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# CITATION INDEXES

Also See: Citation Indexes - Part I

Citation Indexes - Part II

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PART III

Click for Introduction : "The value of an Index is Inversely related to Search-Time" p.206, Essays, Vol:1

## Evaluation of Citation Indexing

Perhaps the best way to evaluate citation indexing is to examine how the *Science Citation* Index resolves the previously discussed deficiencies of subject indexes. For purposes of review, the deficiencies can generally be summarized as follows:

1. Inability to deal comprehensively with the growing volume of scientific literature on a timely basis.
2. Limited ability to cut across disciplines to pull together related information.
3. Semantic difficulties in preparation and use of the indexes.

### COMPREHENSIVENESS AND TIMELINESS

The *SCI*'s method of obtaining comprehensive coverage of the literature has its foundation in Bradford's Law (16.17). In general, this law states that a small percentage of journals account for a large percentage of the significant articles in any given field of science. In support of this, a study of Physics *Abstracts* by Keenan and Atherton (18) shows that 50% of the items abstracted are taken from only nineteen journals. Also, studies conducted by *Index Chemicus* show that 100 journals account for 98% of all new articles in synthetic chemistry (19).

Further analyses have revealed that this concentration of information in relatively few journals is characteristic, not only of the individual disciplines, but of the scientific literature as a whole. Yale Professor Derek J. de Solla Price claims that about 1000 journals contain 80% of *all* scientific articles (20). This estimate is confirmed by continuing *ISI* studies. These same studies show that fewer than 1000 journals account for 90% of the *significant* literature, that is, they are the most heavily cited journals (21).

These findings lead to the reasoning that if the 2200 journals covered by the *SCI* are properly chosen, most of the world's important scientific literature will

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be indexed even though there are an estimated 30 to 50 thousand journals in existence.

The publisher of the *SCI* uses several methods to make sure that covered journals are, in fact, the significant ones. First, he has enlisted an editorial board composed of experts in the various disciplines to recommend journals for coverage. Second, subscribers are invited to suggest journals for coverage; such suggestions are then evaluated by the editorial board. Third, large-scale citation analyses are made to see which journals are cited most frequently. This information is especially helpful in determining those journals that are the most used in emerging fields of science. The coverage rationale that has evolved from this system places heavy emphasis on the multidisciplinary journals, supplementing these with the most important journals from the individual disciplines.

There has been some criticism that the *SCI* is biased in favor of covering the Western-language journals. This is, in part, a reflection of the superabundance of research conducted in the United States and abroad which is published in English, German, and French. This bias is also due to the fact that the *SCI* has, in the past, given preference to cover-to-cover English translations of Russian journals. However, it should be noted that the SCI is the only index that covers every article in the Soviet journal *Doklady Akad. Nauk SSSR*, which ranks as the fifth largest journal in the world in terms of articles published each year.

Another Russian journal covered by *SCI* is *Teploenergetica* (Thermal Engineering). It must be admitted, however, that this journal was not covered until 1968 when *ISI* studies showed that it was among the 500 most cited journals in the world. This is typical of the continuous improvement in journal coverage of *SCI*.

The *SCI* provides timely coverage partly because the type of intellectual activity required to compile traditional subject indexes is not required. The author himself "indexes" his article (by way of his citations), enabling the *SCI* to be prepared by a combination of man-machine procedures which facilitate current coverage of the literature. Thus, indexes covering the literature appearing in any calendar quarter are published within sixty days after the end of the quarter; hard-bound annual cumulations are published within four months after the end of the year.

## MULTIDISCIPLINARY SEARCHING CAPABILITY

The reason citation indexes provide multidisciplinary searching capabilities is, once again, related to the fact that most indexers are not as qualified as the author himself to decide which previously published material is related to his current work. A citation index takes advantage of the built-in linkages between documents provided by authors' citations by listing together *all* items with common citations.

It is this unique ability to group together items that are often seemingly unrelated that is so important to the modern researcher. Everyone knows that there are important, though small parts of the literature which can be called "pure" physics or "pure" chemistry, etc. There is, however, a larger, less specialized part of the literature that is of interest to physicists, chemists, or other scientists as it

relates to their specialties. For example, the chemistry of water is pertinent to oceanography, but it is also pertinent to a vast array of other problems in biology, physics, chemistry, and other applied fields. With the *SCI*, as long as a current item cites a given previous item, it will be indexed under the cited item. It makes no difference if the citing item appeared in a physics journal, a chemistry journal, an engineering journal, or any other type of journal. Therefore, a searcher using the *SCI* can identify a group of items whose contents are in some way related to his topic, but which were published in a variety of journals not normally considered as being related to his discipline.

An interesting example of the utility of the *SCI* in crossing scientific disciplines to retrieve isolated bits of information is found in the relationship between C. H. Whitnah's paper in the *Journal of Dairy Science* in 1959 and a paper by Albert Einstein in *Annalen der Physik* in 1906. This apparently incongruous combination proves to be a legitimate reference by Whitnah to an equation used in calculating molecular dimensions which was applied in a study of the physical properties of milk.

This same article by Einstein was cited in a 1960 article by V. V. Varadaiah in the *Journal of Polymer Science*. In this article, Einstein's equation was used as a basis for calculations relating to the Flory universal constant in the equation for intrinsic viscosity. In two other papers by P. H. Elworthy, one in 1959 in the *Journal of the Chemical Society*, and one in 1961 in the *Journal of Pharmacy and Pharmacology*, the Einstein equation was cited in a discussion on the size and shape of lecithin micelles.

In a 1961 paper by K. Yagi in *Comparative Biochemistry and Physiology*, the Einstein equation is employed in the study of mechanical and colloidal properties of amoeba protoplasm. Still again in 1961, S. G. Schultz, in the *Journal of General Physiology*, reported biophysical studies in which he used the Einstein viscosity equation to confirm atomic dimensions compiled by L. Pauling. In the *SCI*, each of these widely scattered papers would be retrieved by the use of basic search and cycling techniques.

## SEMANTIC PROBLEMS

Citation indexes resolve semantic problems associated with traditional subject indexes by using citation symbology rather than words to describe the content of a document. This concept is rather difficult for most people to comprehend at first. Therefore, the following rather extended example is presented as an aid to understanding.

In 1963, Professor J. Lederberg published a paper in *Nature* entitled "Molecular Biology, Eugenics and Euphenics." In this paper, he established the word "euphenics" as a synonym for the concept of "engineering human development." As long as this paper was the only one in the literature on euphenics, there was effectively a one-to-one equivalence between the word "euphenics" and the citation which identified the document in which it first appeared. The word "euphenics" and the citation "Lederberg J., 63, *Nature* 198, 428" were essentially equivalent symbols for the subject discussed in Lederberg's paper.

Now suppose that other authors use the term "euphenics" in subsequent papers. Customarily, the subsequent authors will give credit to Lederberg as originator of the term by citing his original paper. As a result, in a citation indexing system, the new papers would be automatically grouped together under the citation "Lederberg J., 63, *Nature* 198, 428." In a word indexing system, the subsequent papers would be grouped together under the term "euphenics." Both methods would achieve the same objective—to make information on "euphenics" retrievable. In one system, the word is the indexing term; in the other, the citation is the indexing term.

Once it is understood how a citation can serve as an indexing term, it is not difficult to show why citations are frequently better than words in this role.

Carrying the Lederberg example further, suppose that another author discusses "engineering human development" but does not mention the word "euphenics." As long as the author cites the original paper by Lederberg (which is highly probable), the new paper will be indexed under Lederberg's paper in a citation index. The odds are very slim, however, that any subject indexer would equate "engineering human development" with "euphenics." Thus, the paper that does not specifically mention euphenics has a high probability of being indexed under some other term.

Consider the same situation from the point of view of the user of an index. If the searcher is familiar with the term "euphenics," word indexes will enable him to find the Lederberg article and the subsequent articles that specifically mention "euphenics." The searcher will, however, most likely miss the papers on "engineering human development" unless he is aware that this phrase is an alternate for the word "euphenics." With the *SCI*, the searcher only needs to know that Lederberg had published on this general topic. By simply looking up the name Lederberg, he will find the original paper plus all subsequent citing papers, whether or not they specifically mention "euphenics." This is especially useful to a searcher who is not familiar with the jargon of a different discipline than his own.

Grouping items by a common citation also makes the *SCI* a self-organizing indexing system that is constantly being upgraded by the feedback of more current information.

## UNIQUE CAPABILITIES OF CITATION INDEXES

Citation indexes not only resolve many of the difficulties inherent in conventional indexes, certain things can be accomplished with citation indexes that are not at all feasible with other indexes.

Probably the most important of these capabilities is the ability to bring the searcher forward in time from an earlier known reference. The *SCI* is set up so that no matter when an item originally appeared, it will be indexed in the *Citation Index* as long as it is cited at least once in the current year in any of the covered journals. As soon as the searcher locates his starting "cited item" he is brought forward to items that are currently citing the original. This could bridge a gap of fifty years or more (as in the Einstein article discussed above), or it can take

the searcher forward in increments as small as a year (say from 1968 for the cited article to 1969 for the citing article).

By utilizing this ability of citation indexes, necessary research questions such as these can be answered:

1. Has this basic concept been applied elsewhere?
2. Has this theory been confirmed?
3. Has this method been improved?
4. Is there a new synthesis for this old compound?
5. Have there been errata or correction notes published for this paper?

Also, any scientist may legitimately wish to determine whether his own work has been applied or criticized by others. Citation indexes facilitate this type of feedback in the communication cycle. A further use of citation indexes is to quickly identify scientists currently working in special branches of science for the purpose of correspondence or personnel selection.

Finally, a mention should be made about the unusual ability of citation indexes to serve as a tool in evaluating literary practices and the structure of scientific literature (*22–24*). Using citation data, networks of interconnected articles may be constructed to trace the history of a subject (*25,26*). Citation counts can also be used to determine the length of time that there is any interest in a given article or topic (*27*). The impact of individual articles as well as the emergence of "superclassic" papers can be studied with citation data (*28*).

## FORMAL STUDIES OF CITATION INDEXING

A number of formal studies have been conducted on citation indexing, almost all of which have been based on the *SCI*. Barlup (*29*) describes a study to test allegations that *SCI* searches are "noisy," that is, that they retrieve a high percentage of irrelevant material. In this study, searches were conducted for a range of medical subjects. A team of physicians was used to assess relevance. It was found that 72% of the citing articles located were "closely or directly related in subject content to the cited article." About 22% were "slightly or indirectly related" and about 5% could be considered noise. Of the article found to be directly related to the cited article, about 10% were judged to have titles that did not indicate any relationship.

Spencer (*30*), Rieger (*31*), and Ghosh (*32*) have conducted studies that were mainly concerned with the comprehensiveness and/or the search speed of the *SCI* as compared with discipline-oriented indexes such as *Chemical Abstracts* and *Index Medicus*. On a topic that was clearly within the specialized field covered by *Index Medicus*, Spencer found that the SCI produced better results. Reiger found that the *SCI* was less efficient than *Index Medicus* on a subject that was primarily covered in Italian journals. On the other hand, Ghosh used the *SCI* to conduct a search on "hemorrhagic fever," a narrow field in which articles are almost entirely confined to Indian journals. In this case, the *SCI* produced a high retrieval efficiency.

## Future Improvements and Applications

Several aspects of citation indexing require attention if it is to deliver its full potential in the future. Included in these are improvements in the mechanics of the system itself as well as the conception, investigation, and development of new applications.

### CITATION PRACTICES OF AUTHORS

One of the most obvious areas for improvement in citation indexing systems is the citation practices of authors themselves. Some scientific articles have hundreds of references; others have none at all. Part of the reason for such disparity in the number of references is the great difference in quality, not only in articles, but also in the journals that publish them. Many authors, editors, and referees are quite meticulous in ensuring that an article includes a comprehensive set of references. For some articles, especially in the less scholarly journals, the references may be inadequate or nonexistent. Information scientists and others have discussed this problem at length, although most of their suggestions are aimed at improving the author's awareness of the value of good citation habits (*33*). Garfield went a step further and discussed the possibilities of an automatic system in which a computer could read an article and determine not only if the references provided are appropriate, but also what references are missing (*34*). Needless to say, such a system is not on the immediate horizon.

### STORAGE REQUIREMENTS

A problem that confronts all types of indexes is the growing amount of space required to store the cumulated volumes. One obvious way to approach this is the use of microforms. The improving technology in this area has resulted in increased data storage capabilities through higher reduction ratios and larger magnifications in the optical system of the viewer. An optimized indexing system of the future may make use of remote access to time-shared computers for the current year's indexed material, printed books for three to four year cumulative indexes, and microforms for very large scale cumulative indexes (*35*).

Of course, putting large-scale cumulative indexes on microforms presupposes that such citation indexes are available. To date, this is not the case. It is, however, *ISI*'s announced goal to produce a citation index that will provide total retrospective coverage of the literature of the twentieth century. *ISI*'s plan is to produce this index in stages over the next decade.

### ON-LINE ACCESS TO INDEXED DATA

As indicated, one of the logical developments for citation indexing would be to provide remote access to the indexed data. This would be similar to what is provided on a limited basis by the previously discussed project TIP. With such a system, a searcher would be able to sit before a computer console and do his

bibliographic research by operating a keyboard linked to a computer with several billion stored characters. The required data would then be automatically printed out on a typewriter or teletype unit or displayed on a cathode ray tube. A perforated tape or set of punched cards could even be produced for use as input to another data processing system which could further refine or analyze the data obtained.

Surprisingly, the main deterrent to implementing such a system on a large scale is not the high cost of the computer. The cost of the computer would be shared by all the users in the network. Each subscriber, however, would have to bear the entire cost of the long distance telephone call required to access the computer. The telephone system is not yet organized so that you pay for the call only during the time you are actually using the computer; you also pay for waiting time. A time-shared computer works for someone else during the silent or thinking period of any one subscriber. You pay for the entire telephone call whether you are using the computer for the whole period or not.

## EVALUATION OF SCIENTIFIC PERSONNEL

Although the *SCI* was originally designed to be a retrieval tool for use in library and information science work, there are indications that it will have important applications as a tool for evaluating scientific personnel. By using the *SCI* data base, it is possible to count the number of citations to a given author. Although there are exceptions, frequently cited authors are usually those who have done the most important work in a given field (*36–39*).

For example, by using the *SCI* data base, it was possible to list the fifty most cited authors for 1967. Two of the 1969 Nobelists—Derek H. R. Barton and Murray Gell-Mann appeared on the list (*40*). Since there are over a million scientists in the world's population, producing a list of fifty that contains two Nobel prize winners is no small achievement. This is especially impressive since the list was compiled by a purely mechanical method which did not require reading the works of these men.

The ability of the citation index to measure the impact of a scientist's work has practical economic consequences. Research administrators could use such a tool as an aid in evaluating present scientific personnel or in hiring new people. Officers of various foundations could use it in awarding prizes, grants, fellowships, and other forms of research assistance.

## MARKETING RESEARCH

Another possible use for the data used to compile the *SCI* is in marketing research. In the *Corporate Index* section of the *SCI*, new papers are listed under the companies where the work was performed. Proper analysis of the published information could give a good indication of the type of equipment or supplies needed by a company to conduct its research work. This could be especially valuable information, for example, to a scientific instrument manufacturer trying to anticipate the needs of potential or existing customers.

## Conclusion

When citation indexes for scientific literature were first introduced, they were considered supplements to traditional subject indexing methods (*41*). Time has made it clear, however, that citation indexes that are comprehensive and timely are entitled to be considered as independent, fully integrated, library and information science tools. Further, citation indexes can now perform important evaluative, analytical, and predictive roles that were never imagined for subject indexes.

It seems likely, then, that given the right amount of attention and constructive criticism, citation indexing will continue to grow in usefulness and acceptance in the scientific, academic, and industrial communities.

## REFERENCES


1. D. J. de S. Price, *Little Science, Big Science*, Columbia Univ. Press, New York, 1963, pp. 8–15.
2. C. P. Bourne, *Methods of Information Handling*, Wiley, New York, 1963, pp. 1–12.
3. K. Tietze, "On the Problems of Seasonal Fluctuations in the Dates of Birth and Conception," *Therapie der Gegenwart*, 102, 955–962 (1963).
4. *Index Medicus, 1964 (Cumulated)*, 5(IV), American Medical Association, 1965, p. S-2966.
5. E. Garfield, "A Unified Index to Science," in *Proceedings of the International Conference on Scientific Information*, Vol. 1, National Academy of Sciences–National Research Council, Washington, 1959, pp. 461–469.
6. W. C. Adair, "Citation Indexes for Scientific Literature?", *Amer. Doc.*, 6, 31–32 (1955).
7. E. Garfield, "Citation Indexes for Science," *Science*, 122(3159), 108–111 (1955).
8. I. H. Sher and E. Garfield, "The Genetics Citation Index Experiment," in *Proceedings of the American Documentation Institute, 26th Annual Meeting*, American Documentation Institute, Chicago, 1963, pp. 63–64.
9. J. W. Tukey, "Keeping Research in Contact with the Literature: Citation Indexes and Beyond," *J. Chem. Doc.*, 2, 34–37 (1962).
10. B.-A. Lipetz, "The Effect of a Citation Index on Literature Use by Physicists," in *Proceedings 1965 Congress of the International Federation for Documentation*, Spartan Books, Washington, 1966, pp. 107–117.
11. M. M. Kessler, "The MIT Technical Information Project," *Phys. Today*, 18(3), 28–36 (1965).
12. F. L. Alt and R. A. Kirsch, "Citation Searching and Bibliographic Coupling with Remote On-Line Computer Access," *J. Res. Nat. Bur. Stand., B*, 72B(1), 61–78 (1968).
13. I. H. Sher, E. Garfield, and A. W. Elias, "Control and Elimination of Errors in ISI Services," *J. Chem. Doc.*, 6(3), 132–135 (1966).
14. E. Garfield, "Citation Indexing, Historio-Bibliography, and the Sociology of Science," in *Proceedings of the III International Congress of Medical Librarianship*, Excerpta-Medica Foundation, Amsterdam (1969).
15. A. E. Cawkell, "Search Strategies Using the *Science Citation Index*," in *Computer Based Information Retrieval Systems* (B. Houghton, ed.), Bingley, London, 1968, pp. 27–44. See also: "Current Comments," *Current Contents Life Sciences*, 12(44), 89–103 (1969); "Current Comments," *Current Contents Physical Sciences*, 9(44), 89–103 (1969); "Current Comments," *Current Contents Chemical Sciences*, 3(45), 49–63 (1969); "Current Comments," *Current Contents Education*, 1(41), 33–47 (1969); and "Current Comments," *Current Contents Behavioral, Social & Management Sciences*, 1(34), 41–56 (1969).

16. S. C. Bradford, "Complete Documentation," in *Report of the Royal Society Empire Scientific Conference*, London, 1946, pp. 729–748.
17. B. C. Brooks, "Bradford's Law and the Bibliography of Science," *Nature*, 224(5223), 953–956 (1969).
18. S. Keenan and P. Atherton, *The Journal Literature of Physics*, Report No. AIP/DRP PA1, American Institute of Physics, New York, 1964, 156 pp.
19. E Garfield and G. Foeman, "Statistical Analyses of International Chemical Research by Individual Chemists, Languages, and Countries," paper presented at the American Chemical Society, Division of Chemical Literature Meeting, Chicago, 1964.
20. D. J. de S. Price, "Is Technology Historically Independent of Science? A Study in Statistical Historiography," *Technol. Culture*, VI(4), 553–568 (1965).
21. ISI intends to release these and other data during 1970 in the form of a *Journal Citation Index* (*JCI*). The *JCI* will show how often each of 2200 journals cite each other as well as how often they cite any of the estimated 25,000 other journals in existence.
22. E. Garfield and I. H. Sher, "New Factors in the Evaluation of Scientific Literature through Citation Indexing," *Amer. Doc.*, 14(3), 195–201 (1963).
23. E. B. Parker, W. J. Paisley, and R. Garrett, "Bibliographic Citations as Unobtrusive Measures of Scientific Communication," Institute for Communication Research, Stanford University, Stanford (1967).
24. R. D. Whitley, "Communication Nets in Science: Status and Citation Patterns in Animal Physiology," *Sociological Rev.*, 17(2), 219–233 (1969).
25. E. Garfield, I. H. Sher, and R. J. Torpie, "The Use of Citation Data in Writing the History of Science," Institute for Scientific Information, Philadelphia, 1964, 76 pp.
26. E. Garfield and I. H. Sher, "Diagonal Display—A New Technique for Graphic Representation of Complex Topological Networks," Final report to U.S. Air Force, Office of Scientific Research under Contract AF 49(638)-1547, Institute for Scientific Information, Philadelphia, 1967, 94 pp. See also: E. Garfield and M. V. Malin, "Diagonal Display—A New Technique for Graphic Representation of Network Diagrams," in *1969 Transactions of the American Association of Cost Engineers, 13th National Meeting*, Pittsburgh, 1969, American Association of Cost Engineers, Alabama University, pp. 222–232.
27. J. Margolis, "Citation Indexing and Evaluation of Scientific Papers," *Science*, 155(3767), 1213–1219 (1967).
28. D. J. de S. Price, "Networks of Scientific Papers," *Science*, 149(3683), 510–515 (1965).
29. J. Barlup, "Mechanization of Library Procedures in the Medium-Sized Medical Library (Relevancy of Cited Articles in Citation Indexing)," *Bull. Med. Lib. Assoc.*, 57(3), 260–263 (1969).
30. C. C. Spencer, "Subject Searching with *Science Citation Index:* Preparation of a Drug Bibliography Using *Chemical Abstracts, Index Medicus*, and *Science Citation Index*," *Amer. Doc.*, 18(2), 87–96 (1967).
31. L. A. Rieger, "Subject Searching with the *Science Citation Index, Chemical Abstracts*, and *Index Medicus* in the Preparation of a Drug Bibliography," paper presented at a symposium of the Pharmaceutical Division of the Special Libraries Association, Los Angeles, 1968. Submitted for publication in *Amer. Doc.*
32. J. S. Ghosh, "Literature Searching with the *Science Citation Index;* an Experimental Study," *Ann. Lib. Sci. Doc.*, 14(3), 133–142 (1967).
33. D. J. de S. Price, "On the Side of Citations," letter, *Agr. Eng.*, 5(2), 94 (1970).
34. E. Garfield, "Can Citation Indexing Be Automated?" in *Statistical Association Methods for Mechanized Documentation: Symposium Proceedings* (M. E. Stevens, V. E. Giuliano, and L. B. Heilprin, eds.), National Bureau of Standards, Washington, D.C., Miscellaneous Publication No. 269, 1965, pp. 189–192.
35. E. Garfield, "World Brain or Memex? Mechanical and Intellectual Requirements for Universal Bibliographic Control," in *The Foundations of Access to Knowledge* (E. B. Montgomery, ed.), Syracuse Univ. Press, Syracuse, 1968, pp. 169–196.
36. A. E. Bayer and J. Folger, "Some Correlates of a Citation Measure of Productivity in Science," *Sociology of Educ.*, 39(4), 382–390 (1966).

37. S. Cole and J. R. Cole, "Scientific Output and Recognition: A Study in the Operation of the Reward System in Science," *Amer. Sociological Rev.*, 32(3), 377–390 (1967).
38. J. P. Martino, "Research Evaluation Through Citation Indexing," *AFOSR Research*, AD 659 366 (D. Taylor, ed.), USAF Office of Aerospace Research, Arlington, 1967, pp. 226–227.
39. E. Garfield, "Citation Indexing for Studying Science," *Nature*, 227, 669–671 (1970).
40. E. Garfield and M. V. Malin, "Can Nobel Prize Winners be Predicted?" Paper presented at 135th Meeting, AAAS, Dallas (1968).
41. E. Garfield, "*Science Citation Index*—A New Dimension in Indexing," *Science*, 144(3619), 649–654 (1964).

## BIBLIOGRAPHY


Abelson, P. H., "Coping with the Information Explosion," Editorial, *Science*, 154(3745), 75 (1966).

Bottle, R. T., "Abstracts, Reviews and Bibliographies as Keys to the Literature," in *The Use of Biological Literature* (R. T. Bottle and H. V. Wyatt, eds.). Archon Books, Butterworth, London, 1967, pp. 33–57.

Cawkell, A. E., "Using References to Retrieve Current Articles," *Radio Electronic Eng.*, 35(6), 352–353 (1968).

Dorr, H. A., and I. H. Sher, "The Science Citation Index System and Pharmaceutical Education," *Amer. J. Pharm. Educ.*, 32(2), 177–188 (1968).

Garfield, E., "Breaking the Subject Index Barrier—a Citation Index for Chemical Patents," *J. Patent Office Soc.*, 39(8), 583–595 (1957).

Garfield, E., "Citation Indexing: a Natural Science Literature Retrieval System for the Social Sciences," *Amer. Behavioral Sci.*, 7(10), 58–61 (1964).

Garfield, E., "Science Citation Index—Answers to Frequently Asked Questions," *Rev. Int. Doc.*, 32(3), 112–116 (1965).

Garfield, E., "Patent Citation Indexing and the Notions of Novelty, Similarity, and Relevance," *J. Chem. Doc.*, 6(2), 63–65 (1966).

Garfield, E., "The Role of the Medical Librarian in SDI Systems," *Bull. Med. Lib. Assoc.*, 57(4), 348–351 (1969).

Giuliano, V. E., "Analog Networks for Word Association," *IEEE Trans. Military Electronics*, MIL-7(2&3), 221–234 (1963).

Hayman, M., and R. Peskin, "Need of the Research-Oriented Psychiatrist for Information Retrieval," *Diseases Nervous System*, 28(12), 798–803 (1967).

Malin, M. V., "The *Science Citation Index*: A new Concept in Indexing," *Lib. Trends*, 16(3), 374–387 (1968).

Martyn, J., "An Examination of Citation Indexes," *Aslib Proc.*, 17(6), 184–196 (1965).

Martyn, J., "Citation Indexing," *The Indexer*, 5(1), 5–15 (1966).

Sher, I. H., and E. Garfield, "New Tools for Improving and Evaluating the Effectiveness of Research," presented at the Second Conference on Research Program Effectiveness, Washington (1965); published in *Research Program Effectiveness*, Gordon and Breach, New York, 1966, pp. 135–146.