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Little Science, Big Science...and Beyond Gathers Together the Major Works of Derek de Solla Price

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Were I to list the number of occasions I have written about and cited Robert K. Merton, the space available to me to write this brief introduction would be exhausted. However, I know of no other instance in which Bob Merton and I have actually collaborated from scratch to produce a co-authored work. So when he called me one day to suggest that we honor our mutual friend, Derek Price, by a joint effort, I was thrilled—indeed, exhilarated—by the opportunity to join my mentor in this special tribute. The result of that effort follows. I even broke from my own hard-and-fast rule never to use footnotes, but that seems a trivial compromise.

Of course, Professor Merton's long association with Columbia University, as well as my own feelings about it as an alumnus, made it particularly appropriate for us to respond to the suggestion from the director of the Columbia University Press to introduce the reprinting of the now-classic book, *Little Science, Big Science (LSBS)*. Apart from the above explanation, I need only add that the name of Derek John de Solla Price will not be unfamiliar to *Current Contents*® readers. Even if they are not historians of science or scientometricians, I have written about him or cited his work so often that it is inevitable he would become an ISI® household word.

My last essays dedicated to Derek appeared in the summers of 1984 and 1985—tributes to a scholar who strode like a giant

through the field he himself founded.^{1,2} Indeed, so pervasive was his influence that the advisory board of *Scientometrics*, a journal he helped start, established an award in his honor: the Derek J. de Solla Price Memorial Medal for contributions in the field of scientometrics. I was honored to be the first recipient of the Medal in 1985 and was pleased to present it to Michael J. Moravcsik, University of Oregon, Eugene, last year.

Price is best known for *LSBS*.³ Originally published in 1963, it has been cited over 800 times through 1986, making it Derek's most-cited work. It has long since become a *Citation Classic*®, and Price's commentary⁴ on it has been reprinted in the new edition of *LSBS* and will be included in *Contemporary Classics in the Social and Behavioral Sciences*. This volume, now in press, has been compiled for ISI Press® by sociologist Neil Smelser, University of California, Berkeley; the foreword has been written by Merton.

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 publication. These include four of his most highly cited works from the mid-1960s to 1970 as well as his last paper, "Of sealing wax and string."⁶ Reviewing the new edition of *LSBS*, ISI's Henry Small described it as not only "highly useful," but also said

that "Price's energy, enthusiasm and commitment are transmitted through every page of these essays."⁷

It is hard to believe that more than three years have passed since Derek's untimely death in the fall of 1983. But in reading his work so regularly, we keep him alive in our

minds and hearts. Derek's ideas are still 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 Derek's observations.

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2. -----, In tribute to Derek John de Solla Price: a citation analysis of *Little science, big science*. *Ibid.*, 1986. Vol. 8. p. 232-40. (Reprinted from: *Current Contents* (24):3-11, 17 June 1985.)
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4. -----, Citation Classic. Commentary on *Little science, big science*. New York: Columbia University Press, 1963. 118 p. *Current Contents/Social & Behavioral Sciences* 15(29):18, 18 July 1983.
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Little Science, Big Science...and Beyond
by
Derek J. de Solla Price
Foreword
by
Robert K. Merton and Eugene Garfield

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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.*

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 routinier, 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 compar-

*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!"

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.

ing 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 in-

clude 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 much-quoted aphorism in making a reasonable surmise: most of the future readers of this pathmaking book are probably not yet alive.

Notes

1. 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).

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