Book Reviews

Justifications

Elementary Particles. Science, Technology, and Society. LUKE C. L. YUAN, Ed. Academic Press, New York, 1971. xii, 314 pp., illus. $15.

Particle physics is the most fundamental known branch of science, in the sense that the objects and phenomena studied in it can be used to understand many other aspects of the universe, while these objects cannot, as yet, be understood in terms of anything else. The aspects of particle physics most relevant to everyday phenomena are relatively well understood. The wide unknown areas in the field do not concern the properties of ordinary matter under conditions found naturally on earth, and hence in order to study these areas matter must be subjected to special conditions, such as high energy, which can be obtained only through the use of elaborate equipment. Particle physics is therefore probably also the most expensive branch of pure science, and some $3 billion has been spent on it by various governments since 1945.

It is not altogether clear why governments in the past have been willing to support particle physics research at this high level. It is probably unrealistic to imagine that this support implies an understanding by those in government of the aims and accomplishments of particle physics. Nevertheless, on several occasions, particle physicists have attempted to explain and justify their work to the public and to the government. One such effort, made several years ago, was a booklet entitled *The Nature of Matter,* edited, like the book under review here, by L. C. L. Yuan. This booklet contained a number of short articles by physicists, mainly attempting to justify particle physics as a thing worth doing in itself, without special reference to its applications.

The present volume takes a somewhat different tack. It contains seven long articles, six of which deal with applications of the results and techniques of particle physics to other branches of science and technology. This approach is perhaps more appropriate for a period when, at least in the United States, support for particle physics has come under question and the best justification for government support of any activity is considered to be applicability to immediate practical ends.

The opening article, by R. P. Shutt, is a brief summary of the subject matter and techniques of particle physics together with some thoughtful speculations about the purposes of scientific research and the reasons for public support of such research. This article is the one in the volume most likely to be understood by a nonspecialist.

A particle physicist is likely to find the article by M. A. Ruderman and W. A. Fowler, "Elementary particle interactions in astrophysics," of interest. Although written before the discovery of pulsars, this article convincingly describes several areas of astrophysics that may affect, or be affected by, the answers to yet unsolved questions in particle physics.

The other articles describe applications to chemistry, biology, and engineering, and tend to deal with somewhat peripheral aspects of particle physics. While the specific applications described would probably not benefit much from new fundamental research in particle physics, they do illustrate the possibility that new discoveries coming from such research might also have unexpected applications.

In the reviewer's opinion, justifying new research in particle physics by its possible practical applications, or by its applications in other areas of science, is implausible. In my view, physicists would be better advised to explain to the public more clearly what we have done and what we hope to do in our research. I trust that a wider public understanding would lead to a wider appreciation of these activities and result in their continued support.

GERALD FEINBERG
Department of Physics,
Columbia University,
New York City

Influencing Government

Science, Scientists, and Public Policy. DEAN SCHOOLER, JR. Collier-Macmillan, London, and Free Press, New York, 1971. xiv, 338 pp. Cloth, $6.95; paper, $3.95.

Schooler's book is an only partly successful attempt "to build a theory explaining the relationship of scientists to public policy making." The major finding of the study is that scientists' influence on policy is strongly conditioned by political forces and interests and that, since these forces and interests vary for different types of public policies, so does scientists' influence. In reaching this conclusion, Schooler develops and applies a conceptual framework for comparing different types of policy processes which is a significant advance over prior approaches to analyzing the science–public-policy relationship. However, he does a poor job of operationalizing his key concepts and of gathering and presenting evidence, and these weaknesses bring into question the validity of many of his generalizations.

Most earlier analyses either have been case studies of a particular policy or have discussed the scientist-policy relationship without paying much attention to how it differs for different policies. The key concept in Schooler's attempt is "policy arena," which he defines, following Theodore Lowi, as "the political context surrounding policy formulation." This context will be determined by the perceived impact of the policy on society. For example, the political context surrounding a policy which is seen as "distributive"—that is, as having benefits that accrue to one group, or to society as a whole, without depriving any groups of something they value—will be different from the context of a policy seen as "redistributive"—that is, as conferring benefits on one sector of society at the expense of other sectors.

Schooler concentrates on the influence of scientists within the executive branch of the federal government during the period 1945–1968. He examines 20 different types of government policy in terms of nine policy arenas. Three of these—the "distributive," the "regulative," and the "self-regulative"—are taken directly from the works of Lowi and other political scientists. The other six categories result from Schooler's adaptation and extension of the policy arena concept; these are the "social redistributive," the governmental redistributive," the "economic

management," the "communal security," the "extra-national," and the "entrepreneurial" arenas. The nature of each of these is relatively evident from its name. A self-regulative arena is one in which government allows a sector of society (such as the oil industry) to develop and administer its own rules of conduct; the entrepreneurial arena is one in which the government actively involves itself in producing or consuming a product (such as basic science or space exploration).

Schooler finds that scientists' influence is low for policies classified as self-regulative, redistributive, extra-national, or narrowly distributive; moderate for policies classified as regulative; and high for policies in the economic management, communal security, and entrepreneurial arenas. These last three arenas, Schooler points out, are distributive in the particular sense that they produce benefits—economic security, security from eternal attack, and new knowledge—that are perceived as being in the interest of almost every segment of society.

Schooler also attempts to relate differences in the level of scientists' influence to 22 other independent variables, for example the field of science involved, the presence of scientific or political conflict among scientists, and the stage at which scientists participate in the policy process. He is unable to carry off this attempt in any systematic manner, and the relative importance of these 22 variables in different policy situations is never very clear. By the time he reaches his summary chapter, separate treatment of them has been abandoned.

To me the most interesting of Schooler's findings is that scientists' influence is greatest in just those areas of government activity—science policy, deterrence and weapons policy, space policy, and fiscal and monetary policy —in which there is a newly developed (since World War II) and intimate relationship between the top levels of the executive hierarchy, especially the presidency, and other elite segments of our society—universities, high-technology aerospace and defense industries, and large financial institutions. The integrated nature of these relationships has recently come under scrutiny by such diverse analysts as John Kenneth Galbraith, Murray Weidenbaum, and Charles Reich. These are the areas in which conflict over the goals and especially over the means of policy is least widespread and the decision-making process most centralized. On the other hand, scientists' influence over government policy in areas of high social conflict or deeply vested interests such as education, welfare, and agriculture has historically been low, according to Schooler. In these areas, pluralist politics and incremental decision-making still determine policy choices. Yet it is just this conflict-ridden, pluralist set of issues to which the federal government is now asking scientists and engineers to address their attention, apparently more or less with the expectation that if technology can get us to the moon it can solve—for example—urban blight. Schooler's analysis suggests that there are formidable obstacles, primarily political in character, in the path of effectively making science and scientists "relevant" to many of our social problems. As long as the impact of a public policy is viewed by important groups in society as "redistributive"—as taking from some to benefit others—politics rather than science is likely to have the primary role in shaping it.

There are serious deficiencies in Schooler's work, most of them related to the way in which he attempts to provide evidence to support his arguments. As noted earlier, Schooler's goal was theory-building, but he is candid in characterizing his work as "more exploratory than hypothesis testing" and as "a hypothetical sketch working sometimes impressionistically from a minimum of data." Schooler's data are drawn exclusively from secondary sources such as newspaper accounts of policy decisions, case studies, and the like, and are often merged, says Schooler, with his "own perceptions and observations." The crucial variable which the study seeks to explain is the level of scientists' influence, yet Schooler admits that "describing scientists' influence is a matter of judgment. No . . . visible evidence exists." He states no criteria by which he arrived at his judgment of influence level. The empirical core of the book is a series of 20 essentially separate essays on each of the policy types studied, and these essays seldom evidence any feeling for the details or realities of the forces influencing decisions within the executive branch. In the area which I know best, space policy, Schooler's interpretation of the decision process misses most of what really went on. Because he has spread himself thin in attempting to analyze, on the basis of questionable data, 20 types of policy, some of them over a 20-year period, he often lapses into generalizations unsupported by evidence. Some of these seem plausible—for example, "scientists concerned with the structure and performance of governmental organizations have no driving desire to influence policy making." Some appear far less credible—for example, "Americans would prefer to substitute hardware for 'humanware' in any war, even if it means the use of nuclear weapons." The book is also verbose and terribly repetitious.

Despite its limitations, however, Schooler's work is an important contribution to the literature of science and public policy, most particularly because it contains a potentially fruitful conceptual scheme for the analysis of an important question. What is needed now is refinement of that scheme and its use in studies based on first-hand evidence of the scientist-government relationship.

JOHN M. LOGSDON
School of Public and International Affairs, George Washington University, Washington, D.C.

Heredity in Man

Human Cytogenetics. JOHN L. HAMERTON. 2 vols. Vol. 1, General Cytogenetics. xvi, 412 pp., illus. $18.50. Vol. 2, Clinical Cytogenetics. xviii, 546 pp., illus. $27. Academic Press, New York, 1971.

Innumerable books on medical cytogenetics have appeared in recent years, but few, if any, have combined the biological depth and clinical usefulness of the volumes by Hamerton. The serious student of human cytogenetics will welcome these scholarly, eminently readable discussions of basic and clinical cytogenetics.

The indebtedness of the human cytogeneticist to plant and animal cytologists is duly acknowledged in volume 1. Hamerton properly describes the beginnings of modern human cytogenetics in terms of techniques adapted from work on the chromosomes of simpler organisms. His historical perspective is aptly chosen, and his account serves to remind the human cytogeneticist that cytogenetics did not begin as a scientific discipline with the discovery in 1956 by Tjio and Levan that the human chromosome number is 46. Volume 1 reviews, from this perspective, meiotic and mitotic cell division and the evidence for (and against) the idea of inactivation of the X chromosome. The