Current Comments

Price's Citation Cycle

On a few occasions in the past, I have reprinted in *Current Contents* (*CC*) papers by close colleagues that seemed particularly relevant to ISI's basic mission to improve scientific communication. In the paper that follows this essay, my colleague and friend of 20 years, Derek Price, has written about citation analysis and the citation cycle in a particularly illuminating style.

I have always been envious of Derek's special aptitude for applying his mathematical training to scientometric problems. He has a special personality as well; he has a way of mesmerizing an audience with his Oxbridge accent, his aplomb, and his flair for the dramatic metaphor. Some scientists are irritated by his "outrageous" assertions that often come without warning, but though he sometimes seems intolerant of other's ideas, he has never been unwilling to admit that he was wrong. He is a formidable, yet affectionate, adversary.

I have often had to chastise Derek about his name and his manner of complaining about our treatment of it in the *Science Citation Index* (*SCI*). As many readers probably know, his full name is Derek John de Solla Price. De Solla is a middle name, *not* a part of Derek's last name. But unless he publishes his works as Derek John de S. Price, we must index his work under De Solla-Price. Price doesn't understand why we must add the hyphen. However, there is usually no way for our indexers to know (other than personal knowledge) that his last name is just Price. Of course, his work should properly be indexed under Price, as we index under any author's last name.

Price was born January 22, 1922, and named Derek John. His father, Philip Price, was a tailor, and his mother, Fanny de Solla, a singer. Both came from early 19th-century Jewish immigrant families and Derek is understandably proud of these origins. About 1950 he adopted his mother's Sephardic last name, de Solla, as a middle name.

Born in Leyton, a northeast London suburb, Derek was educated at British state schools. In 1938 he took a position as a physics lab assistant at the South West Essex Technical College. Since that time his work has taken him many places, including one three-year stint teaching applied mathematics at Raffles College (now the University of Singapore) in Singapore. He did war research, taught college science courses, received his BS in physics and mathematics in 1942, and his PhD in experimental physics in 1946 (both from the University of London), before concentrating on what is now his speciality—the history of science and technology. Price also has a PhD in the history of science from the University of Cambridge, and an honorary MS from Yale.

Price has had more than his share of achievements. He formulated the law of exponential growth of scientific literature, which he first presented in a paper to the VIth International Congress for the History of Science at Amsterdam in 1950.[1-3] This law has been a consistent basis for much of his subsequent work. He formulated the law while reading consecutive issues of the *Philosophical Transactions of the Royal Society* from 1665 to 1850. He was storing this complete set in his home for Raffles College

Derek J. de Solla Price

where it is attracting a larger and larger proportion of our most gifted and imaginative students."[6] Both books have been highly cited—enough to classify them as classics.

Price has been extremely influential in the field of history of science at Yale University. He has been at Yale since 1959, when he was appointed Avalon professor of history of science. In addition to his duties there, he has been involved in numerous other scientific activities. He has worked with the United Nations Educational, Scientific, and Cultural Organization (UNESCO) and other agencies as a science policy advisor, and has been a consultant to many nations, among them Denmark, Germany, Switzerland, Brazil, Argentina, Israel, Egypt, Australia, India, Pakistan, the East European nations, and the Soviet Union. He helped found and served as the first president of the International Council for Science Policy Studies, under the auspices of the International Council of Scientific Unions, an international organization which promotes scientific research.

Derek has continued with his own research throughout, and has published extensively during his career—so far, more than 200 scientific papers and six books, and more are on the way. His works have covered various subjects, many of them dealing with ancient scientific instruments. One of his proudest achievements was the solution to the problem of the Greek Antikythera mechanism. This geared mechanism was discovered in 1900, and though it was of great interest to scholars, its function was unknown. Using gamma-radiology photographs of the inside of the object, Price showed it to be a sophisticated mechanical calendar previously not thought technically possible in the 1st century BC.[7]

He has held more honorary posts and fellowships than I could ever hope to list here, and he has won many awards. One of the most recent was the Society for the History of Technology's Leonardo da Vinci medal. This medal is awarded annually to an individual "who has

while its library was being built, and took the opportunity to read it.

While working on a thesis for his second doctorate, Price accidentally discovered a Middle English manuscript which described the construction of a planetary calculating instrument. He identified the piece as a companion to Chaucer's 1391 *Treatise on the Astrolabe.* He then proved it to be an author's draft holograph, the only lengthy piece of Chaucer's writing known.[4]

In 1961, Price published the first of his well-known books on the history of science, *Science since Babylon.*[2] In it, Price began developing his idea of the exponential growth of science. Said one reviewer: "All who are interested in general history, as well as the history of science, should read and ponder upon this essay."[5] The same theme was expanded in his later book, *Little Science, Big Science,*[3] published in 1963. Writing in the *New York Times Book Review,* John Pfeiffer, author of *The Changing Universe,* commented that Price had succeeded in this book "in bringing together considerable information on one of the outstanding phenomena of the times, the rise of science to a point

made an outstanding contribution to the history of technology by research, teaching, publication, or otherwise."[8] When the award was presented, the Society had this to say about Derek: "Derek de Solla Price: You have left the mark of your researches throughout the broad field of the history of technology from the core to the periphery. At all points you have shown the skill of a virtuoso, and the depth of perception which marks the truly gifted researcher combined with the foresight which has opened new areas for others to follow."[8] There is little that I can add.

Derek has long been associated with ISI. He has served on the editorial advisory board of the *Science Citation Index* since 1964. He also serves on the boards of the *Arts & Humanities Citation Index*[TM], the *Social Sciences Citation Index*", *CC/Arts & Humanities*, and *CC/Social & Behavioral Sciences*. He chides us constantly for neglecting to exploit more adequately the statistical data which we generate each year in the creation of our indexes and for neglecting the more sophisticated statistics we could generate. I understand his frustration, but such desires have usually had to take second place to our production needs. He compensates partially for our failing, however, by putting our data to good use in the following paper, as he has done on numerous occasions, such as his 1965 paper, "Networks of scientific papers."[9]

In recent years, Derek has been preoccupied with the process and theory of cumulative advantage.[10, 11] It is cited and used in the paper which follows, and was discussed in my recent essay on Bradford's law.[12] The question of cumulative advantage was first raised by Robert K. Merton in 1942.[13] The paper reprinted here tackles a new aspect of citation analysis, however. In this article, Derek tours the citation cycle, and discovers a built-in structure to citation relationships. He provides a model for this structure that can help the student of citation analysis visualize the various dimensions and interworkings of the citation cycle. I am pleased to be able to reprint this important contribution to the study of science, and pleased that it gave me a chance to offer this small tribute to my great friend Derek Price.

* * * * *

My thanks to Susan Fell Evans for her help in the preparation of this essay.

REFERENCES

1. **Price D J D**. Quantitative measures of the development of science.
   Arch. Int. Hist. Sci. 1951(14):85-93, 1951.
2. --------------. *Science since Babylon.* New Haven: Yale University Press, 1975. 215 p.
3. --------------. *Little science, big science.* New York: Columbia University Press, 1963. 118 p.
4. --------------. The equatorie of the planetis. *Bull. Brit. Soc. Hist. Sci.* 1(9):223-6, 1953.
5. **Fleming D**. *Science since Babylon.* (book review). *Amer. Hist. Rev.* 68:170, 1962.
6. **Pfeiffer J**. Problems raised to a higher level. *N.Y. Times Book Rev.* 16 June 1963, p. 6.
7. **Price D J D**. Antikythera mechanism. *Proceedings of the Fourteenth International Congress of the History of Science,*
   19-27 August 1974, Tokyo and Kyoto, Japan. Tokyo: Science Council of Japan, 1975. p. 193-6.
8. The Leonardo da Vinci medal. *Technol. Culture* 18:471-8, 1977.
9. **Price D J D**. Networks of scientific papers. *Science* 149:510-5, 1965.
10. --------------. A general theory of bibliometric and other cumulative advantage processes.
    J. Amer. Soc. Inform. Sci. 27:292-306, 1976.
11. --------------. Cumulative advantage urn games explained: a reply to Kantor.
    J. Amer. Soc. Inform. Sci. 29:4, 204-6, 1978.
12. **Garfield E**. Bradford's law and related statistical patterns.
    Current Contents (19):5-12, 12 May 1980.
13. **Merton R K**. The normative structure of science. (Storer N W, ed.)
    The sociology of science. Chicago: University of Chicago Press, 1973. p. 221-78.