Foreword

On its first appearance, this book crystallized a new element in the historiography and sociology of science. It did so in the course of examining the major transformation in the structure of science prefigured in its title: from little to big science. As is often the case with innovative inquiry, the methods of investigation have proved to be rather more consequential for an understanding of the subject than the provisional results reached by use of those methods. For in elucidating the social and cognitive arithmetic of science, this book did much to lay the foundations of the field of inquiry given over to the quantitative analysis of science and scientific development -- the field that has come to be known as scientometrics, or, at times, bibliometrics. And although the genealogy of science and learning has become somewhat crowded with the ascribed founders of this or that discipline, of this or that specialty, we can hardly doubt that with this book and the papers which followed it -- nine of them included in this new edition -- Derek John de Solla Price takes his place as the father of scientometrics.

Throughout the book, its author is mindful of the distant as well as the immediate antecedents of his own approach to the historiography and sociology of science. He invokes the attitudes and practices of that inveterate nineteenth century measurer of many things, Sir Francis Galton, just as he alludes to Sir William Petty, whose systematic study of bills of mortality in the seventeenth century inaugurated what he described as "political arithmetic." It is symbolically apt, therefore, that in an address to the New York Academy of Sciences a decade ago, Price should have elected the title "The Political Arithmetic of Science Policy." Himself passionately devoted to the taking of measurements "drawn from many numerical indicators of the various fields and aspects of science," Derek Price can be described, in an almost inevitable eponymous metaphor, as the William-Petty-and-the-Francis-Galton of the historiography and sociology of science. *

> (* Upon reading this foreword, Ellen Price, Derek's Danish-born wife, wrote to provide the ultimate evidence that Derek could put even the great Galton to shame in the depth of his passion for measurement. With her permission, we quote the decisive passage in her letter: "When I began labor with our first child, Linda, in '50, Derek obtained some graph paper to mark down the periodicity of contractions in order to predict the birth-time of the baby -- but Nature doesn't work quite like that -- and Derek became very angry -- God had let him down -- darn it, it *ought* to work this way. The conclusion -- God was really not very smart -- just look at the rotten job he did on optics of the eye!")
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> A paragraph reminiscent, not least in its beautifully calibrated use of the expressive Sternian dash, of Tristram Shandy's many passages on the vicissitudes of his own birth, while telling everything of Derek's mensurative passion.

Throughout the book, the style of thought and expression bears the author's unmistakable stamp. This is evident from the very first page where we find the pithy aphorism: "we can say that 80 to 90 percent of all the scientists that have ever lived are alive now. " So often quoted for so many years, the aphorism in its appearance here may lead some new readers to suppose that Price must himself be quoting, with obliteration of source, from someone's earlier work. But that is only the most familiar case in which he encodes his new ideas in lively and memorable prose. In a felicitous stroke of terminological recoinage, to take another case, he adopts and conceptually extends Robert Boyle's seventeenth-century term, "invisible college," to designate the informal collectives of closely interacting scientists, generally limited to a size "that can be handled by interpersonal relationships." Invisible colleges, he suggests, are significant social and cognitive formations that advance the research fronts of science, a conception largely confirmed by the early studies of Crane and Mullins and explored in some 300 articles and monographs lately compiled by Chubin.[1] Metaphors such as the invisible college serve to fix in memory some of Price's many contributions to what he describes as "the calculus of science."

Derek Price enjoyed, indeed, actively cultivated, a distinct kind of theoretical panache. In the words of Henry Small, a member of the same invisible college, Price as a theoretician of science took data seriously -- but not too seriously. Nor was he given to understatement. Where others might be inclined to speak of "hypotheses" or, at most, of "empirical generalizations," he liked to speak of "laws" of the development of science. No routineer, he created his own orthodoxies but then did not invariably abide by these, either. What did remain intact was a style of thought that could ever after be recognized instantly. His flair for the dramatic often served to call attention to ideas and problems that had long gone unexamined.

Fired by Price's ample numerical imagination, this book is dedicated to establishing and interpreting the magnitudes of growth in "the size of science": in the numbers of scientists and scientific publications and in the societal resources allocated to the pursuit of science and science-based technology. But, as is emphatically asserted, it is not so much the sheer exponential growth in the size of science -- an estimated five orders of

magnitude in three centuries -- as the logistic character of that growth that calls for special notice. It is argued that the inevitable saturation of science will require freshly formulated science policy: "new and exciting tactics for science." Much of the book sets out the Pricean vision of the changing structure and dynamics of scientific work over a wide spectrum ranging from modes of collaboration found in invisible colleges to global aspects of contemporary science.

That vision is enlarged by the array of Price's later papers included in this edition of the book. "Networks of Scientific Papers" is probably his most important single contribution to information science. A pioneering effort to characterize the world network of scientific literature, it indicates that patterns of citation to the papers composing that literature define the parameters of research fronts in science. As the scientometrician Belver Griffith has testified, it was this paper, along with *Little Science, Big Science*, which drew many young scholars, including himself, to the quantitative study of science.

The other papers included here are also innovative. Not since Bertrand Russell had distinguished between "hard" data and "soft" data in his 1914 Lowell Lectures -- these being published in the book *Our Knowledge of the External World* -- had any historian or sociologist of science undertaken systematic quantitative study of similarities and differences among the various disciplines making diverse use of these types of evidence. In "Citation Measures of Hard Science, Soft Science, Technology, and Nonscience," Price, undaunted by another difficult pioneering effort, undertakes to elucidate certain features that distinguish kinds of scientific from *nonscientific* scholarship. This he attempts to do by comparing the proportions of citations in the various disciplines which have high "immediacy" (i.e., references to research published within the preceding five years). He concludes with the hypothesis, still on trial, that the higher the proportion of references to older research in particular works of scholarship, the more probable that they are works of soft science or the humanities.

We refer here to only one more, the last, of the nine papers included in this edition of the book which advance ideas stated or implied in the first edition. Linked with the technique of cocitation analysis introduced by Small and Griffith and with the concept of cumulative advantage in science introduced by Merton,[2] "The Citation Cycle" visualizes an intrinsic structure of cognitive relationships between the scientific archive and newly developing scientific knowledge. A playful endnote tells much-in-little about its author's tiring exchanges with the bureaucracies of science: "This paper acknowledges no support whatsoever from any agency or foundation, but then, no time wasted, either, from preparing and submitting proposals."

Little Science, Big Science has acquired worldwide fame and, much more to the point, has been put to worldwide scholarly use. In light of its author's many-sided applications of citation analysis, it is only apropos to note that the fourteen books he wrote or edited and his approximately 240 published scientific papers have been cited in at least 2,200 articles, a figure that places him well within the highest 1 percent of contemporary cited authors. (That citation figure does not include the unnumbered references to his work in books.) Of all Price's writings, this book has received the greatest notice by far, with some 725 articles referring to it alone. The citations are found in the journals of some 80 disciplines or specialties, ranging from A (aeronautics and anthropology) to Z (zoology) with, of course, the greatest concentration in information science, scientometrics, and the social studies of science. It is drawn upon for its distinctive methods and for the disparate empirical evidence it brings together. Moreover, the book plainly has staying power. The number of references to a scientific paper or book generally peaks about two to five years after publication. In contrast, the references to this book continued to increase for a dozen years and have pretty much maintained that peak plateau during the decade since. One therefore has reason to suppose that the publication of this new edition will lead to a new upswing of attention to it.

The exceptional history of the book led to its being designated as a "Citation Classic" by *Current Contents*, the weekly overview of the contents of scientific and scholarly journals. In accord with the practice of having the author of a citation classic tell how the work came to be, Derek Price wrote his account, shortly before his premature death in 1983. That brief statement can be taken as in effect his preface to this new edition, as we paraphrase his muchquoted aphorism in making a reasonable surmise: most of the future readers of this pathmaking book are probably not yet alive.

Robert K. Merton

Eugene Garfield

Notes

1.[back to text] Diana Crane, *Invisible Colleges* (Chicago: University of Chicago Press, 1972); Nicholas C. Mullins, *Theories and Theory Groups in Contemporary American Sociology*(New York: Harper and Row, 1973); Daryl E. Chubin, *Sociology of Sciences: An Annotated Bibliography on Invisible Colleges*(New York: Garland, 1983).

2.[back to text] Henry Small and Belver C. Griffith, "The structure of scientific literatures 1: Identifying and graphing specialties" *Science Studies* (1974) 4:17-40; Belver C. Griffith and Henry G. Small, "The structure of scientific literatures 11: The macro- and micro-structure of science," *Science Studies* (1974), 4:339-65; Henry C. Small, "A excitation model of a Scientific specialty: A longitudinal study of collagen research," *Social Studies of Science* (1977), 7:139-66.

Robert K. Merton, "The Normative Structure of Science" [1942], reprinted in Merton,*The Sociology of Science*, Norman W. Storer, ed. (Chicago: University of Chicago Press, 1973), p. 273; "The Matthew effect in sciences" *Science* (January 5, 1968), 159:56-63, reprinted in Merton, *The Sociology of Science*, pp. 439-59.

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The reprinted version of LSBS, entitled Little Science, Big Science and Beyond,5 includes not only the original, unabridged text from the 1963 edition but also nine of the papers Price wrote subsequent to its pub-lication. These include four of hk most highly cited works from the mid- 1960s to 1970 as we~ as his last paper, â€œOf se-ding wax and string.â€6 Reviewing the new edi-tion of LSBS, 1S1â€™sHertry Small described it as not only â€œhighly useful, â€ but also said.Â minds and hearts. Derekâ€™s ideas are stifl vital parts of the growing disciplines of the history of science and scientometrics. The reprinting of Little Science, Big Science is testimony to the richness and utility of Derekâ€™s observations. @laa7 1s1. REFERENCES.

D. De Solla Price Little Science, Big Science...and Beyond. ISBN 13: 9780231049566. Little Science, Big Science...and Beyond. D. De Solla Price. 3.71 avg rating â€¢.Â Examines modern science, looks at scientific literature, and discusses the growth of science, invisible colleges, and the process of discovery. "synopsis" may belong to another edition of this title. From Library Journal: In its first (1963) edition, Little Science, Big Science explored the then fantastic expansion of resources devoted to the advancement of science, and the social significance of that phenomenon. The current edition contains nine additional essays that delve further into the same themes. The original papers touch on rules theoretically governing the life cycle and be The reprinted version of LSBS, entitled Little Science, Big Science and Beyond,5 includes not only the original, unabridged text from the 1963 edition but also nine of the papers Price wrote subsequent to its pub-lication. These include four of hk most highly cited works from the mid- 1960s to 1970 as we~ as his last paper, â€œOf se-ding wax and string.â€6 Reviewing the new edi-tion of LSBS, 1S1â€™sHertry Small described it as not only â€œhighly useful, â€ but also said.Â minds and hearts. Derekâ€™s ideas are stifl vital parts of the growing disciplines of the history of science and scientometrics. The reprinting of Little Science, Big Science is testimony to the richness and utility of Derekâ€™s observations. @laa7 1s1. REFERENCES. Little Science, Big Science is a book of collected lectures given by Derek J. De Solla Price, first published in 1963. The book presents the 1962 Brookhaven National Laboratory Pegram Lectures, a series of lectures dedicated to discussing science and its place in society. Price's goal in the lectures is to outline what it may look like for science to be analysed scientifically, by applying methods of measuring, hypothesizing, and deriving to science itself. With this goal in mind, he sets out to