation (Brown, 1975; Brown et al., 1981), general systems theory (Miller, 1972; Ericson, 1979), economics (Mullen, 1980), information processing (Samuelson, 1971; Buckland, 1989), the location of information centers (Rothenberg & Ho, 1977), operations research (Malone & Smith, 1988), and even anthropology/archaeology. The last reference is particularly interesting. Wright and Johnson (1975) discuss the Kochen/Deutsch mathematical model in relation to the appearance of specialized local administrative and exchange networks during the Early Uruk Period in Southwest Iran.

Related Kochen contributions have been cited in the literature of urban sociology (e.g., Jones, 1973) and economics (Stevens, 1990).

#### *Miscellaneous*

Other items by Kochen have been cited in the literature of communication theory (Harrah, 1956; Flood, 1975), sociology (Wellman & Wortley, 1990), computer science (Di Paola, 1973),

political science (Rosenau, 1984), computer conferencing (Rice & Love, 1987), and statistical bibliography (Lancaster, 1970).

## CONCLUSION

There are several possible ways of looking bibliometrically at a writer's influence. The most obvious (and most commonly used) is to count the total number of citations the author received or to relate the number of citations received to the number of items published (impact). However, one could argue that a preferred measure of a writer's influence is the extent to which his work is cited outside his own field or, better, the number of different subject fields that draw upon his work. With citations in the literature of library science, information science, scientometrics, bibliometrics, computer science, artificial intelligence, social science, political science, psychology, education, management science, economics, engineering, the health sciences, archaeology, and other fields, Kochen may well have been the most influential of all information scientists.

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