Book Reviews

The Use of Resources and the Uses of Research

Science Policy and the University. HAROLD ORLANS, Ed. Brookings Institution, Washington, D.C., 1968. xvi + 352 pp., illus. Cloth, $7.50; paper, $2.95.

The questions asked and discussed in this book are: How should resources be allocated among various branches and types of science? How could the relationships between the federal science programs and the universities become mutually more productive?

The book offers useful suggestions and insights; but it does not presume to give final answers. As is stated cryptically after a lengthy discussion of the federal budgetary process in the area of science (p. 222), "budgeting in this field, as in many others, is always going to be a highly judgmental process."

The book is a carefully edited report of a seminar on Science, Technology, and Public Policy sponsored by the Brookings Institution during the period 1964–1966. The members of the seminar were eminent scientists, economists, administrators, and congressmen representing universities, educational associations, private industry, and the federal government. Among them were Harvey Brooks, Representative Emilio Q. Daddario, Kermit Gordon, Charles J. Hitch, Francis Keppel, Don K. Price, Frederick Seitz, Eric A. Walker, Logan Wilson, and Dael Wolfle. The seminar was heavily weighted with persons who, in one capacity or another, have been deeply involved in federal science policy. The book includes many of the papers presented to the seminar and brief reports of the discussion of these papers. The editor has helped to unify the volume through a useful and lively introduction.

In considering the allocation of resources to the various branches and types of science, considerable attention was given to the classification of scientific activities. Before one can discuss allocation, a useful set of categories into which scientific activity can be divided is needed. There are many possible systems of classification, all useful for some purposes; among them are classification by disciplines, subdisciplines, and interdisciplines; by purpose (for example, basic, applied, R & D); by social objective (for example, defense, health, natural resources); by scale or style (for example, "big" versus "little" science); by character of performing institution (for example, university, private industry, government laboratory); and by object of study (for example, oceans, space, atmosphere). But having identified the categories, the members of the seminar offered little in the way of principles to guide policy-makers in deciding on allocations among several categories. It was admitted that cost-benefit analysis has limits, especially since the outcome of research is always uncertain; it was suggested that certain apparent prejudices against "big science" should be modified; and it was recommended that basic science might be considered an overhead cost of applied research and R & D and be carried at some percentage of expenditures for those activities. To me, an interesting suggestion was that a cadre of "scientific critics" comparable to artistic critics might help in decisions on allocations. These people would presumably stand above narrow disciplinary and institutional interests and would appraise the broad progress of science and express their critical judgments on various actual and proposed developments just as artistic critics study and observe trends in art and express their interpretations and judgments.

The question of allocation led to discussion of central planning for science. The members of the seminar tended toward skepticism of central planning and control of science. They favored pluralism with the preponderance of decisions rising spontaneously from thousands of working scientists, with review by peers, rather than handed down from the top. However, there was uneasiness over the "capriciousness" of a laissez-faire system, and there was recognition that some central planning is inevitable, especially when major installations for "big science" are under consideration. The difficulties of rational allocation were expressed almost poignantly by Harvey Brooks (p. 80), who said, ". . . in basic research, the target—'the advance of knowledge'—is so broad, could it ever be missed? What is a mistake in high energy physics? What is a mistake?" And of course it was clearly recognized that if scientists do not have the answer, neither do congressional committees, officials of the Bureau of the Budget, or anyone else. So we are forced to rely on informed "judgment" and "hunches," and the outcome is inevitably affected by lobbying and by political factors. The members of the seminar did not despair, however; most apparently believed that fairly good decisions emerge from our pluralistic, judgmental, partially political process of reaching allocational decisions. This tacit conclusion, however, is also questionable, since there are few reliable criteria by which the goodness of decisions can be judged. Possible criteria might be the progress of American science as compared with that of other nations or with that of other periods. But the "progress" of science is itself not easy to measure.

The papers and discussion on the effect of the federal science program on the universities seemed to converge on one recommendation, namely, that proportionately more federal money should go to the universities for unrestricted or broadly defined purposes and proportionately less in the form of specific project grants. There were many arguments for this view, the main one being the need—even in the long-run interests of science itself—to strengthen institutions as distinct from promoting specific projects. The matter was summed up by Don K. Price (p. 38):

> We have to learn how to support an educational and scientific establishment, including private as well as public institutions, without either destroying its freedom or leaving it in a position of privileged irresponsibility. We have to learn how to fit the research interests of free scientists into a pattern of public policy and to take account of the need for balanced national development while building up our existing centers of high scientific quality. And we need, equally obviously, to devote our knowledge to the service of human welfare, as effectively as it has been enlisted in the service of national defense.

Price then says, and the entire book supports this thesis, "We obviously have not learned how to do all these things."

The important decisions of human life—those pertaining to friendship, love, family planning, morality, careers, personal opportunity, distribution of wealth and income, education, knowledge, foreign policy, esthetics, and recreation—must all be made on broad judgmental grounds relating to the ultimate values and meanings of human life. Few specific criteria or objective standards are available. Where quantitative standards can be applied, as in the case of costs and prices within the private economy or tests within the educational system, these quantitative standards often tend to dominate decision-making to the exclusion of nonmeasurable and usually more important considerations. The allocation of resources to scientific investigation is partly an economic matter in which there are some quasi-objective standards, but it is largely an esthetic and educational matter relating to fundamental values and meanings of human life. As the seminar so clearly showed, the allocation of resources to science, including the determination of the role of universities in scientific investigation, is one of those important matters that call upon human beings to use their broad judgment (expressed in part through the political process) and not merely to resort to simple and automatic quantitative analysis.

The importance of the book is not lessened by the paucity of clear-cut answers and formulas. It is the best available discussion of a subject vital to our society and should be read and pondered by all those concerned with science policy.

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Colloque Ampère

Magnetic Resonance and Relaxation. Proceedings of the 14th Colloque Ampère, Ljubljana, Yugoslavia, Sept. 1966. R. BLINC, D. HADŽI, and M. OSREDKAR, Eds. North-Holland, Amsterdam, 1967. xvi + 1241 pp., illus. $50.

The advent of magnetic resonance methods, in the early 1950's, has been recognized by some as the latest major contribution to the study of physical chemistry, where "physical chemistry" can be defined in the words of the late G. N. Lewis as "all those things in which I am interested." Certainly, the interest has grown from a physicist's laboratory curiosity (albeit, a Nobelprizewinning observation) through a period of exciting, almost romantic, discovery of the inner secrets of molecules and on to its present stages as an essentially routine exploratory or analytical tool.

This rapid maturation of a technique which was in many ways mechanically complex and even awesome to the chemist can to no small extent be attributed to the efficient, rapid communication systems developed by the early practitioners. Publications in the conventional literature serve their useful purpose, but are too slow and too restricted for the serious student. The solution was found in the formation of specialized colloquia, of which the Colloque Ampère is a prime example. This continuing series of colloquia has provided the international latticework for the interchange of results and ideas at the current state-of-the-art.

This compendium of the 14th session is illustrative of the range and intensity of activities of a cross section of the world's contributors. The emphasis of the conference was on the basic physics of magnetic resonance and on its applications in physics, chemistry, and biology. The almost 200 papers can be, somewhat artificially, sorted into about 60 on the fundamentals of the magnetic resonance phenomenon, 60 on applications to solid state physics including metals and semiconductors, 40 on the physical chemistry of molecules and aggregate systems, and the remainder on a variety of topics in dielectrics, radiation damage studies, deuteron resonance, and the computerization of magnetic resonance experiments. The rigor of the condensations printed here is highly varied, ranging from a few excellent general review articles of 30 pages or so down to abbreviated abstracts of less than 50 words. It is an admittedly arbitrary reflection of one's own interests to select individual articles for comment, but the several which I found particularly informative included R. L. Mössbauer's general discussion of recoil absorption of gamma rays and nuclear hyperfine interactions, the historical survey of the impact of NMR on the knowledge of hydrogen bonding by G. L. Hofacker and A. H. Hofacker, three descriptive articles on nuclear dynamic polarization by A. Abragam, E. L. Hahn, and K. H. Hauser, and the entire session on new techniques, which includes a particularly good survey on the superconducting magnet by F. A. Nelson and H. E. Weaver. Other readers would undoubtedly select a differing list.

In general, however, this compendium should not be viewed as a source book or even as a general review. The coverage is too extensive and, in consequence, too abbreviated—even considering the 1241 pages. Unfortunately, it becomes a moot question even as to justification for hard-cover publication of a volume of such a relatively high price and predictable short-term utility.

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Successful Theorists

The Atomists (1805–1933). BASIL SCHONLAND. Oxford University Press, New York, 1968. x + 198 pp., illus. $5.60.

Sir Basil Schonland has written an engaging semipopular account of an extremely interesting and complex aspect of the history of modern science. *The Atomists (1805–1933)* discusses the major post-1800 antecedents of the quantum mechanical atom, what Sir Basil calls "the final mathematical model of the atom." The story begins with Dalton and reviews very briefly the development of the ideas of the ion, electromagnetic waves, the electron, the early atomic models of the atom of Rutherford and of Bohr, and finally the changes wrought by quantum mechanics. The ideas and the relevant experiments pertaining to each are described clearly and economically; the illustrations are skillfully selected and helpful.

This account of historical landmarks in science raises some interesting questions. Without a doubt, Sir Basil's story of atomism is an example of "Whig" history; that is, the author has sought to illuminate only those aspects of history which have contributed positively to the development of present-day "textbook" versions of atomic structure. Consequently, armed with hindsight, the book systematically slights the concerns of the past. There is no discussion, for instance, of the vortex atom of William Thomson, which played so interesting and important a role in Victorian physics. There is bare mention of the influential Boscovichean atom and scarcely a reference to the opponents of atomism, the ranks of which included a fair number of distinguished scientists.

Yet there are uses even of Whig history, and Sir Basil's book amply illustrates them. As a concise source for clear discussions of important and wellknown scientific events, *The Atomists (1805–1933)* succeeds admirably. More-