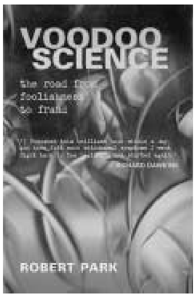
Magical Mystery Tour

Voodoo Science. The Road from Foolishness to Fraud. Edited by *Robert L. Park*. Oxford University Press, Oxford 2000. 230 pp., hardcover £ 18.99.—ISBN 0-19-850745-3

Voodoo Science: The Road from Foolishness to Fraud is authored by Robert Park, who has been active in university research in physics and astronomy and who has authored a weekly newsletter on science, *What's New*, which is maintained by the American Physical Society. The book is intended for a general readership and is concerned with the question of why scientists sometimes choose to work on certain projects which seem far-fetched while dismissing other far-fetched projects out of hand without a second thought. Park begins with the disclaimer that the book is not intended to be a scholarly work, and indeed it is not. The reader should be aware of this disavowal from the start. However, within the framework of its thesis, that there is a kind of science described by Park as "voodoo science", the book is entertaining and provocative reading, and provides an interesting and sometimes insightful perspective as to why voodoo science exists in the first place, and why it is accepted by large sections of society.



In *Voodoo Science*, Park points out that nearly all of the major problems confronting society, such as the environment, national security, health, and the economy, need to be addressed with a certain amount of input from science. He then suggests that there are many cases, especially high-profile, long-standing, and seemingly intractable problems, for which an extraordinary, often simple, "scientific solution" has been proposed. In some cases, according to Park, the science proposed to solve these problems is "totally, indisputably, extravagantly, wrong, but nevertheless attracts a large following of passionate, and sometimes powerful, proponents." These are examples of Park's voodoo science.

What exactly does Park mean by voodoo science? It is Park's thesis that in science, as in all human endeavors, it is possible to make an initial "discovery" that then turns out to be wrong as the result of an honest error. However, in voodoo science such honest errors may evolve into self-delusion and sometimes even transform into fraud. Park states that "The line between foolishness and fraud is thin. Because it is not always easy to tell when that line is crossed, I use the term voodoo science to cover them all: pathological science, junk science, pseudo-science, and fraudulent science." The book goes on to discuss examples of voodoo science that make entertaining reading and provide some important insights into the "nonscientific" politico-religio-economic factors that are part and parcel of high-profile science. These examples involve extraordinary scientific claims of the following types: cheap and unlimited forms of energy (perpetual motion machines, engines that produce more energy than they take in, "cold fusion"), novel and remarkable products for health care (magnets and infinitely diluted medicinals to cure ills of all types, Vitamin O), predictions of horrific disasters that will devastate humanity (radiation from electrical cables), and the allegedly enormous value of particular research projects (microgravity research in space), etc.

Voodoo science inevitably catches the attention of the nonscientific communities consisting of the media, politicians, and entrepreneurs who need to have science "explained" and "interpreted" to them. However, because the listeners are not scientists, they usually ask questions and then interpret the explanations in terms of the paradigms of their own communities, without subjecting the conclusions to any scientific analysis. This leads to a huge range of "fuzziness" in the interpretation that can go well beyond the bounds of the science associated with a claim. Park proposes that a significant fraction of the nonscientific community tend to judge the explanation of an extraordinary claim by how well it agrees with the way they want the world to be, that is, in terms of their own narrow self-interest or personal philosophy of reality, politics, economics, religion, etc. He also lambastes the media, which he feels selects scientific information to be released to the public in terms of its entertainment value rather than its scientific validity. There is also, according to Park, a tendency for the media to highlight the human interest side of the "little guy" scientist who has made an extraordinary claim and is fighting the establishment that is trying to deny him/her the fruits of his/her genius. The media know the public favors the underdog and would like him/her to be victorious.

A common characteristic of voodoo science is that an extraordinary claim is first publicized through the media rather than by the normal and established process of independent scientific review. The power of the media to highlight science that is poorly or incompletely documented allows voodoo science to obtain an initial degree of respectability, and often encourages the proponents to

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become passionately and irreversibly committed to their extraordinary claims. The media can also transform a scientist who has made an extraordinary claim (which turns out to be an honest mistake) into a celebrity. Disaster can follow when, in order to maintain the celebrity status, the scientist embraces a dubious piece of science forcefully and publicly, and leaves no room to back down when the claim is challenged. That may put the scientist on a slippery slope leading from an honest mistake to self-indulgence, to self-delusion, and ultimately to fraud. In the end it is generally impossible to be sure about the motivations and mind-set of the proponents, and where they are positioned (honest mistake? fraud?) on the slippery slope of voodoo science.

An interesting historical example of how "classical" voodoo science has been dealt with is the response of the US patent office to the submission of patents for perpetual motion machines, which initially resulted in enormous amounts of time being spent on a concept considered to be scientifically impossible. In 1911 the office ruled that a patent application for a perpetual motion machine could not be submitted until one year after an actual operating model of the machine was deposited at the office. A patent application would be allowed immediately to the inventor of any perpetual motion machine that was still operating after one year. That ruling effectively ended the run of patent applications for perpetual motion machines. Unfortunately, most instances of voodoo science cannot be dealt with so decisively.

What are "true" scientists to make of voodoo science? How do they distinguish voodoo science from true revolutionary science? Park couches possible answers to this question in terms of another question: "Why, faced with the same set of facts, [do] some believe and others doubt?" Certainly all scientists understand the power of the possibility of an extraordinary discovery to turn on a "belief engine" that has evolved in the human brain. This reviewer has hypothesized that the brain's evolution of the belief engine can be traced to its survival value in a world that requires frequent rapid discrimination between important and unimportant stimuli. Beliefs allow an intellectual closure whose goal is to interpret each phenomenon in a way that is as complete, stable, and self-consistent as possible. The belief machine makes facts support preconceived knowledge and resists the creation of new knowledge. Although Park does not mention this, cognitive research has produced significant evidence that we create new knowledge only when we change preexisting beliefs; in other words, no change in previous beliefs implies no new knowledge creation. Although scientists are always seeking the creation of new knowledge, there is the experiential anchor that preconceived beliefs provide to connect us with the "real" world. Self-deception is a natural outcome of the primordial desire to preserve beliefs that have survived the test of time and experience. Each scientific community possesses ideas and theories and results that are well known to the practitioners, but which are not true! In chemistry there are many examples of the halo effect of ideas, which are important for a time in the development of a field, but which are later shown to be partially or substantially incorrect, yet nevertheless remain widely believed to be true.

Park discusses "cold fusion" as perhaps the example to end all examples of voodoo science. As a consequence of the "cold fusion" episode, the concept of the possibility of achieving nuclear fusion in a manner fundamentally different from that proposed by high-energy physics is nowadays dismissed out of hand by the scientific community. This is an interesting case, in which the exploration of the possibility of a true breakthrough requiring "out of the box" thinking has been made politically incorrect by the bad example of the cold fusion episode. [Incidentally, this reviewer does not believe that cold fusion is impossible, but believes that the media's presentation of evidence to support cold fusion was terribly flawed (as was the evidence itself) and that the media circus surrounding the "debate" on the evidence provided a classic backdrop to encourage voodoo science.] In his scientific analysis of cold fusion, as with his other examples of voodoo science, Park presents his perspective on how the established scientific process works and the peril that results when the process is bypassed.

An interesting thesis in Park's book, relevant to the belief machine, is the concept of "Pascal's wager". Pascal, a distinguished mathematician and physicist of the 17th century, rejected a life of science and mathematics at the age of 32 for a life of faith in God. He concluded that he would wager that God exists, because if he won this wager, he won everything. Do you know someone who makes scientific decisions as if they always apply Pascal's wager? For an extraordinary scientific claim such individuals may think quite rationally: the probability that this scientific claim is correct is infinitesimally small, but not exactly zero. Nonetheless, the scientist may passionately defend the claim because the prize is so great if the science happens to be correct. Like Pascal, although the chance of being right may be small, if you are right you've won big. Cold fusion seems to be a good example in which Pascal's wager was the attitude of chemists during the active debate. However, the other side to the scientific Pascal wager is that if you lose, you may lose big, especially if you have not followed the tried and true methods of the established scientific process.

Park's point of view reflects that of scientists who are trained in standard paradigms and who measure the "foolishness" of an idea by its misalignment with currently accepted paradigms. How does one distinguish the voodoo science as defined by Park from revolutionary science as defined by the paradigmatic shifting of ideas that produces candidates for Nobel prizes? There are many reasons why truly new and revolutionary ideas in science are never accepted readily. These include the simple statistic that the overwhelming majority of ideas that appear to be too good to be true, actually prove to be not true. Science works most efficiently when "normal science" is practiced. Kuhn[1] defines normal science as the operation of science in the limited framework of existing paradigms of a field. Commenting on "party-line" science, which he terms "normal science", and on the scientific process, Kuhn writes: "Normal science…often suppresses fundamental novelties because they are necessarily subversive of its [normal science's] basic commitments…the very nature of normal research ensures that novelty shall not be suppressed for very long." Thus, according to Kuhn, for true scientific revolutions to occur, the system must eventually respond to those who think "outside the box" or "outside the paradigm". One learns from studying the history of science that the scientific process assumes that its entire structure is contingent on the arrival of another structure that does everything the current one does, and more. However, the history of science also teaches that one must be prepared to get things wrong, and that there are mechanisms in the scientific process for eventually bringing to light errors in extraordinary claims. The larger the error of the extraordinary claim, the more there is at stake, and the greater the need to identify the error quickly. Progress in science requires a balance between the conservatism imposed by the prevailing paradigms and the necessary skepticism for new ideas, and the liberalism of new ideas that smack of paradigm shifts. The tension between thinking inside the box and thinking outside the box is an essential tension without which scientific progress would languish. For the reader who would like to pursue the subject further several references are provided.[2–6]

Whether or not you agree with Park's take on voodoo science, a message of the book is that if scientists do not take a more significant role in the way that science is disseminated to the public and especially to politicians, voodoo science will continue to survive. The book is an easy read and will probably be a source of enjoyment to some who see in Park's examples situations that resonate with their own experiences. However, the book may be a source of irritation to others who are not entertained by a polemical point of view. I strongly recommend that you give it a try to see how it fits your particular tastes concerning how science works (or doesn't).

Nicholas J. Turro
Department of Chemistry
University of Columbia
New York (USA)

Molecularly Imprinted Polymers. Man-Made Mimics of Antibodies and their Applications in Analytical Chemistry. Edited by *Börje Sellergren*. (Series: Techniques and Instrumentation in Analytical Chemistry, Vol. 23.) Elsevier, Amsterdam 2000. 557 pp., hardcover $ 301.00.—ISBN 0-444-82837-0

"Intelligent polymers", "polymers with memory", and "artificial antibodies" are some of the descriptions often applied to molecularly imprinted polymers (MIPs). These are inorganic or organic materials that are prepared by polymerization with cross-linking in the presence of templates, which may consist of small molecules, biopolymers, microorganisms, or crystals. On removing the template one obtains a specifically molded polymer which is a negative image of the template. The origins of the technique go back 80 years, but it is only very recently that the method has become widely used, and publications on the subject are now appearing with a near-exponential growth rate.

This book edited by Börje Sellergren consists of 21 chapters, many of which are contributed by the leading experts in their special fields. It begins with a very interesting historical overview, which is followed by a brief description of the physicochemical fundamentals of the molecular imprinting process. The next ten chapters describe in detail the different methods for preparing MIPs and the special polymerization techniques used. The remaining eight chapters are concerned with applications of MIPs in analytical chemistry, for example in chromatographic investigations. Four of the chapters are devoted to the rapidly developing area of chemosensors based on MIPs.

The book comes close to fulfilling the editor's claim that "this book provides the first complete coverage of the area of molecular imprinting". However, the focus on analytical chemistry as indicated in the title means that not all aspects are covered. Applications in organic synthesis and in catalysis would certainly have provided material for another special chapter, in view of the many publications on these aspects that have appeared. For readers who are already working in the area of molecular imprinting or intend to do so, the many technical details and the extensive bibliography (over 1400 references!) will be of great interest. On the other hand, those who only seek an initial overview of the technique should instead read some of the shorter reviews (e.g., G. Wulff, *Angew. Chem. Int. Ed. Engl.* **1995**, *34*, 1812).

With such a large international team of authors it would be difficult to avoid some overlapping of subject matter, and unfortunately this book has not escaped that problem. Many research results are described in several places. Also some of the introductions to individual chapters are unnecessarily detailed and redundant. For example, on page 396 the difference between covalent and non-covalent imprinting is explained yet again with diagrams, even though that topic was covered in detail at the beginning of the book in two chapters of over 100 pages in total. It is especially annoying when two chapters with a partly shared authorship contain whole passages of text that are nearly identical (pp. 196 and 286; pp. 197 and 290).

In a first edition of a book with almost 600 pages, there are inevitably a few small mistakes. Examples are the duplication of one of the figures (pp. 299 and 300) and the highly unsuitable abbreviation Me for a metal ion (p. 199). However, the book can be recommended for all readers interested in gaining a detailed and up-to-date survey of the fascinating technique of molecular imprinting.

Kay Severin
Institut de Chimie Minérale et Analytique
École Polytechnique Fédéral
de Lausanne (Switzerland)

Quantum-Mechanical Prediction of Thermochemical Data. Edited by *Jerzy Cioslowski.* Kluwer academic publishers, Dordrecht 2001. 251 pp., hardcover $ 90.00.—ISBN 0-7923-7077-5

The book provides an excellent survey about recent approaches towards highly accurate ab initio methods for the prediction of thermochemical data, which is very useful for theoretical chemists and certainly worth the price. The editor

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