Government and Science in an Age of Scientific Revolution

A revolutionary change has occurred in institutional relations between science and the federal government.

A. Hunter Dupree

All the many evocations of the figure of the scientific revolution as a description of this or of any other age are metaphors based upon metaphors. Between the changes in ideas which make up a scientific revolution and the turning wheel lie the great political and social upheavals of history, of which the greatest and most fully developed model is the French Revolution. The meaning of revolution in political and social terms has never ceased to attract and to baffle the profoundest of scholars. Hence it is little wonder that we seem to live in the midst of a superfluity of scientific revolutions that overlap and sometimes contradict one another, each related in a different way, by analogy, to political revolution. J. Stefan Dupré and Sanford A. Lakoff, in **Science and the Nation: Policy and Politics** (Prentice-Hall, Englewood Cliffs, N.J., 1962. 181 pp. $1.95), have taken pains to delimit their revolution. They keep well clear of the changes in the body of scientific understanding itself and only imply the significance of both the classical industrial revolution and the changed relation of science to technology. In a qualified way they recognize these last two revolutions, in the sense that C. P. Snow described them in the *Two Cultures and the Scientific Revolution.* But Dupré and Lakoff's aim, in their book, is to trace the implications of these more general revolutions in the "revolutionary change in the relation of government to science." They have largely succeeded in drawing the main outlines of the American experience with this momentous change of the last two decades, a change which Snow himself did much to obscure with his misnamed and tendentious *Government and Science.*

The reviewer, a professor of history at the University of California (Berkeley), is the author of *Science in the Federal Government, a History of Policies and Activities to 1940* and he is currently directing a group of historians engaged in writing a history of science in the federal government, 1940–1960.

The Nation's Science Policy

Dupré and Lakoff are concerned with the particular problem of the relation of science to the government of the United States. "During most of American history, science was regarded by government as a useful and even wholesome activity, but not as one so crucial to national security and welfare as to require constant concern and heavy subvention. Today, the situation is drastically altered. Government and science have joined in a national enterprise born of necessity and sustained by the challenges and complexities of the modern world." In outlining the growth of policy for the new age, the authors point to the growth of industrial research and then to the growing partnership between government and business in the conduct of research for the defense industries. As examples they briefly describe the Sandia Corporation, the joint development of the NIKE missile, and the weapons system management provided by North American Aviation for the B-70. After sketching the legal structure of the research partnership in weapons research, the authors polish off the problem of budgeting for research and the problem of patents in two pages each.

Just as the government-business partnership has revolutionized weapons research, the universities and the government have increasingly become intermingled in the support of science as a whole. The separate research centers, such as Brookhaven and Los Alamos, operate in a semiautonomous fashion, but much federal money flows directly onto the campuses. "To the extent that government support of research (or of manpower programs) comes close to the universities' ideal, it contributes to the public service of higher education. But to the extent that it forces universities to deviate from their goal, higher education will be sacrificed in favor of other public functions. To be sure, federal funds need not conflict with higher education even in the case of purchased research; specific agency needs often result in major contributions to knowledge. However, tensions between government and universities frequently arise over problems of finance and administration." The much-surveyed and much-discussed tensions of this area—loyalty and security requirements, indirect costs, financing capital facilities, the National Defense Education Act—form the bulk of this discussion.

As a capstone to their delineation of the changes in policy, the authors trace briefly the relation of the presidency to the shaping of scientific institutions culminating in the establishing of the President's Scientific Advisory Committee (PSAC) and the Federal Council of Science and Technology. They also take a brief look at the various proposals for a Department of Science in the government. Yet, in view of the importance justly attributed to this range of subjects by James R. Killian in his foreword, this section is disappointingly short. The authors thus recognize the importance of changes in institutional structure as the surest indicators of the revolution, but they must rush on to examine the politics of the system.

Politics of Science

In political terms, "scientists have been most active in those matters touching the military applications of their work, and only sporadically active in other areas." Hence the politics of scientists means, to the authors, the efforts of the scientific community to shape policy within the context of the new institutional structure which they have already described. Although they refer briefly to earlier identifications of science and warfare, such as in the controversy over poison gas during and after World War I, they really see scientists arriving at the seats of power

with the unveiling of the atom bomb. The participation of some scientists in the decision to drop the bomb and the attempt of others to influence that decision was the first political campaign of the new era. After their intense effort in 1946 to act as a lobby while Congress was considering the fundamental postwar legislation for science, the scientific community took up again the task of shaping military strategy as their fundamental political role.

The central drama of the scientist-as-strategist reached its climax in the decision for the crash development of the H-bomb and in the various attempts, which followed in its wake, to change the emphasis of strategic policy —projects East River, Vista, and Lincoln. The authors see the change of administrations in 1953 as a real dividing line, at which many of the most active advisers to the government lost influence. Thus relegated "to a kind of political limbo, scientists critical of official policy rapidly became vulnerable targets in the campaign for security and against 'subversion,' that agitated the nation from the end of the war until the censure of Senator Joseph McCarthy of Wisconsin." The peak of the security problem, as the major source of alienation between the scientific community and the government, came in the early years of the Eisenhower Administration, first with McCarthy and the Signal Corps scientists and then with that crisis which surely ranks with the Dred Scott decision as one of the most enigmatic episodes in all of American history—the trial of Robert Oppenheimer. The authors devote unusual attention to the testimony revealed in the *Oppenheimer Transcript*, although dealing with this in nine pages requires considerable simplification of that lengthy and revealing source. From this height of alienation the scientists return once again to the councils of government in the late fifties, and the PSAC emerges as a device for legitimate political participation by scientists just as it climaxes the authors' quest for a policy machinery within the government.

Needed: A Social Science of Science

Any book that makes bold to delineate a major revolution in human affairs, to evaluate the relation of science to the nation, takes on some of the grandeur of its subject. And the summary remarks above are sufficient evidence that the authors have not conceived their task narrowly. The list of topics touched upon is impressive, not only for number and importance but also for the immense complexity of the subjects themselves. In addition, the substantive body of research results, which makes the whole structure of science a dynamic force in modern civilization, is complex beyond any indication the authors have been able to give. The book is marred much less by actual errors than by persistent and omnipresent oversimplifications.

Historical transitions tend to occur starkly and without foreshadowing. Sputnik draws a sharp line. The PSAC, the science adviser to the President, and the Federal Council of Science and Technology thereupon promptly emerge, without much differentiation in their separate potentialities. The Manhattan District has a complex and continuous history, but the few pages used here to introduce it as crucial evidence imply that it moved along by a few jerks. On page 10, the atomic energy research program was transferred from the Office of Scientific Research and Development to the Army Engineers "only in 1943 when much of the R & D had been done." Yet the transfer to the Manhattan District began in the summer of 1942 and was complete by the spring of 1943. One must then account for the implication, on page 92, that research support was very meager before the first chain reaction at Stagg Field in Chicago, for this event occurred in December 1942. The event did, according to the authors, convince scientists, the government, and industry of the importance of the research, but even it "was not enough to induce a radically larger government involvement." How does one reconcile these two oversimple versions?

The support of basic research by the government between 1945 and 1950 is disposed of in the following two sentences: "The Office of Naval Research embarked on a major effort to foster university work. And the National Institutes of Health, the research branch of the Public Health Service, launched a rapidly growing program of support for research in the medical sciences." One would think that such a major ingredient of the revolution in government and science as the arrival of the National Institutes of Health upon the scene might evoke both more comment and more enthusiasm.

The important question about the oversimplification evinced in this book is, however, why did the authors feel forced to indulge in it so freely? To some extent, of course, this is a textbook for use in the new science and public policy seminars, to which Killian refers in his foreword. But textbooks need not necessarily be imprecise. The authors are in difficulty here, despite their own quite sensible approach, because they had a grotesquely inadequate secondary literature on which to base their account. One can conceive of an adequate, short, interpretative account of the French Revolution or of the American Revolution, largely because of the immense amount of research that has been done by many scholars, during several generations, who have approached their subject from many points of view. Dupré and Lakoff had no such advantage here, for the social science of science is a field in which the revolution is yet to come.

Their method, in general, is the telling of short-run histories. And historians have scarcely begun the digging into primary sources which is needed to provide a detailed and reasonably correct account of the men and the events whose actions and interactions made the revolution. The study of a period so recent and of a series of subjects so foreign to the conventional preserves of the professional historian has frightened off those without extensive training in the sciences and, at the same time, many scientists have not possessed the scholarly equipment or the interest to appreciate history as a highly developed scholarly craft. It is understandable, though no compliment to historians, that the authors should even in a qualified way rely on Robert Jungk's *Brighter than a Thousand Suns*. Their pessimism is unwarranted, however, when the authors conclude that "Jungk's contribution makes the record as complete as it is likely ever to be. . . ." For historians to do better than Jungk has done with the most important events of the 20th century is not an impossibility but a necessity.

In the same way, the economics and sociology of science are still largely undeveloped. A more sophisticated understanding of the economics of research would give the authors an adequate basis for their discussion of the government's relation to industry. And one of the inevitable results of the revolution described here will be the necessity of weighing research as one of the most important factors in any economic situation. That science is a social activity amenable to the tools of sociological analysis has long been recognized, but

this approach has been largely limited to the so-called external relations of science. In the near future lies the possibility that social relations may be the key to the internal development of science as well.

Dupré and Lakoff are both identified on the cover of this book as assistant professors of government at Harvard. Hence they would doubtless admit themselves accountable for the query as to what political science has to offer in the delineation of the scientific revolution. While most of their account is descriptive narrative, they do in their conclusion venture into a more analytical way of stating the changed relation that is their subject. They see the partnership in research between the federal government, on the one hand, and business and the universities, on the other, as profoundly modifying the definition of the words *public* and *private* in our national life. They also conclude that, in the political sphere, the line between technical advice and policy-making is equally modified and that scientists are inextricably engaged in both. "If science and the nation have become interdependent but not indistinguishable it is because implicitly and explicitly those who have shaped the relationship have recognized that cooperation is essential if free institutions and individual freedom are to continue to function successfully. They have therefore sought to answer a national need but at the same time to promote institutional pluralism and personal responsibility."

Plea for Public Understanding

In their final paragraph, the authors transcend analysis with a fervent plea for better public understanding of the policy structure and politics of science in the nation. "Without public understanding of the new ways of partnership in which science and the nation have been brought together, old ideological dogmas may hinder vital progress. In the last analysis, a democratic nation can cope with the scientific revolution wisely only if thoughtful citizens know what it truly entails." Among the several groups within the public who must exert themselves in this enterprise are both scientists and social scientists, whose aroused efforts might provide the basis of information and theory on which the present authors could thankfully take up anew the task of sketching a portrait of the scientific revolution of our time.

Facets of Achievement

Essays in Pre-Columbian Art and Archaeology. Samuel K. Lothrop and others. Harvard University Press, Cambridge, Mass., 1961. 507 pp. Illus. $12.50.

Most of the 27 papers in this volume deal with American Indian civilizations in Middle and South America, but there is some coverage of less advanced cultures, both ancient and modern. Counting joint authorships, it is clear that 28 students of the American Indians in areas south of the United States have contributed to this volume as a gesture of respect and affection for one of the greatest producers and thinkers in their field. The lead article and one other are by Lothrop himself.

The editorial committee consisted of Doriz Stone, Gordon F. Ekholm, Junius B. Bird, and Gordon R. Willey, who provide a preface. Their effort was to make the collection "representative of the extremely wide range of interests in a distinguished career" and with "a particular eye to those objects that are commonly classified as art." They justly note that no Americanist contemporary of Lothrop has "extracted from the work of art so much information on the past or such insight into the lives of the makers." I steal space to add that no one has been more universally liked as well as respected for his accomplishments.

With one exception all the papers involve recent discoveries or new research. The top-drawer nature of the editorial group assured contributions of high quality only. Most students of the field covered will find required reading among these papers, and they will broaden their knowledge by reading them all. The emphasis on art objects gives the collection a special unity and requires generous illustration. The book is attractively printed and aims at the general reader as well as at the specialist. It should prove an excellent medium for showing the former how archeologists use "art" where written documents are lacking.

The objects discussed range through small and large stone sculpture, products of the lapidary, baked clay figurines, pottery vessels, textiles, paintings on pottery and wood, and work in the precious metals. Without entirely departing from the art category, there are valuable contributions on the design of ancient ball-game courts and equipment for the players. A new "experimental formulation of horizon styles" illustrates the desire of all the authors to rise from well-founded particulars to the level of useful inferences.

The first of the two papers by Lothrop himself breaks the pattern. "Archaeology—then and now" covers the period from 1915 to 1960. A leading theme is the change in a field man's problems wrought by the automobile and the airplane, and there is much delightful reminiscence. A prize photograph, taken at Copan, Honduras, in 1916, shows Lothrop in the background and the already venerable W. H. Holmes watching Sylvanus G. Morley, who is apparently loading his own mule. The final pages outline the history of Middle and South American archeology as Lothrop has seen it develop during the last 35 years.

LINTON SATTERTHWAITE
University Museum,
University of Pennsylvania

Problems and Potentials

Control Mechanisms in Cellular Processes. The seventh annual symposium publication of the Society of General Physiologists. David M. Bonner, Ed. Ronald, New York, 1961. v + 248 pp. Illus. $8.50.

Someone has spoken of modern biology as the "coming science." The designation has certainly been justified by the recent explosive and well-publicized advances in the elucidation of genetic coding, a "breakthrough" of knowledge that has been very properly characterized as one of the great scientific achievements. Lest any biologists think, however, that the opportunities for exploration have been reduced, I hasten to refer them to this timely volume.

The amazing profusion of reactions occurring within the cell is fully appreciated by today's biologists, many of whom have been engaged in discovering and characterizing these reactions. The contributors and the editor of this volume go a step further. They concern themselves with the question, "What regulates this complex system and keeps it functioning in an orderly way?" To be meaningful, they ask the question of parts of the cell, beginning with the nucleus and proceeding outward. Thus, the regulation of the activity of one