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"Current Comments"

The 'Obliteration Phenomenon' in Science--and the Advantage of Being Obliterated!

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Recently, I drafted a paper on the seeming constancy each year of the ratio between number of cited papers and total citations ('Garfield's constant'). It set me thinking about some older constants--for example, the history of the ratio between the diameter and circumference of a circle.

Archimedes estimated the value of this constant in the third century B.C. In his treatise, *Measurement of the Circle*, he placed it within very narrow limits (for his time and his purposes): greater than 3 10/71 and less than 3 1/7. Subsequently, most of Archimedes' works were lost, and began to be revived only in the Middle Ages. Meanwhile, the fraction 22/7 was used.

In the sixteenth century Ludolph van Ceulen calculated the ratio to 35 decimal places--making it more precise than ever before. In Germany, in fact, as late as the middle of this century, it was called the *Ludolfian number*. Earlier the ratio had been designated by the letter *E*, and later it would be designated by using a small square. In 1706, William Jones first used the Greek letter π, and by the middle of the eighteenth century the familiar *pi* had become almost universal.

In 1853 pi was calculated to 500 decimal places; in 1959 to 10,000; and more recent computer studies have calculated it to 100,000 decimal places. The motivation for such fastidious precision is not to make practical use of the resulting number, but to discover regularities.[1]

What if, by impossible quirk, Archimedes' discovery had taken place today?

To begin with, it would be designated not by a Greek symbol, which can't be handled by many typewriters and computer terminals, but by the logical modern name *Archimedes' constant*. Once the discovery had been reported in a contemporary journal, mathematicians could be expected to begin using and citing Archimedes' constant as often as today's biochemists cite Lowry's method for protein determination.

But the number of mathematics papers published today is much smaller than the number of biochemistry papers, so it is probable that even the primordial citation to Archimedes' constant would be cited less often than Lowry's method. More significant, while the term *Archimedes' constant* would become increasingly familiar even to school children, scientists themselves would begin citing Archimedes' primordial paper less and less, until finally citations to it would be dropped, and the idea of citing it at all would finally disappear. While *Archimedes' constant* would survive, his original paper would, in terms of citation analysis, have been obliterated.

The 'obliteration' or 'palimpsest' phenomenon affects citations to discoveries that are so quickly absorbed into the fabric of science and technology that they become (to use sociological jargon) too quickly institutionalized. The term *palimpsest* refers to a piece of

parchment used for manuscript copying more than once--earlier texts having been erased to make room for some newer work. The erased texts can sometimes be deciphered by close examination and special techniques. Thus, like a trace of writing which is rubbed out to make a place for a newer message, certain scientific documents are obliterated in order to make way for citations to more pertinent, less well-known, or more modern papers.

This process of scientific obliteration was first described in 1968 by Robert Merton in his beautifully conceived book, *On the Shoulders of Giants:* "I should like to identify the anatopic or palimpsestic syndrome in some detail. Naturally enough, most of us tend to attribute a striking idea or formulation to the author who first introduced us to it. But often, that author has simply adopted or revived a formulation which he (and others versed in the same tradition) knows to have been created by another. The transmitters may be so familiar with its origins that they mistakenly assume these to be well-known. Preferring not to insult their readers' knowledgeability, they do not cite the original source or even refer to it. And so it turns out that the altogether innocent transmitter becomes identified as the originator of the idea when his merit lies only in having kept it alive, or in having brought it back to life after it had long lain dormant or perhaps in having put it to new and instructive use."[2]

The same phenomenon was noted by Joshua Lederberg in 1972. Referring to the work of geneticists in the 1940s, he said, "If we sometimes omitted a specific citation to the original work, this is testimony to his name (like Mendel's) having already become a household word, too familiar to require routine attribution."[3]

Each scientific discipline has its own language: its own peculiar shorthand, its jargon, its slang, and its protocol regarding citations. Every paper on atomic physics, for example, doesn't need to cite Einstein's 1905 paper; nor does every mathematics paper need to cite Archimedes. Historians of science might applaud the adoption of a rigid protocol aimed at completeness above all else, but most working scientists would abhor it. They'd find themselves so busy locating references, cross-checking, and compiling unwieldy lists of citations that they'd have little time left for research. Scientists would become frenzied librarians, and journals would become obese with citations. We would have just what my late friend Ted Herdegen was accustomed to 'cite' when he felt it necessary to curb the overthoroughness of some perfectionist (usually new) subordinate in the parameters of a 'quick-and-dirty search'. "Remember," Ted used to say, "I'm not interested in a bibliography on the Erlenmeyer flask!"

But too little attention to citations could be just as dangerous. The conduct of the search for truth requires that assertions be checked, that conclusions be doubted, that results be replicated. And citations contribute to education. Neither too much nor too little attention to citations will do: what is needed is just enough. Fundamentally, the function of a citation is no different from that of the paper itself: to supply the reader with information he doesn't already have. Most scientists will not cite a source if it has already been absorbed into the body of scientific knowledge, since the reader is already aware of it.

For any scientific paper there are certain earlier works that 'must' be cited. These are papers that any honest scholar would be ashamed to omit from his bibliography--and that any careful referee would insist on. But less than 100 years ago, scientists were not so careful. The availability of journals was

severely limited, and most scientists depended on personal letters, private libraries, and face-to-face meetings to keep up with the 'literature'.

So it is remarkable that modern scientists have reached such a broad consensus regarding the protocol of citations. Just how broad this consensus is can be illustrated by an experiment I have performed every year for the past ten years, using as subjects my information retrieval class at the University of Pennsylvania. I once wrote a review paper which was presented to a meeting of the American Chemical Society. The editor of the then new *Journal of Chemical Documentation* was so eager to have the paper that he took the manuscript I had read to the audience, unaware that it didn't contain my bibliography of forty-five references. The paper was published without the bibliography. Each year, I have given this paper to my students and instructed them to indicate where they felt a reference was needed. Over the years, the range has been from fifteen to seventy-five, but the overall average has remained about forty-five!

My experience in dealing with thousands of papers in all fields has confirmed this: some reference lists are inflated, others are deficient, but on average we seem to arrive at the right number of citations.

For the benefit of historiography, we need to develop a means for identifying cases where obliteration was especially rapid. This might call for the use of an 'obliteration factor'--perhaps calculated in a manner analogous to a radioactive half-life. Studies now being carried out at ISI® under the direction of Dr. Ira Yermish should pave the way for further study. Lamentably, the investigation of the obliteration phenomenon will be impeded by lack of a *Science Citation Index®* (*SCI®*) for the years before 1961. But the creation of *SCI* for the years 1945-60, 1900-45, and perhaps even earlier is a project in which I continue to believe strongly.

In my own case, there are two instances where the obliteration phenomenon has affected the number of citations to certain of my papers. I've seen dozens of papers that simply could not have been written without *SCI* data. Yet their authors neglected to cite any papers at all--my own or those of others--on the methods of citation indexing. The availability of the anonymous *SCI* has obliterated citation of the primordial papers. In the same way, although it was only three years ago that I described *ISI's Journal Citation Reports* (*JCR*) in *Science*,[4] many authors now merely refer to the *JCR*, without citation. Although this might seem to be cause for regret, it is not. Obliteration--perhaps even more than an astronomical citation rate--is one of the highest compliments the community of scientists can pay to the author.

So if Archimedes were alive today, he could take comfort in the fact that his primordial paper on pi had been obliterated. It would mean that his contribution was so basic, so vital, and so well-known that scientists everywhere simply take it for granted. He would have been obliterated into immortality!

1. **May K O.** Personal communication, 19 November 1975.

2. **Merton R K.** *On the shoulders of giants: a Shandean postscript.* (New York: Harcourt Brace & World, 1965), p. 218-19.

3. **Lederberg J.** Reply to H.V. Wyatt. *Nature* 239:234, 1972.

4. **Garfield E.** Citation analysis as a tool in journal evaluation. *Science* 178: 471-79, 1972. Reprinted in *Current Contents®* No. 6, 7 February 1973, p. 7-24.