Book Reviews

Political Formats for Science and Technology

Science and Society. HILARY ROSE and STEVEN ROSE. Allen Lane–The Penguin Press, London, 1969. xviii, 294 pp. £2.50.

This book deals mainly with British science policy. The British case, however, is viewed in a historical and comparative perspective, and the authors' purpose is to reach conclusions of general validity.

The first two chapters of the book provide an overview of the development of science and scientific organization in Britain from the 17th century to the First World War. Chapter 3 is an account of British governmental policies toward science between the two world wars. This is followed by an account of British scientific research during and since the Second World War (chapters 4–6). Taking as their starting point the high hopes created by the successes of research during the war, the authors trace the disillusionments that followed because of (i) the inability of Britain to compete with the United States and the Soviet Union in rocketry and space research and in "big science" and (ii) the lack of success in using science as a means of solving Britain's economic problems. The picture is then complemented (in chapters 7–12) by a description of science organization and policies in Western Europe, the U.S., the U.S.S.R., and the Third World, of international scientific organizations such as UNESCO, OECD, and CERN, and of the brain drain and the technological gap; and a detailed case study of the rejection by the British government of a World Health Organization proposal for the establishment of a large international research center in biology at Edinburgh. This case study (chapter 12, "Decisions: Megamouse and C.E.R.N.") is a good example of the method employed throughout the book. It consists of an examination of the arguments put forward by the different groups involved in decisions about science policy, according to two criteria: (i) whether the decisions were taken as part of clearly formulated plans about the objectives and purposes of research and (ii) whether they were taken on the basis of intrinsically scientific considerations.

The results are negative. The authors find that there were usually no plans and that the decisions were taken ad hoc on the basis of political as much as scientific considerations. This leads them to conclude that

> the sort of science that is done today . . . is neither inevitable nor . . . the best. . . . It is the product of certain philosophies, ideologies, economic and political structures. It is thus to a considerable extent modifiable and plannable. . . . [Therefore] the continuance of the present structure of, even apparently non-political, scientific administration in Britain is irreconcilable with the goals of creating an open, accessible and man-centred science, nor yet of one which is effectively planned according to technocratic criteria. In order to achieve these goals, the decision-making processes need to be opened at all levels.

Like many other writings in the still largely unexplored field of science policy, this book combines scholarly investigation with critical comment. There is a great deal in it that is valid in both respects. I learned most from the interpretations of international science policies in Europe, which are apparently based on firsthand knowledge. The nearly comprehensive survey of science policies around the world (chapters 7, 8) is a first attempt of its kind, and it is a tour de force in spite of its inconclusiveness. Only the first two chapters, which deal with the development of British science organization and policies up until the First World War —and which are unnecessary from the point of view of the central theme of the book—contain errors. Otherwise the book is informative and reliable.

The main intention of the book, however, is to criticize the present state of scientific affairs, rather than to analyze it from a purely scholarly point of view. The authors describe British science policy and compare it with that of other countries in order to draw attention to serious shortcomings and reach the conclusions about the need for the political control of science. The criticism raises many an important problem, such as the need for constant redistribution of the scientific effort from firmly institutionalized lines of research that have reached the stage of diminishing returns, to new and more promising, but institutionally less powerful, fields; the distortion of scientific priorities by some scientists and scientific cliques who expropriate for themselves the lion's share of the science budget, using a mixture of scientific and technological arguments (with or without military implications); and the inaccessibility of science to the general public, whose lives and purposes are increasingly affected by it.

These concerns of the authors with the state of science, as well as with the state of society, are shared by many people, including the reviewer. Nevertheless I found the critical interpretation of the British case, and also some of the conclusions, unsatisfactory.

The first point that has to be taken up is that the conclusions are only apparently based on the evidence presented in the main part of the book. In fact neither the British case nor the comparative material offers any evidence that a greater degree of politicization and more planning of science in Britain would have made it either more "man-centred" or technologically more useful. As a matter of fact the conclusions can be questioned even on the basis of evidence contained in the comparative part of the book itself. French science policy, which is presented as an example of clarity of political purpose and planning, turns out to be wasteful as well as stiflingly bureaucratic. Although it is adduced as a contrast to the fumblings and indecisions of the "apparently non-political" administration of science in Britain, neither the authors nor anyone else assert that the results of French policies have been superior to the ones attained in Britain. Furthermore, I doubt the validity of the interpretation of the British case itself, because it is based on only part of the evidence. The policy decisions discussed in detail concern mainly government schemes for the promotion of applied research and subsidies for very "big" science, and these do not exhaust science policy.

As to government-supported applied

research, even if one accepts the judgment of the authors that it has been ineffective it does not follow that more planning and greater political control would have improved it. In fact, the successes of industrial research in Japan, in the United States, and in much of the private sector in Britain itself indicate that what may be needed is the transfer of the responsibility for industrial research to the industries themselves (which is, I understand, present British policy) rather than more politics and more central planning.

Moreover, it is not sufficient to evaluate British or any other science policy merely on the basis of its performance in applied science. Fundamental science has to be considered as well, and I know of no evidence that Britain has done worse there than any other country in the world. As a matter of fact a good argument could be made that on the whole it has done better. The only evidence of shortcomings produced in the book consists of the hesitations and changes of mind concerning British investment in local and international big science. But it is not justifiable to take these as evidence of failure. All realistic descriptions of even the most successful policy decisions will show such inconsistencies in the way these are arrived at (and, by the way, one finds the same kind of fumblings in the genesis of some of the greatest discoveries).

As to the particular cases analyzed in this book, it is possible to interpret the hesitations and doubts of the policy makers as the only possible reaction to a situation where there was, and still is, no sufficient knowledge available. It is true that they have not arrived at a brilliant solution, but no one has so far. Dealing with problems on an admittedly ad hoc basis was probably the only honest course of action, and it might well have been the best strategy from the point of view of the development of science in Britain and elsewhere —better at least than subscribing to unfounded general conceptions and diverting research funds from a fairly flourishing system of relatively small science to grandiose international schemes of big science. In any case, those who think otherwise have to state concretely what they think should have been done. Showing that what was done was based on less than prophetic foresight is not enough.

Indeed, as becomes evident in the last chapter, the author's conclusions are based on a general philosophical view of science rather than on British or any other particular science policy. According to this view, science and technology are inseparable. Both are the "products of society," and the idea of the value neutrality of science and technology is a "liberal trap." If we cling to the prevailing pretension that science is apolitical, we leave the control of science in the hands of vested interests such as the (established) scientists and the "industrial-military complex." The alternative is the transfer of control to the democratically constituted "nation" or "people."

The need for the planning of science does not automatically follow from these premises, but it seems to be related to them through the common source of Marxist-Bernalist doctrine from which it and they derive. This doctrine asserts the superiority of a planned socialist to a decentralized, privately controlled economy, as well as the existence of a very close interdependence between science, technology, and the social uses of technology. I shall not deal here with the problem of socialist planning and shall concentrate on the second assertion.

Recent investigations of the relation between technological invention and scientific research by the late Jacob Schmookler and others have shown that only in exceptional cases is there a direct link between them. Since furthermore even technological know-how can be bought and copied from abroad, the connection between scientific research and economic growth within any national economy is tenuous indeed. Hence there is no ground for the planning of science within a framework of the planning of production (as an expenditure science is, of course, part of every economy). It is possible, on very general grounds, to consider research as a very long term economic investment. In such an approach, however, there would be no attempt to apply external criteria to scientific choice.

The extreme looseness of the link between scientific research and technological invention is equally relevant from the point of view of the argument that science has to be controlled lest it commit society to a socially unacceptable political course. Science does not commit society to any definite course; it only creates options. There is very little reason to believe that more political control of scientific decisions would function better or produce better results than political decisions about the uses of these options have done in the past. The whole current discussion about the political responsibility of science for the present-day ills of society is irrelevant, and probably even detrimental, to the curing of those ills.

Much of that discussion arises from the belief that science is to blame for the danger to man's survival presented by the nuclear bomb. It was not, however, the discovery of fission, but the threat that a criminal régime might conquer the world, that led to the bomb. The exploration of the atomic structure in the 1920's and '30's was a scientific venture, the result of decisions made by scientists who received little support from others and whose work was of little interest except to those who loved physics; they did not know and could not know what they would find or whether they would find anything. Had anyone tried to discuss publicly the potentially harmful applications of that research, he would probably have aroused no interest at all; and the average citizen would have been completely unable to understand the issue.

The development of the bomb, on the other hand, was not a scientific but a military-technological project, and the scientists involved in it served the military purpose as others before them had done since the days of Archimedes. The men who made the decision to develop the bomb knew exactly what they were after and had a fairly good estimate of their chances of success. This decision had very obvious and immediate bearing on the public interest. Had it been discussed publicly, all citizens could have formed opinions on the issue, and the decision would probably have received their enthusiastic support. After the development of the bomb, there was still a decision to be made about how to use it. The decision to drop it on a populated city was not a scientific decision (and if it had been left to a "participatory democracy" I doubt that it would have been different).

Irrespective of whether one approves of any or all of these decisions, it is obvious that they require very different kinds of information, resources, and moral commitment. I fail to see, therefore, how such different decisions could be subjected to the same criteria of relevance, as suggested in this book. Nor can I see the usefulness, or even the possibility, of the same kind and

degree of public involvement in all of them. As to the first, scientific, decision, there seems to be no alternative to the autonomous processes of the scientific community. These, of course, need not necessarily be based on the same kind of autonomy as that which prevails in Britain or anywhere else today, and I agree with many of the authors' criticisms of the ways academic and scientific communities conduct themselves. The second and third types of decisions are technological or operational ones. They can be and have to be taken according to the same criteria that are applied in economic and political decisions and by the people who deal with economic and political affairs in general. As there is now abundant evidence that technological devices, and especially how they are used, have very far-reaching consequences, there is a good case for more public control and planning of such developments.

In the more concrete part of their discussions the authors are perfectly aware of these differences. But they try to dismiss them by the argument that in effect

> many scientific developments are allowed to proceed from the point where they are nothing but a gleam in a research director's eye to that at which they are so technically sweet that they are virtually impossible to rescind without their *ever* being subject to public scrutiny.

These things undoubtedly happen in technological as well as other kinds of decisions. The dangers that result from insufficient alertness about the possible consequences of all kinds of actions are probably greater in an increasingly crowded, interdependent, and fast-changing world than they were in the past. But this problem is not particular to science, or even to technology; it pertains to public and international life in general. To keep mankind alive today requires greater moral responsibility and a greater degree of political rationality than at any other time in history.

This being the case, the recommendations—in this book and in many parts of the scientific community in general—about the need of greater political control of science and technology, as the principal means of preventing total disaster for mankind, are dangerously misleading. Science in this way of thinking is conceived of as an omnipotent force that somehow failed its mission. It not only failed to redeem mankind but has actually turned into "an instrument of man's destruction." This way of thinking places the blame for the state of the world on some impersonal thing, instead of facing the commonsense truth that man alone is responsible for his deeds. For our most grievous difficulty there is no remedy short of finding ways of dealing with conflicts without violence and war. It is difficult to bear the idea that mankind may have to continue walking on a precipice for who knows how long and to avert disaster only by the day-to-day efforts of fallible politicians and their advisers. One can understand that people tend to lose their nerve in such a situation and seek scapegoats, but the idea that the danger can be averted by controlling science is an attempt to exorcise the evil spirits by magic.

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The Fluoride Saga

Water Fluoridation. The Search and the Victory. FRANK J. MCCLURE. National Institute of Dental Research, Bethesda, Md., 1970 (available from the Superintendent of Documents, Washington, D.C.). xii, 304 pp. + plates. $3.25.

This book is an attempt to prepare a simple, straightforward account of the historical developments that led to the sequential recognition that mottled enamel was caused by excess fluoride ingestion during tooth development, that an optimal intake of fluoride resulted in a highly significant, indeed spectacular, reduction in tooth decay, and that the water engineer could inexpensively, safely, and efficiently either increase the fluoride concentration of a deficient water supply to an optimal level or reduce an excess fluoride concentration to an optimal one.

McClure points out in the preface the Jekyll and Hyde aspects of fluoride and the ultimate recognition and subdual of Mr. Hyde and survival of Dr. Jekyll. The fact that a single element in excess can be harmful but be beneficial in lesser amounts still bewilders many laymen and is the root of the controversy whenever the subject comes up for discussion in political campaigns.

The first seven chapters are devoted to the toxic manifestations of excess fluoride ingestion and the processes by which water was identified as the carrier of the toxic principle and by which fluoride was (in 1931) identified as the toxic agent. Early descriptions of mottled enamel are given, such as the one in 1901 by Eager, a Public Health Service physician who was stationed in Naples, Italy, to examine emigrants embarking for the United States. McKay's work in Colorado Springs and elsewhere in the United States and Italy is described in detail to show the background for his hypothesis that the source of water during tooth development was pivotal in the determination of whether an individual would have mottled enamel. Changing water supplies in several communities established this concept, and then years later several investigators reported within months of each other that fluoride was the active agent. A full-color foldout plate is included to show the various degrees of mottled enamel (dental fluorosis). This plate was reprinted from a recent report on the epidemiology of fluorosis in Denmark (I. J. Møller, *Dental Fluorose og Caries*, Rhodos, Copenhagen, 1965). The systemic toxicosis in domestic animals and man occurring at still higher levels of fluoride ingestion than those associated with endemic dental fluorosis is documented with good references to pertinent literature.

The next section of four chapters is devoted to the recognition of the relationship of fluoride ingestion during tooth development to reduced incidence of dental caries in areas where the water contained fluorides and then to the testing of whether a comparable benefit could be obtained by the adjustment of the fluoride concentration of low-fluoride water supplies. McClure meticulously documents the procedures and the results in the four earliest water fluoridation trials in Newburgh, New York, Grand Rapids, Michigan, Brantford, Ontario, and Evanston, Illinois. Another chapter is devoted to alternative means of administering fluoride to achieve dental benefits.

The third major portion is devoted to evaluation of the safety of fluoridation at the recommended level of approximately 1.0 part of fluoride per million, which is to be varied according to the climate and other contingencies in the community. These studies occurred in abundance between the recognition of dental benefits and the initiation of fluoridation trials. Many other factors continue to be examined