The Quest for Certainty: Science Citation Index

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Any real evaluation of *Science Citation Index* must be based on an extensive use test, and there has not been time for that. Most of us are accustomed to literature searches that begin with a subject. This, of course, presents real problems if one wishes complete coverage of the subject, because subject matter indexes are no better than the choice of words indexed. However, we are used to them —like an old shoe, they are comfortable.

Science Citation Index (vols. 1–5. Prepared and published by the Institute for Scientific Information, Philadelphia, 1963. 2704 pp. $700) is primarily a list of authors' names, and insofar as names can be identified with subjects, a citation index search can be thought of as having subject matter content. A citation index on any subject has the advantage of being complete within established boundaries. Still to be tested by scientists is the question of whether the virtue of completeness compensates, to the scientist, for the work necessary to relate authors' names to scientific content. A trial run which I conducted with some graduate students resulted in a split vote.

With these comments in mind, I will "review" the first set of the *Index* as a novel and interesting example of a device to cope with the scientific literature explosion.

To form these first volumes of the *Index*, 613 journals (for 1961) were selected, and a rather casual reading indicates that it is a well-chosen list. The senior author of each article became a unit in a master source-article index. Each senior author of each reference cited by source authors then became a unit of the *Science Citation Index*. By proper machine work one then ends up with a list of 102,000 names with journal references, followed in each case by the names of all who have cited the paper of which the man was senior author and references to the papers in which he was cited. It is important to emphasize that the references in the *Index* list are not limited to the "source year" (1961) since, in most cases, the source articles cited references from prior years. If a name appeared as senior author in one of the source journals in 1961 or was cited by a senior author in 1961, then that name and reference appear in *Science Citation Index*.

In use, the name of a senior author is necessary to make a start. Given that ingredient one can very quickly assemble a list of names, with journal references, of other senior authors who have cited him, presumably for some reason. Thus, as is pointed out repeatedly, the *Index* can be used to trace citations forwards as well as backwards. As Garfield (*1*) points out, this forward-in-time method shows clearly that Einstein's diffusion equation has had an influence on present day work dealing with properties of particles in solutions. Similarly, Aristotle has influenced recent reviews in physiology. It is perhaps less surprising that Aristophanes influenced a recent author's writing in the *Eugenics Quarterly*.

Reading about and trying to use the *Index* has convinced me that it will be of value and that all scientists should indeed examine it and consider its potentialities. I cannot agree completely with Garfield's (*2*) statements: "Whether or not citation indexes are useful is a question that has now been answered. We have enough favorable experience in using them to know that they are both desirable and useful." This statement may be correct with respect to its use by administrative personnel and librarians; its usefulness in advancing the wisdom of science must be judged in the future by scientists.

Science Citation Index has the great advantage that, once conceived, its formation is automatic with only routine intellectual input. Its usefulness in advancing knowledge depends on the user. This is good, and the value of the system must be determined in practice. I know of no theoretical way to predict whether the noise level of *complete* citation coverage will drown out individual thought. I can see how the *Index* could have been of great assistance to Pliny the Elder, to Gesner, and possibly to Lamarck. I find it hard to think that Newton, Lavoisier, or Loewi would have used it. The closer one gets to encyclopedics or technology the clearer are the uses of the *Index*. On the other hand, the larger the basic science contributions to *understanding* the more remote the many voices of the published literature become. On the basis of having observed the use of scientific literature by my scientific friends over many years, I offer two axioms that illustrate a personal bias on my part. The importance, to a scientist, of *knowing the literature* is (i) inversely proportional to the size of the idea (many people think of many small things) but (ii) directly proportional to the proximity to technology (finding out someone else did something saves time—sometimes).

There is something wistfully comforting in the thought of knowing all facts. It is an old idea that, if the scientific facts are known, wisdom follows. This idea has virtues which are occasionally built into Utopias but which are also treated less sympathetically in Swift's *Voyage to Laputa*. The Utopian aspect is illustrated by one of Garfield's citations (*2*) and by a noun that he uses enthusiastically. Garfield characterizes *World Brain* by H. G. Wells (*3*) as "a magnificent, if premature, plea for the establishment of a world information center." I cannot share his enthusiasm. As the following quotation shows, Wells clearly felt that all the facts relating to many important problems were kicking around and that all one needed to do was put them in orderly array.

> A World Encyclopaedia no longer presents itself to a modern imagination as a row of volumes printed and published once for all, but as a sort of mental clearing house for the mind, a depot where knowledge and ideas are received, sorted, summarized, digested, clarified, and compared. It would constitute the material beginning of a true world brain.

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As a biologist, I must shudder that Wells left out such vital functions as assimilation, excretion, and egestion, but the description also smacks of an authoritarian intellectual soup that is not appealing to me. The impression of ultimate relaxation into a sort of final truth is heightened by Garfield's (*2*) statement that the *"Science Citation Index* is a harbinger of things to come—a forerunner of the World Brain" and by his devotion to the word "nirvana." Nirvana, of course, derives from the Sanskrit word meaning "to blow out." Webster (*4*) lists the usage of the word as "extinction of the flame of life," "the dying out of the threefold fire," and "oblivion to care and pain"—hardly an attractive prospect for a creative scientist.

There are other faint auras of authoritarianism in some discussions of information handling systems. As Wells puts it, "It is *Science* and not *men of Science* that we want to enlighten and animate our politics and rule the world" (in *World Brain*). The report of the President's Science Advisory Committee (*5*) draws an analogy that illustrates the point.

> Lawyers have used a citation index, *Shepard's Citations*, for more than 100 years. Each year Shepard's lists all appellate decisions that have cited any previous cases. Since the law is unified in somewhat the same way as is science in that the rule of precedent connects what happens later with what happened earlier, it is not surprising that a bibliographic tool so useful to the lawyer could also be useful to the scientist.

My understanding is that a precedent in law is an authoritative example, a judicial decision, and I doubt that most references cited in science would be so regarded.

Properly speaking, the major use of *Science Citation Index* would be to contribute to science. However, the advertising blurb (*6*) "What is the *Science Citation Index*" lists "other applications" that I wish I could sweep under the rug, but they should be reported in the interests of a complete discussion and as examples of "uses," many of which will be easier to put into effect than retrieval of scientific information. (The "other applications" are quoted in full.)

Although the *Science Citation Index* was originally designed to be used for simple, direct retrieval of scientific information, it can facilitate utilization of the literature for sociological and historical evaluations and applications including:

The evaluation of the impact of a paper, a man's total works, a journal, material published during specific time intervals, the works of students of specific teachers, works coming out of a university or department, work financially sponsored by a specific agency.

The *Science Citation Index* may be used to good advantage in writing historical reviews and descriptions of the evolution of specific subjects.

It may be used to study journal utilizations, measuring literature habits of scientists, effectiveness of specific journals in reaching specific audiences, purchasing requirements of specific libraries, library's need for maintaining files of most-frequently requested reprints, utilization of literature of one country by another, impact of scientific discoveries and inventions on technological development.

Misused, some of these "other applications" could cause some important practical and political difficulties, tending to foster the idea that what has been good in the past is best for the future. (A high "impact factor" means more support?) Garfield (*1*), who I assume is the author of these statements, discusses possible misuses of the *Index*.

Science Citation Index at the very least provides an easy way of looking at the complexity of modern scientific literature in an orderly fashion. It should facilitate a search for, and an answer to, the question (*7*) "Is the literature worth keeping?" posed by John Maddox:

> By its meek acceptance of the ponderous accumulation of the current literature, indeed, the scientific community has lent support to the somewhat Freudian view that scientists, collectively as well as separately, have come to regard this mountain of printed paper as their primary product. . . . Clearly, there is good reason for asking that some institution, and preferably one of the learned societies, should take the lead in a search for vastly improved methods of presenting scientific information to a scientific readership. Certainly it is ingenuous almost to the point of dishonesty that the scientific community should so persistently badger the librarians for more and more elaborate methods of cataloguing the scientific literature. . . .

References and Notes

1. E. Garfield, *Am. Documentation* **14** (4); 289-291 (1963).
2. ———, *Science* **144**, 649 (1964).
3. H. G. Wells, *World Brain* (Doubleday, Garden City, N.Y., 1938).
4. Webster's *New International Dictionary*, second unabridged edition (Merriam, Springfield, Mass., 1961).
5. A. M. Weinberg *et al.* (President's Science Advisory Committee) *Government and Information* (GPO, Washington, D.C., 1963).
6. What is the *Science Citation Index?* (Inst. for Scientific Information, Philadelphia, 1964).
7. J. Maddox, *Bull. Atom. Scient.* **19** (9), 14 (1963). I regret closing this discussion with a citation and quotation. Thinking about citation indexes has put me in a citation frame of mind, and, besides, Maddox says things with a nice flair. My use of citations in this discussion represents a habit I deplore—that is, the use of citations to express opinions. This seems to me legalistic and unjustified, and the presumption is that repetition of opinion leads to certainty. Garfield's article in *Science*, cited above is a case in point. Some 50-odd citations are made, many of them expressing opinion, but the largest single group comes from the author of the source article or from his associates. I suggest that this sort of reliance on authority does not give proper recognition to individual thinking—and after all the thinking of an individual is a very important component of the *advancement* of science.

Cabot Foundation Symposium

The Formation of Wood in Forest Trees. A symposium. Martin H. Zimmerman, Ed. Academic Press, New York, 1964. vxi + 562 pp. Illus. $16.

The second Cabot Foundation Symposium was held at the Harvard Forest (Petersham, Massachusetts) in April 1963. The purpose of the symposium was to bring together, for a few days in a quiet and peaceful place, a small but internationally constituted group of invited scholars whose work has had some bearing on anatomical, physiological, or biochemical aspects of wood formation.

This book is the record of proceedings of that symposium. It includes 29 papers, as well as transcripts of the interesting and enlightening open discussions that followed presentation of the papers. These discussions should assist the reader in orienting his own thinking and in evaluating some of the ideas presented.

The papers are grouped into sections dealing with (i) the evolution, anatomy, and activity of cambium and the anatomy and ultrastructure of its derivatives; (ii) the biochemistry of cambial derivatives, including biosynthesis of cellulose, lignin, and related compounds; (iii) the translocation of photosynthate to the cambium and the relation of translocation, storage, and mobilization of reserves to growth; and (iv) the internal and external control of wood formation. This last section is the most voluminous and includes discussion of hormonal regulators, mechanical pressure, water supply, and various light and temperature conditions as possible controlling factors. It, perhaps more than the first three sections, leaves one with the impression that the vast mass of available information is in continu-