Commentary: Fifty years of citation indexing

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About 30 years ago we began the series called 'This week's Citation Classic'. Over the next 15 years, we asked thousands of authors to write commentaries on these highly cited papers (www.citationclassics.org). So I was surprised to be asked to do the same for my 1955 paper in *Science*.[1] As a confirmed citationist, I must point out that it is not my most cited work. It is my 1972 paper in *Science*,[2] on using citation analysis to evaluate journals, which has attracted much more attention, although the 1955 paper is far more significant. In that sense, I am like many other authors who feel that their most-cited work is not necessarily their best. My most-cited work is in fact my 1979 book *Citation Indexing*.[3]

Tracing the genealogy of citations to this paper reveals the evolution of the concept of citation indexing from a system for information retrieval to a tool for research evaluation. In a paper that I had prepared at the request of the then editor of *Science* in 1995, but rejected by his successor, I suggested that the tail was now wagging the dog.[4]

In the first few decades after the appearance of this 1955 paper, and its 1964 successor,[5] most of the citing papers concerned the pros and cons of citation indexing for information retrieval. In those days there was a preoccupation with controlled vocabulary-based indexing. So we created the Permuterm Subject Index as a natural language supplement to the Citation Index. Henry Small much later would formalize the role of citations as concept symbols.[6]

An early portent of the use of *SCI* for evaluating science was the 1967 paper by Margolis.[7] By that time Irving Sher and I had already done the simplistic exercise of sorting the *Science Citation Index* to produce a list of the 50 most cited authors. About one-third of these proved to be Nobel Prize winners and almost all were authors 'of Nobel Class'.[8]

When the 1955 paper was published there were no computers. Punched-card methods were considered revolutionary. Even 10 years later, when we launched *SCI* punched cards were used as input to the first primitive IBM computers to produce the printed *SCI*.

In those days, Vannevar Bush's concept of Memex was as close as we came to thinking about the idea of an internet.[9] But the linking properties of citations were fully recognized and given formal descriptions by Ralph Garner[10] and Derek Price.[11] The idea of mapping science based on the linking properties of citations was well understood and used to explore the historiography of DNA.[12] Early on a small group of people saw in the *SCI* its significant potential for bibliometric evaluations. It would be tempting to outline the various significant papers and reports that have eventually made the *SCI* a standard tool in the hands of science policy analysts and others interested in evaluation, including those who like to play parlour games predicting Nobel Prizes. However, the *SCI* is now not only considered essential in libraries and elsewhere but also sufficiently popular to engender competition from Elsevier, the world's largest journal publisher, as well as Google Scholar. Both have creatively rediscovered citation linking. Indeed Google's technological success as a search engine is based on its citation ranking process.

Reading the 1955 paper once again reminds me of the inspiration that the concept had from my early interest in encyclopaedism. In 1970, Manfred Kochen commented on its role in the worldwide encyclopaedic movement.[13] Today the Internet has enabled the development of Wikipedia and other grand schemes that will make the H.G. Wells dream of a World Brain a reality.

The relatively low memory capacity of computers in the early days would prevent their application for these uses for three or more decades. Since then the network properties of citation indexes have been explored by numerous investigators. These were pioneered by Derek deSola Price in his 1965 network[11] paper. It appeared shortly after my 1964 paper in *Science*[5] describing not only the *SCI* as a new dimension in indexing but pointed to its use in science evaluation. It is easy to forget today that even over a decade after the first *SCI* annual was published libraries hotly debated whether to purchase it to supplement or even replace a combination of traditional indexing services. Eventually the basic conservatism of scientists and librarians was overcome. This evolution paralleled the growth in computer memory capacity—from the 16K memory of the IBM 1401 computer we used in those days to the gigabyte capacity we take for granted today.

While the *Web of Science* is now routinely used in industry for alerting purposes, one of my greatest disappointments has been the failure of scholars to use it as a tool for selective dissemination of information. Today SDI is performed by weekly or daily alerts, but the first such service, the *Automatic Subject Citation Alert (ASCA)*,[14] was started in 1965, a year after we started *SCI*. It is still difficult for most users to develop citation consciousness.

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