The public perception of science

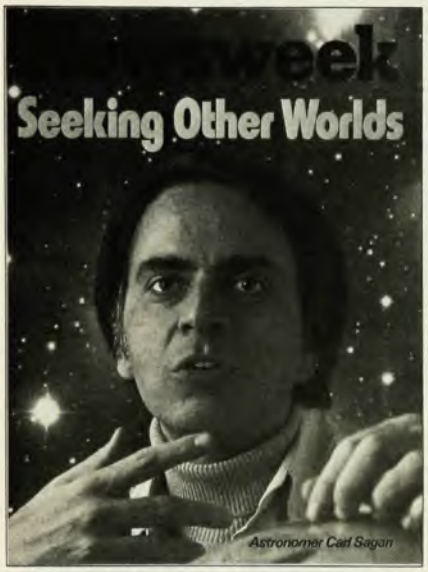
The Visible Scientists

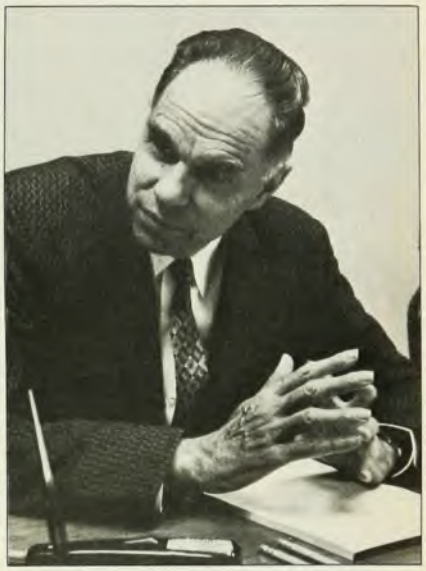
R. Goodell
242 pp. Little, Brown, Boston, 1975. $9.95

The Future of Science

T. C. L. Robinson, ed.
145 pp. Wiley-Interscience, New York, 1977. $12.95

Reviewed by Rodney W. Nichols





Carl Sagan and Glenn Seaborg are two different types of scientific spokesmen. In his review on this page, Rodney W. Nichols discusses how the public gets its information about science.

Funny things happen to Science on the way to The People. These two books reveal a lot about what is right and wrong, uncertain and disappointing, in the relations between society and science. Science, in both, means the full range of the world's scientific and technological activities, with all of the attendant quarrels over motives and consequences. Probably neither book will come close to being a best seller. Yet both books ought to be required reading for everyone in the research and development community.

Rae Goodell's volume, based upon her 1975 PhD dissertation in the Department of Communications at Stanford, aims to explain the phenomenon of "visible scientists," those celebrities who consistently capture headlines as experts and present much of the information that the public gets about science. Using surveys of journalists and students during 1972–73, Goodell picked seven main subjects: Barry Commoner, Paul Ehrlich, Linus Pauling, Margaret Mead, B. F. Skinner, Carl Sagan and William Shockley. She also mentions other scientists, including Rene Dubos and Glenn Seaborg, who are highly visible but generally less argumentative than the media's scientific superstars.

As she smoothly introduces brief biographical sketches of her main subjects, Goodell reveals how scientists become visible and how they use their power in the media to promote views on certain issues. Of course, the media have their own purposes, and Goodell is especially convincing in her analysis of the techniques of the press in its interaction with celebrities. But the book veers away from analyzing the merits of the viewpoints held by these "visible scientists." So we learn little about why certain issues appeal to Johnny Carson and his fans.

The Future of Science, edited beautifully by Timothy C. L. Robinson, presents the proceedings of the 11th Annual Nobel Conference held at Gustavus Adolphus College in 1975. Sparkling addresses were given by Nobel laureates Sir John Eccles, Polykarp Kusch and Glenn Seaborg. Theologian Langdon Gilkie gave the fourth major paper, a grave critique of science's role as the "queen" of contemporary society. Highlights of the penetrating reactions to each talk, contributed by almost all of the 27 Nobel laureates and six theologians present, are as provocative as the principal papers. This modest volume touches most of the contemporary hopes and anxieties about the likely future paths of science and technology.

If, as Goodell says, only 0.1% of the newspaper is science news and if, as Seaborg says, the course of science will determine the future of mankind, can the public gain enough understanding of science to play any meaningful role in making policy? Can we depend upon tiny bands of Science-for-the-People advocates who often insist, in the public stadium, that only their umpires be trusted? Why is the scientific establishment usually perceived by the press and the public as conservative in its internal style and optimistic in its social vision? These two books raise many such questions about the public misunderstanding of science, its methods and applications, and its potential to satisfy utilitarian and humanistic goals.

Other questions about the actual results of research emerge in the overlapping themes of these books. For example, B. F. Skinner has become famous in part because of his absolute conviction that all behavior can be controlled, while Sir John Eccles insists that the functions of the brain are fundamentally beyond the reach of the methods of modern research. Although these perspectives do not quite converge, together they raise the mind–body problem—which keeps sophomores talking till dawn, and philosophers musing till death. But even the most visible scientists cannot compete with astrologers for the public's attention. The enormous excitement of the emerging neurosciences

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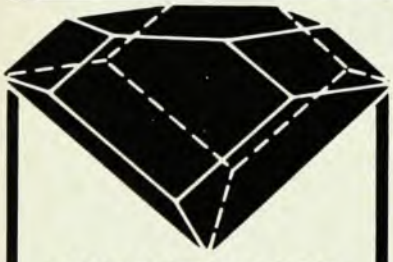

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tends to be buried under waves of ignorance and mysticism.

To make science-as-usual even more unsettled, Theologian Gilkie argues that, in our culture, science now is being dethroned because "it is sin not knowledge that threatens us" and because the "increase of man's power through applied knowledge has not increased his virtue or his wisdom." In a sense, he is correct, but recent public-opinion polls emphatically contradict some of Gilkie's assumptions. For instance, in 1972 and 1974, 70% of the American public reacted positively to science and technology. Moreover, I suppose every citizen would be interested in a clear explanation of the extraordinary frontiers of research on the evolution of life and the causes of death, the origins of the universe, the fundamental structure of matter as a source of energy. Only sensationalized pieces of this endeavor tend to be brought into public discussion. Whether it is science for science's sake, science for the people's sake, or science in a broad philosophical and cultural context, the debate is thin.

For perhaps understandable reasons, neither book is concerned with industrial R&D. None of the selected "visible scientists" works in industry. Even though Seaborg, Kusch and others appreciate the varied ways that science interacts with technology, *The Future of Science* does not explore the importance of economic incentives for the environment in which invention can flourish and national productivity can increase. Furthermore, although US scientific and technological leadership is usually a source of pride, the views in these books are fairly complacent about how to ensure the long-range health of the enterprise.

Near the end of *The Future of Science*, a theologian remarks candidly that "these meetings depress me, frankly . . . because I don't think we listen to one another." That is clearly part of the problem in Washington, particularly when Congressional committees arrange for headline-grabbing but inconclusive adversary hearings with "visible scientists" and other experts whose expertise is often extended too far and, in any event, is rarely focussed meaningfully. In these situations, the public is confused and science discredited. Moreover, as Goodell points out, the "popularizers" often make science *un*-popular. With these cross-currents, how will we be able to cut through the thick technical uncertainties that amount to a quicksand threatening the life of as many as half the bills before Congress? With refreshing verve and honesty, these two books serve the public interest by sorting out some of the causes of these uncertainties.

* * *

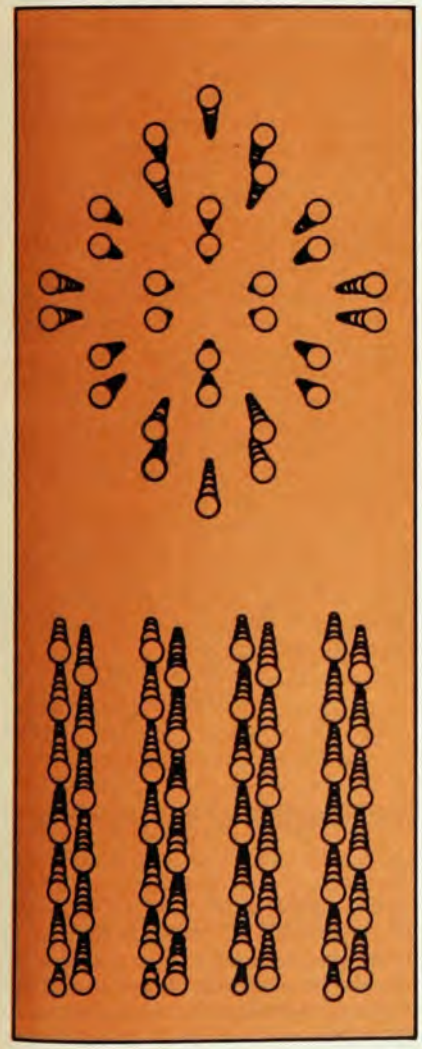
Rodney W. Nichols, an applied physicist with experience in both industry and the federal

government, has been involved in many activities concerned with national policies for science and technology. Currently he is Vice-President of The Rockefeller University in New York.

Ion Implantation of Semiconductors

G. Carter, W. A. Grant
214 pp. Halsted, New York, 1976. $19.75

While there may be some questions as to the usefulness of ion implantation, one aspect of the business is thriving—the writing of books or review articles on the subject. When the first book on ion implantation in semiconductors, by Jim Mayer, Lennart Eriksson and John Davies (Academic), appeared in 1970 there was real doubt as to the role of the technique in doping semiconductors.



Silicon crystal lattice as viewed in the ⟨110⟩ axial direction (top) and in the (111) planar direction (bottom). From the book by G. Carter and W. A. Grant reviewed on this page.

Such misgivings are long past, and the technique is now an integral part of the all-pervasive semiconductor industry.

The technique has found acceptance for the simple reason that dopants can be introduced in a precise and highly controllable fashion; silicon-device technology demands such control. The dopant ion enters the semiconductor from a clean environment (vacuum), and the ion's energy determines the subsequent range. The number of incident ions can be determined from the integrated charge during the implantation. To be electrically active the dopant should reside substitutionally on lattice sites. The main drawback is that the highly energetic ions create considerable damage in the host lattice—silicon can be made amorphous during implantation—and it was with considerable relief that ion implanters found that annealing restored crystalline integrity and electrical activity.

George Carter and Bill Grant, from the Department of Electrical Engineering of Salford University, are well known practitioners of ion-implantation and particle-solid interactions. Their book *Ion Implantation in Semiconductors* is the first volume in a series entitled "Contemporary Electrical Engineering." The authors actually spend little time discussing the electrical properties of solids, but rather they emphasize the interaction of ions with solids, scattering and energy-loss mechanisms, defect production and the use of channeling for analyzing implanted layers. They do this in an expert and lucid fashion. The book is intended as an introduction to the subject and should be suitable for study at the undergraduate and postgraduate level.

The discerning student will probably realize why the field has attracted so many chroniclers: It is something of a success story of physics and technology; it is also an attractive pedagogical subject with a lineage stretching from Niels Bohr, Enrico Fermi and Edward Teller to William Shockley. Physicists have pushed the concept of ion implantation, and its development undoubtedly stimulated many areas of particle-solid interaction, such as channeling.

The book has some deficiencies; I will cite the minor, technical ones first. My copy had pages that were stuck together and defied separation. I also caught several errors that probably occurred in the proofreading of the text and references. These are minor problems.

Although the contents of the book have been well thought out, there are some obvious textual deficiencies. Students of electrical engineering are going to demand more than one short chapter on device applications. The section on radiation damage is quite comprehensive, but the authors make no mention of the recent experiments on regrowth of amorphous

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