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Foreword

by Harriet Zuckerman

It now verges on tradition to begin a foreword to Eugene Garfield's collected essays by recalling the time one first encountered him. At least this is how Joshua Lederberg and Derek Price begin their forewords to earlier volumes of these essays. Being a respecter of traditions well begun, I follow suit by reporting the combined deprivation and revelation I experienced when I met Gene and first heard about the Institute for Scientific Information at a briskly run session in New York designed to introduce potential users to the *Science Citation Index* (SCI). This was sometime in 1963 or 1964. The reason for my sense of deprivation was obvious enough. The *Social Sciences Citation Index* did not, of course, exist in those early days—thus my envy of the physical and biological scientists who could make use of this new tool for coping with what was being described as the "information explosion." The sense of revelation stemmed not from recognizing the primary bibliographical uses of the SCI, but rather from seeing its secondary, though far from unimportant, uses for research in the sociology and history of science.

In point of fact, Garfield and his several collaborators took pains, even at the beginning, to point to possible uses of citation analysis for examining certain aspects of what is now called the cognitive structure of science, notably in tracing the genealogy of ideas backwards and forwards through time and, along the way, tracking down how much attention was paid to these ideas and by whom.[1] Garfield's early papers also show that he was well aware of the

potential uses—and some of the limitations—of citation analysis for appraising the relative scientific contributions of individuals and groups of scientists, just as he foresaw that these appraisals would capture the attention of science administrators and policymakers.[1,6]

A good many sociologists and some historians now make use of citation analysis to study the cognitive structure of science. As a result, there has been considerable evolution along the way in directions evidently not foreseen in the early 1960s. In any case, there is no inkling in Gene Garfield's early papers of certain developments now at the center of such research into the cognitive structures of the sciences.

These lines of investigation include co-citation analysis and the mapping of specialties over time,[3-7] comparative studies of the growth of knowledge in "hard" and "soft" sciences and technology,[8,9] linkages between theoretical and experimental contributions,[10-12] studies of cited documents as "concept symbols" or "concept markers,"[13,14] the relations between co-citation clusters and the social structures of specialties,[15-17] the extent of agreement (consensus) in various cognitive domains,[18,19] and, to stop here, studies of the process by which the sources of contributions to science become obliterated through their incorporation into the structure of scientific knowledge.[20-24] That these diverse developments were not foreseen says far more about the vigor, speed, and imagination with which citation analysis has been pursued than about the prescience of Garfield and other early "citationists."

As the norm of organized skepticism in science would lead us to expect, such studies based on citation analysis have been subjected to vigorous criticism—such criticism serving as an unobtrusive indicator of the liveliness of the field. It centers on the continuing ambiguity of the relationship between citation behavior and actual cognitive influence,[25-28] the paucity of systematic information about "the norms [governing] citation practices in science" noted more than 15 years ago by Kaplan,[29] and, most of all in the judgment of

some of us, the absence of a "theory of citing" that would help account for citation behavior.[30,31]

Specific developments in the use of citation analysis in the sociology of scientific knowledge cannot, of course, be predicted now any more than they could be two decades ago. Still, there is one line of investigation, already under way, which has strong sociological resonance. It focuses on the social location and intellectual commitments of *citing* authors and their papers rather than the characteristics of *cited* authors and their papers, which have been the focus of much of the work to which I have just alluded. The point, of course, is that citations, whether taken to be indicators of cognitive influence, ceremonial acknowledgments of intellectual forebears, supporting evidence, or part of the rhetoric of persuasion, may be socially patterned and may also reflect shared scientific beliefs. This sort of analysis aims to find out whether diverse cognitive commitments are differentially distributed among scientists at work on the same sorts of problems and, if so, how and why this is so—these questions representing a special case of the old and fundamental problem in the sociology of knowledge of the existential bases of cognitive developments.

Thus far, studies of citing authors have dealt with the extent to which authors who cite the same works in fact share the same theoretical orientations, the extent of cognitive insulation between groups subscribing to different theoretical orientations, and the extent of reciprocity in citing practices among scientists in closely related specialties. Such matters have been variously dealt with in S. Cole's examination of the citation practices of sociologists committed to differing theoretical orientations to deviant behavior,[32] Edge and Mulkay's study of British radio astronomy,[33] and Stigler and Friedland's inquiry into citation practices of economists educated at different universities and presumably in different theoretical "schools."[34] Studies of this kind can of course easily lend themselves to vulgarized interpretations of the sources of shared or

divergent citation practices after the fashion of conspiracy theory; nevertheless, they provide a procedure for systematic inquiry into the distribution and operation of schools of thought and "thought collectives"[35] in science and scholarship.

Along somewhat different lines, Peter Messeri[24] has adapted this mode of citation analysis to study the rates and patterns of acceptance of novel ideas, i.e., plate tectonics in geology, along with the social and cognitive attributes of early and late acceptors and the changing significance of similar citations as the field of inquiry developed.

Investigations comparing attributes of both cited and citing authors as well as relationships between them would also serve to enlarge our understanding of the channels of diffusion of scientific and scholarly ideas. Are there significant similarities of status—age and sex, for example—among cited and citing authors after the fashion of homophyly in the formation of friendships? To be more specific, is it the case that women scientists are more apt than men in the same research domains to pick up the work of other women scientists earlier and to cite it more often? If so, how does this differ in the various disciplines? And to what extent do any such patternings reflect differing patterned foci of scientific attention among diverse status-categories of scientists, with women and men scientists, to continue the example, tending to have somewhat differing distributions among the various specialties? Sustained attention to patterns of citing authors and symbolic cognitive interactions between cited and citing authors will suggest an array of further studies along these lines.

The growth and differentiation of citation analysis as one mode of inquiry bodes well, I think, for the better understanding of the interaction of cognitive and social structures in science, especially if some dent can be made in the persisting ambiguities in the meaning of citations as well as various patterns of citation practices. Gene Garfield must surely be a little gratified by the emergence of citation analysis as one of the few specialty-specific research tools

available in the sociology and history of science and by the new, not wholly anticipated, steps in the evolution of research in these domains.

Things really did look quite different back in the early 1960s.

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