TO APPEAR IN *SCIENCE*

Review of *The Empire of Chance: How Probability Changed Science and Everyday Life*, by Gerd Gigerenzer, Zeno Swijtink, Theodore Porter, Lorraine Daston, John Beatty, and Lorenz Krüger (Cambridge, England).

By Glenn Shafer, School of Business, Summerfield Hall, University of Kansas, Lawrence, Kansas 66045.

The increasing role of mathematical probability in modern life has finally attracted the attention of historians of science. Eight monographs and several anthologies on the history of probability and statistics have appeared in this decade--more than during the preceding century. Six authors who have contributed to this burst of activity have now tried to summarize their results for a general audience. Beginning with the inception of probability theory in the 1650s and speaking with one voice—they do not identify their contributions to individual chapters, and they used a lottery to determine the order of their names on the title page—the authors attempt to explain the ways in which probability and statistics have “transformed our ideas of nature, mind, and society.”

The first five chapters of this book will be useful to statisticians, philosophers, scientists, and other historians of science who want to understand the roots of the probability-based statistical methods we use so widely today. Chapter 1 summarizes Lorraine Daston's prize-winning *Classical Probability in the Enlightenment* (Princeton, 1988), covering the philosophy and applications of probability from 1660 to 1840. Drawing heavily on Theodore Porter's *The Rise of Statistical Thinking, 1820-1900* (Princeton, 1986), Chapter 2 deals with nineteenth-century social statistics, Francis Galton's work in biometry and mathematical statistics, and aspects of the nineteenth-century discussion of

determinism. Chapter 3 covers R.A. Fisher's work in agricultural experimentation and statistical theory, Jerzy Neyman and E.S. Pearson's mathematical elaboration of Fisher's work, and the institutionalization of this work in the modern statistical profession. This chapter is an unusually broad and judicious treatment of its topic, and it succeeds in describing the topic in a less technical way than the other treatments of which I am aware. Nevertheless, the general reader will find it much more difficult than the preceding chapters. Chapter 4 is the most original and detailed in the book; it surveys the various ways that chance and determinism cropped up in nineteenth-century biology. Chapter 5 covers the various roles of probability in physics, from Laplace to quantum mechanics. Its tone is philosophical rather than mathematical, but it will be even more difficult for the general reader than Chapter 3.

The remaining chapters—which summarize parts of Gerd Gigerenzer and D.J. Murray's *Cognition as Intuitive Statistics* (Hillsdale, New Jersey, 1987), discuss impressionistically the role of statistics in contemporary life in the United States, and wax philosophical on chance and determinism—are a good deal less valuable.

In the general introduction, the authors present their book as a coherent narrative for a broad audience, including interested laymen. The book will be most valuable, however, as a entry point into the current literature for interested scholars. The chapters are too uneven in style, level of difficulty, and purpose to hold the interest of many laymen. Unfortunately, in their attempt to make the book look as much like a coherent narrative as possible, the authors have weakened the book's value as a guide to the current literature. In the absence of decent chapter introductions, readers have no clue as to which parts of the book are summaries of earlier books and articles and which represent hitherto unpublished research.

The general introduction also says that the authors are less interested in the mathematical theory of probability and statistics than in its impact on broader thinking. This permits them to concentrate on their own work and to slight important recent writing of Stigler and Schneider. Yet the first three chapters are more concerned with the evolution of theory—a balanced account of which would have to include topics emphasized by Stigler, notably the invention of least squares—than with its impact on contemporary thinking.

This neglect of important authors extends to important topics as well, so the presentation as a whole is incomplete. The role of probability and statistics in psychology, biology, medicine, and physics is treated in some depth, but their role in other social sciences, in meteorology, engineering, and business is treated shallowly or not at all. The authors seem to be completely unaware of the role probability has assumed in economic theory during the past three decades, so that they overlook the decisive influence of economic theory as an explanation for the recent interest in probability as a model of rationality in psychology.

Many of the problems I have noted thus far might have been remedied by careful editing, but I fear that there are more basic problems that make the plan of this book—no matter how fine the execution—premature. In my judgment, the basic historical research has not yet been done that would allow us to explain the evolution of probability and statistics without reference to mathematical details that would baffle general readers

In the case of the seventh, eighteenth, and nineteenth centuries, we have a wealth of information about the evolution of the mathematical theory and much new information, from Daston, Porter, and Stigler, about the scientific and cultural context of this evolution, but these streams of inquiry have not yet been integrated into a coherent synthesis. Consequently, a narrative at a distance

from the mathematical details, such as we do find in most of this book, becomes misleading. For instance, Chapter 1 presents the early concept of mathematical probability as a legal concept, even though the mathematical structure of the theory was based on games of chance and owed little to the concept's connections to legal rhetoric. Non-specialist readers could not know that all the books written on mathematical probability during the first century of its existence were concerned almost exclusively with games of chance.

When they move into applications of statistical theory in the twentieth century, the authors have very little basic historical research on which to draw, and consequently their discussion remains superficial and impressionistic. In Chapter 3, for example, the authors note that our standard statistics textbooks present a compromise between Fisher's views and those of Neyman and Pearson, and they denounce this compromise as unsatisfactory. But they are not able to tell us anything about how it came to prevail.

The Empire of Chance is a very valuable book. It teaches two extremely useful lessons. The first is that despite the flurry of new publication, we do not yet know enough about the history of probability to give general readers a reasonably full analysis of its rise in the eighteenth and nineteenth centuries and its impact on the twentieth century. The second represents the book's greatest contribution, a valuable one indeed: its research agenda. The authors have asked the right questions, and their efforts to answer these questions show us how much more work there is to be done. Unprecedented as it may be, the activity of the past decade is only a beginning.