

Web of Science: A New Method in Maintaining Citation Index

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Indeks sitiran adalah daftar artikel-artikel yang merujuk atau mengutip dari artikel sumber (orisinil). Indeks sitiran ini digunakan sebagai metode melacak sumber-sumber rujukan yang disusun para pengarang di akhir setiap artikel yang diterbitkan yang biasa disebut dengan bibliografi. Salah satu keuntungan utama pengindeksan sitiran adalah untuk mengidentifikasi hubungan antara dokumen-dokumen atau tulisan-tulisan yang sering muncul pada jurnal-jurnal ilmiah. Ketika teknologi informasi berkembang, ketersediaan indeks sitiran dalam bentuk basis-data berdampak cukup signifikan bagaimana indeks sitiran dapat dimanfaatkan secara lebih optimal. Beberapa peneliti menggunakan data sitiran untuk evaluasi tulisan-tulisan para peneliti, jurnal-jurnal, dan lembaga-lembaga yang bergerak dalam penerbitan karya ilmiah. Sebagian lainnya memanfaatkannya untuk analisis struktur bidang penelitian tertentu, evaluasi kecenderungan-kecenderungan riset berdasarkan terbitan-terbitan sebelumnya, dan prediksi terhadap kecenderungan-kecenderungan yang akan datang. Tulisan ini mencoba mendiskusikan perkembangan terakhir penggunaan indeks sitiran dari cara-cara tradisional ke lingkungan berbasis teknologi. Dengan demikian, perkembangan awal pengindeksan sitiran hingga munculnya web of science sebagai sebuah media mutakhir dalam pemanfaatan indeks sitiran berbasis web, dibahas dalam tulisan ini.

Key words: citation index, web of science, ISI, SCI

I. Introduction

Research or innovation as sated in the history of research development is built on the base of preceding research. Researchers usually cite the ideas and papers of pioneers. This behavior is called “citation”. A citation includes two objects: one is the source work; the other is the cited work. Furthermore, if we call “citation index”, simply it can mean as tracking references that authors put in the bibliographies of published papers.¹

Citation indexing has some advantages. The primary advantage of citation indexing is that it identifies relationships between documents that are often overlooked in a subject index. The important secondary advantage is that the compilation of citation indexes is especially well suited to the use of man-machine indexing methods that do not require indexer who are subject specialists. This helps to make citation indexes more current than most subject indexes. Then citations are not vulnerable to scientific and technological obsolescence as that are the terms used in subject indexes.

¹ M. Weinstock, “Citation Index”, in A. Kent (Eds). *Encyclopedia of Library and Information Science*. Vol. 5 (New York: Marcel Dekker, 1971), pp.17-18.

Although there are many reasons for a citation, the cited work has something to do with the source work. For general users, cited works provide a guide to further reading. For researchers, the collection of information about cited works is a treasure for citation analysis. Citation analysis permits the researcher to comprehend current developments in subject fields, the properties of bibliographical usage, and research trends.²

Citation indexing began in the 1950s, and the market has been controlled by the Institute for Scientific Information (ISI) in Philadelphia, creator and publisher of the three citation indexes available today: *Science Citation Index* (SCI), *Social Sciences Citation Index* (SSCI), and *Arts & Humanities Citation Index* (AHCI). All three ISI citation indexes are available online to users via the Web of Science system. University of Texas (UT) has licensed ISI data back to 1975.³

This writing tries to describe brief history of citation index in its traditional format until Web of Science available to be accessed. In the light of aforementioned, it will simply highlight some citation index aspects in terms of definition, function, and history. Furthermore, it discusses development of citation indexing up to launching for Web of Science and its effect towards scientific writings' activity.

II. What is about Citation Index?

If we want to find materials on some piece of research we are working on, there are in general three strategies conducted for that. The first strategy is following references back to other work. We look through the documents (books, monographs, articles) that we already know about to find references (footnotes, endnotes, etc., that we generally call "citations") made by their authors to other, former works. We get and read those works too, because we assume they will, in some way, are related to the relevant document's content. The second one is bibliographies and indexing services. We search through bibliographies or abstracting/indexing services, using subject words we think are

² Kuang-hua Chen, "The Construction of the Taiwan Humanities Citation Index", *Online Information Review*. Vol. 28, No.6 (2004), p. 410

³ *Using Citation Indexes*. Retrieved on January 31, 2006 from:
<http://www.lib.utexas.edu/chem/info/citations.html>

reflective of what it is we are looking for. Then, the third one consults to a subject expert. We talk to a researcher or scholar (maybe the professor who taught us in a related course) who knows the area, and who advises us of what authors/researchers we should be familiar with.⁴

The essential problem with the first two strategies above is that they are only going to point us to research literature that is older than they themselves are. For instance, if we are reading a 1995 article on “cognitive dissonance”, we just would not find references to more recent literature in it than at least a couple of years before the date of the article that referenced it. It is the same with much of the bibliographic literature too. The third method, going to a scholar who keeps up with who is working on what aspects of some topic, is a wonderful way of getting an evaluated assessment of who is now working in the research area, and an assessment of what they are saying in their research. Unfortunately, also the method is not generally available to most of us. This is a form of inquiry that depends on the requestor's professional/academic relationship with the scholar being queried.

However, there is still another strategy, a fourth technique, which can be employed to locate recent research: *citation indexing*. This strategy will be explained in the following section.

Definition

Citation index is a list of articles that, subsequent to the appearance of the original article, refer to, or cite, that article. This method is particularly applicable to scientific literature and allow easy tracing of similar research.⁵ Furthermore, in Weinstock's view, citation index is defined in conjunction with method as, “... a method of organizing the contents of a collection of documents in a way that overcomes many of the shortcomings of the more traditional indexing methods.”⁶ In a more complete explanation, Lawrence, Giles, and Bollacker state that citation indexing reveals relationships between articles,

⁴ *Citation Indexing: ISI's Web of Science*. Retrieved on January 31, 2006 from: <http://www.ou.edu/webhelp/librarydemos/isi/>

⁵ R. Prytherch. *Harrod's Librarians' Glossary*. 8th Edition. (England: Gower, 1996), p. 133.

⁶ M. Weinstock. “Citation Index... p.17.

draws attention to important corrections or retractions of published work, identifies significant improvements or criticisms of earlier work, and helps limit the wasteful duplication of prior research.⁷ The latter definition describes relation between the citation indexing and the scientific communication improvement. They also mention that citation indexes can also be used to analyze research trends, identify emerging areas of science, and find out where and how often a particular article is cited.

Based on three definitions mentioned above, citation index can be understood as a way to search for, analyze the literature in a way not possible through simple keyword /topical searching, and enable users to gather data on the ‘performance’ of individual authors and journals. This differs from ‘bibliometrics’ that studies on how to collect data in assessing particular areas of research activity and publication and we will not discuss it in this paper.

If citation indexes connotes as tracking of references that authors put in the bibliographies of published papers, so the main use of a citation index is to find, for a particular publication known to the searcher, later items that have cited it. In this case, the Institute for Scientific Index (ISI) published three indexes that allow the user to undertake searches in broad subject areas. Those indexes are *Science Citation Index*, *Social Sciences Citation Index*, and *Arts and Humanities Citation Index*. They are all structured in the same way including four indexes: Source Index, Citation Index, Permuterm Subject Index, and Corporate Index.⁸ The three citation indexes are international in scope, covering many journals published outside the United State as well as the major U.S. titles in each subject area. Source articles in languages other than English include a language code the English translation of the title. They are available with more restricted time coverage online from various vendors but for the time period covered, their sources can be search much more easily online than print. Coverage is also more current online because updates are made weekly. Besides that, CD-ROM editions are available that have

⁷ S. Lawrence, C.L. Giles, and K. Bollacker. “Digital Libraries and Autonomous Citation Indexing”. *IEEE Computer*. Vol. 32, No. 6 (1999), p. 68.

⁸ R.E. Bopp and L.C. Smith. *Reference Information Services: an Introduction*. 3rd Edition. (Englewood: Libraries Unlimited, 2001), p. 520.

some advantages such as the capabilities in searching as found in print, “related records” feature, enabling user to find articles related to a known article.⁹

Just as earlier mentioned, citation index enables one to get recent articles in which earlier work are cited. Using the citation index, terminology problems may be avoided since earlier published works can be used to represent concepts or topics of interest. Citing publications are assumed to be related in some way to those earlier cited publications. Only first authors are listed in the citation index entries, so the first author of multiauthored papers must be known to use the paper as a starting point.

History

The concept behind citation indexing is fundamentally simple. By recognizing that the value of information will be determined when the information is used, what better way to measure the quality of the work than by measuring the impact it makes on the community at large. The widest possible population within the scholarly community (i.e. anyone who uses or cites the source material) determines the influence or impact of the idea and its originator on our body of knowledge. Because of its simplicity, one tends to forget that citation indexing is actually a recent form of information management and retrieval.

Three factors led to the development of citation indexing back in the 1950. The first factor was that there was need for a better way of managing information. With the huge influx of government dollars into research and development following World War II, the research community naturally began to document publicly its findings through the accepted channel of published scientific journal literature. The subsequent burgeoning of the literature created a need for a method of indexing and retrieval that would be more cost effective and efficient than the then-current model of human indexing of materials for subject specific indices. While the subtle judgments made by subject specialists were valuable in giving depth to a subject index, manual indexing was both a more time-consuming process and labor intensive. Its costs increased in proportion to the growth of material to be indexed.

⁹ R.E. Bopp and L.C. Smith. *Reference Information...* p. 521.

The second factor was the growing dissatisfaction with the capacity of subject indexing to meet the needs of the active researcher. A subject index could have excessive lag times in adding materials to the indexes of the time; months could pass before researchers in one field would learn of published findings in some other field that had relevance to their own study.

The third factor was that there were limitations to the subject indexing in terms of retrieval. Terminology appropriate to one specific discipline would not necessarily have meaning to researchers in another, perhaps overlapping, discipline. At the same time, scientists were recognizing that they had to be aware of, if not completely familiar with, work in a number of different subject disciplines in order to be confident that they had properly grounded the research through an appropriate review of the literature.¹⁰

Thus, existing of the citation indexing was conceived in the early 1950s as a way to monitor, organize, and retrieve published scientific and scholarly literature. While citation indexing had been implicit in legal citators such as *Shepard's Citations*, the concept had not yet been applied to the literature of any field of scientific research. *Shepard's Citations* came into existence in 1873 to provide the legal profession with a tool for tracking subsequent decisions based on cases decided by federal and state courts.¹¹

In 1958, Eugene Garfield set up ISI to provide information retrieval services. He was deeply involved in the research relating to machine generated indexes in the mid-1950's and early 1960's. One of his earliest points of involvement was a project sponsored by the Armed Forces Medical Library (predecessor to our current National Library of Medicine). The Welch Medical Library Indexing project, as it was called, was to investigate the role of automation in the organization and retrieval of medical literature. The hope was that the problems associated with subjective human judgment in selection of descriptors and indexing terms could be eliminated. By removing the human element, one might thereby increase the speed with which information was incorporated in to the

¹⁰ *History of Citation Indexing*. Retrieved on January 31, 2006 from:
<http://scientific.thomson.com/free/essays/citationindexing/history/>

¹¹ J. Trolley and J. O'Neill. "The Evolution of Citation Indexing from Computer Printout to the Web of Science. Retrieved on January 31, 2006 from:
http://www.chemheritage.org/explore/ASIS_documents/ASIS98

indexes. It might also increase the cost-effectiveness of the indexes. Garfield grasped early on that review articles in the journal literature were heavily reliant on the bibliographic citations that referred the reader to the original published source for the notable idea or concept. By capturing those citations, Garfield believed, the researcher could immediately get a view of the approach taken by another scientist to support an idea or methodology based on the sources that the published writer had consulted and cited as pertinent in the bibliography. As retrieval terms, citations could function as well as keywords and descriptors that were thoughtfully assigned by a professional indexer.

Along with this need was the hope that automation might hold the answers, the third and final factor in the development of citation indexing. Computerization in the 1950's was far removed from the desktop environment of today, but there was tremendous excitement over potential benefits to be derived from the application of machines to the generation and compilation of data. The U.S. government hoped that automation could mitigate or even eliminate the difficulties of manual indexing. A number of projects were launched by the United States with the intention of investigating these possibilities.

ISI is now the most authoritative citation index company in the world. ISI provides the following academic data search services: life sciences, clinical medicine, physics, chemistry, agriculture, biology, livestock medical, engineering and technology, society, environment and behavioral science, art and humanities, etc. These databases cover journals, proceedings, and monographs in the sciences, social sciences, and the arts and humanities. The service includes complete bibliographies and references.

ISI's products and services include Citation Index, Current Awareness, Specialized Content, Evaluation/Analytical Tools, Information Management Tools, ISI Custom Marketing and Intelligence, Research Community, etc. Moreover, these products and services are provided in print, on diskette, on CD-ROM, on magnetic tape, and online via the internet. ISI began publication of its first citation index, the Science Citation Index in 1961. Since then, the company has developed other indexes, such as the Social Science Citation Index and the Arts & Humanities Citation Index. These citation indexes

are not only important search tools for the general public, but are also used as tools for faculty evaluation, journal evaluation, and institute evaluation.¹²

In the early 1960's, Eugene Garfield and Associates developed two pilot projects that would test the viability and efficiency of citation indexing. The first project involved the creation of a database that would index the citations of 5,000 chemical patents held by two private pharmaceutical companies. The referenced citations in this instance were to prior patents, the documentation sources that the government patent examiners were using to support a decision to grant or deny a patent. The connections that the patent citation index made were then analyzed with two comparable classifications and indexing systems that were currently being used by the participants. Based on this investigation and analysis, the project sponsors determined that citation indexing permitted the retrieval of relevant literature across arbitrary classifications in a way that subject-oriented indexing could not.

A second pilot project in 1962 involved Garfield's recently incorporated enterprise, the Institute for Scientific Information, with the United States National Institutes of Health in building an index to the published literature on genetics. This project was far more complex in nature than the patents index. Three databases were built to cover the literature over 1 year, 5 years and 14 years with a varying number of source publications indexed in each. While this project was to test the feasibility and utility of a narrow, discipline-oriented citation index, at completion, it was concluded that the database with the *most broadly based set of source publications* formed the most comprehensive and useful guide to the published literature in the field of genetics. The database for the single-year term had drawn not just on journals that were primarily devoted to the field of genetics research but had drawn as well from a large pool of journals that published genetics papers on a more peripheral or occasional basis. Additionally, while the automated system required a certain level of effort in standardizing the entries from a wide variety of published materials, the project demonstrated the cost-effectiveness of citation indexing as opposed to the expense of traditional subject indexing processes.

¹² Kuang-hua Chen, "The Construction... pp. 415-416.

While, at the time of the project's completion, the government sponsors chose not to subsidize the development of a national citation database, Eugene Garfield was encouraged to move ahead with the private publication of his multidisciplinary citation index as the first edition of the *Science Citation Index* (SCI). His achievement lay in establishing the utility and objectivity of a citation index in pulling up related papers in published literature that at first glance might not have seemed pertinent to the researcher's inquiry. Today, it is considered as one of the most reliable of resources in tracing the development of an idea across the multitude of disciplines that are part of our body of scientific knowledge.¹³

III. Development of Citation Index

Eugene Garfield is an important figure in terms of citation indexing. History of emerging of citation index is related closely to him since he was deeply involved in the research relating to machine generated indexes in the mid-1950's and early 1960's. Not only that, but evolving of it also is connected to him. He published the first edition of Science Citation Index, covering 1961-source literature, required six volumes. It was made available for purchase in 1963. The *SCI* then and now represents the most comprehensive citation index to the scientific journal literature. Today, the Web-based version of that index covers 5,600 journals across more than 150 scientific disciplines.

After its first publishing, the *SCI* was launched on a current quarterly basis with an annual cumulating in 1964. In 1970, a five-year cumulating covering 1965 to 1969 was produced. Eventually cumulated citation indexes for 1945 to 1954 and 1955 to 1964 were created. Few people, even at ISI, believed that the costs of these indexes could not be recovered, but Garfield believed the leading research libraries of the world would eventually buy these indexes for historical and sociological research. He felt they were essential to the future value of *SCI* as a tool for contemporary history of science and technology. His prediction proved correct. The *Social Sciences Citation Index* (*SSCI*) was launched in 1965 and its source literature now goes back to 1956.

The *Arts and Humanities Citation Index* (*A&HCI*) was started in 1975. Since 1980 the *SCI*, *SSCI*, and *A&HCI* have been offered in CD-ROM format. Also in 1975,

¹³ *History of Citation Indexing...*

ISI's new *Journal Citation Reports (JCR)* was included as the last volume of the *SCI*. The *JCR* would eventually become a separate service. *JCR*'s current impact factors and other citation data have a great influence on journal and research evaluation worldwide.¹⁴ Standard measures of relevance made popular by the Cranfield group led by Cyril Cleverdon could not be applied to the evaluation of citation indexing because by using cited reference searching a researcher was, in fact, able to retrieve papers that at first glance might not seem relevant to his or her study. Yet these references often proved crucial to research, and users of the *SCI* soon recognized this advantage. The *SCI*, *SSCI*, and *A&HCI* are considered today to be among the most reliable resources for tracing the development of scientific or scholarly ideas beginning with the primordial papers or books on any given topic.

In 1997, ISI launched a web-based and completely integrated continuation of the *SCI*, *SSCI*, and *A&HCI*. Known as the *Web of Science*, it bridges the cultures of the arts and sciences, providing integrated coverage of all the academic disciplines via the Internet or intranets. Based on the latest information retrieved on January 31, 2006 from <http://www.lib.rpi.edu/help/guides/webscience.html>, *SCI* covers 5300 major journals¹⁵ across 164 scientific disciplines containing full database with over 14 million articles and there is author-written abstracts for ~70% of articles in the database. It has subscribed since 1945 up to now and continuous updated weekly. In addition, *SSCI* covers 1,700 journals across 50 disciplines, and selected items from 3,300 additional titles containing full database with almost 3 million articles and there is Author-written abstracts for ~60% of articles in the database. It has subscribed since 1956 up to now and continuous updated weekly. Furthermore, *A&HCI* has 1,100 journals and selected items from 6,800 additional titles providing full database with over 2.3 million articles and be found added indexing to clarify article contents. It has subscribed since 1975 up until now and continuous updated weekly. Therefore, Web of Science has online links to full text of

¹⁴ E. Garfield. "The Permuterm Subject Index: an Autobiographical Review". *Journal of the American Society for Information Science*. Vol. 27 (1976), pp. 288–291.

¹⁵ Based on a report retrieved from <http://www.lib.utexas.edu>, *SCI* covers nearly 6,000 journals across all science and engineering disciplines. Google Scholar and Elsevier's Scopus have emerged as new competitors to ISI, but as yet these systems are unproven in citation indexing.

articles from selected publishers with whom we have electronic agreements in place; more publisher full text links will be added over time.

Citation networks are an inherently hypertext approach to navigation of the literature: Users can instantaneously search the bibliographic literature independent of time. Bibliographic coupling, called related records, provides an additional method of clustering documents. It is significant to the history of citation indexing that Garfield began his career as a chemist. In the same period that Current Content (CC) was growing from one to seven editions across the academic and industrial spectrum, Garfield also pursued his dream of a unique chemical information service. Thus, in 1960 he launched the *Index Chemicus*. It is now approaching its fortieth anniversary and has culminated in the development of an integrated chemical compound and reaction database fully linked to the citation index.¹⁶

IV. Use of Citation Index in Web of Science

Just as earlier mentioned, citation indexing makes links between books and articles that were written in the past and articles that cite those older publications. In other words, it is a technique that allows us to trace the use of an idea (an earlier document) forwards to others who have cited it. The evidence that we take as indicating this "relationship" between earlier research and subsequent research are the references, footnotes, or endnotes (citations) in the more recent work.

This following explanation simply shows some steps in terms of using for citation indexing:

- Who is citing your research, and how it is being used to support current research.
- Tracking the research activities of colleagues or competitors.
- Following the history of a method from its inception through to today.
- Finding relevant articles on subjects that are difficult to express with a few keywords.
- Following a subject over time, even if the terminology describing it evolves.¹⁷

¹⁶ J. Trolley and J. O'Neill. "The Evolution of Citation Indexing...."

¹⁷ *Web of Science: a Database Guide*. Retrieved on January 31, 2006 from:
<http://www.lib.rpi.edu/help/guides/webscience.html>

For instance, there is an informational "ancestry" of a current idea as it is expressed in the literature. The author of the current idea (his journal article) through his footnotes or his research report's citations notes that ancestry. Suppose that there were 12 citations made in a current journal article about some research topic. Just as there might be four "assigned" subject headings to this current journal article for indexing purposes in some indexing database, we could also find the 12 citations to previous journal articles and books "assigned" as headings to "index" this article under as well. Were we to do that for all of the current journal articles we are adding to our indexing service, we could look up current articles by subject headings *or by authors of previously published materials that were cited by articles that are more recent*. That is the trick: we tread the citations found in recent articles as "index entries" to be put in our indexing database for retrieval purposes.

How does this technique change a searcher's strategy for locating information? This is enabled to follow a concept's or idea's or methodology's use by other scholars. We can refer to ISI as a company that makes citation-indexing services that builds a database of current articles coming from thousands of journals that it selects to use for this purpose. For the social sciences, there are about 8,000 journal titles whose separate issues are analyzed as they are published to see what journal articles are in them.

Thus, we can say that citation indexing is a way to look forward in the literature from the starting point of a particular paper or group of papers. This is a different and complementary approach to ordinary word-based literature searching, which looks backward in the literature from the present time. For example, if we have an excellent paper on a particular topic that was published in 1992, we can use Science Citation Index (via Web of Science) to find papers published after 1992 that cited that paper. Citation implies a direct subject relationship between the papers. Therefore, by searching for later papers citing your known paper, you can find more documents on the same or similar topic without using keywords or subject terms at all. To know more detail how to use the Web of Science, click the following web site:
<http://www.ou.edu/webhelp/librarydemos/isi/>

Figure 1: The main menu before going to Web of Science



Figure 2: The Web of Science menu will appear after entering password correctly



V. Concluding Remarks

Based on at length explanation above, it can briefly be said that citation index is to link between books and articles that were written in the past and articles that refer to those older publications. By this way, it will be enabled to trace the use of an earlier document idea to others who have used it in which their relationship can be known through the references, footnotes, or endnotes in the more recent work.

Citation indexing was developed in the late 1950s as a new way to monitor, organize, and retrieve the literature. The Science Citation Index is one of the first large-scale, machine-generated indexing systems. Over the course of forty years, it has become an essential tool for the scientific community. In particular, the SCI provided a new dimension in indexing, permitting the researcher to trace the literature both retroactively and retrospectively. Thus, the SCI complemented traditional bibliographic databases that are designed to assist the researcher with current awareness, to aid in retrieving relevant material from an ever-larger body of literature, and to help separate the more relevant from the very relevant publications.

Web of Science, from the Institute for Scientific Information, includes all three ISI citation indexes: *Science Citation Index*, *Social Sciences Citation Index*, and *Arts and Humanities Citation Index*. This Web has online links to full text of articles from selected publishers with whom we have electronic agreements in place; more publisher full text links will be added over time.

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