1949, when the communist regime first came to power. In part this progress is due to the great emphasis placed by the regime on both general and specialized educational expansion; in part it is due to the unique ability of a centralized system of political decision making to mobilize and channel human and material resources into high-priority developmental sectors.

The authors estimate that approximately 1 million full-time students were enrolled in China's higher educational institutions—primarily in the fields of science and technology—in 1964–65 (the last years for which adequate statistical data exist). This figure represents more than an eightfold increase over the figure for 1949–50. In this same 15-year period there was a tenfold increase in the number of professional scientific and technical personnel in China, from less than 10,000 to almost 100,000.

With respect to financial support for scientific R & D, the authors conclude that "on the basis of published data alone, the science budget is the fastest growing item in the Communist Chinese state budget." While the estimated overall state budget grew at an average annual rate of 16 percent from 1952 to 1965 (from approximately $7 billion to $17 billion), the science budget in the same period increased at an average rate of 117 percent (from $4.6 million to $625 million). Within the overall scientific R & D budget, the largest single item in recent years has been the nuclear development program, accounting for roughly 50 percent of all state investment in scientific activity. It is estimated by the authors that in 1960 the Chinese government employed approximately 2000 engineers and 750 scientists in its nuclear R & D program, with a like number employed in the production of materials for this program.

The major locus of scientific research in China is the Academy of Sciences, whose budget in recent years has accounted for approximately 20 percent of the total state budget for science. The Academy's 148 component central and branch institutes concentrate primarily on work in the three basic sciences and employ approximately 22,000 R & D personnel. Of the current (estimated) total of 100,000 to 200,000 persons engaged in scientific research and development work in China, approximately 50,000 are known to be employed in the higher education sector. Salaries of scientific R & D workers are estimated by the authors to range from $350 a year for a research assistant to $1250 for a senior researcher, with the mean for all scientific workers being approximately $500. (By way of contrast, the average factory worker in China earns between $200 and $250 a year.)

Turning to the question of research priorities, as measured by the contents of China's scientific journals, the authors note that published research in the life sciences (biology, medicine, and agriculture) accounted for 58 percent of the total scientific output for the decade 1950–60, with the engineering sciences accounting for 31 percent and the physical sciences (including mathematics) for 10 percent. The authors conclude, however, that such statistics may be somewhat misleading, since some research findings (most notably in nuclear science and other defense-related fields) are never published.

One of the more interesting questions to which the authors address themselves is that of the effects of China's Great Proletarian Cultural Revolution on the scientific establishment. While noting that virtually all institutions of higher education in China suspended operations for periods of from one to three years during the recent upheaval and that China's professional intellectuals (including some scientists) were a major target of Red Guard criticism, the authors conclude that the more sensitive sectors of Chinese science—particularly defense-related R&D—were consciously and effectively insulated from the most disruptive effects of the Revolution. In the long run, however, the authors believe that one important side effect of the Cultural Revolution may be the politicization of science, which they view as potentially deleterious since it may lead to "compulsory conformity imposed by the enshrining of Mao Tse-tung's thought, which is basically anti-scientific." This reviewer, while agreeing with Wu and Sheeks that the politicization of science in any country is in principle abhorrent, would question the criteria by which they judge Maoist thought to be antiscientific.

Arguing that China's impressive scientific achievements over the past two decades have been gained through the stressing of immediate returns of applied research at the expense of long-term pure research, the authors foresee the occurrence of a developmental bottleneck and predict that at least in some critical areas "the continuation of growth at past rates will be increasingly difficult." This is undoubtedly true; indeed, the long-term continuation of the growth rates of the 1950's and 1960's would be difficult under the best of conditions. Nevertheless, and despite the existence of a major developmental dichotomy in China, there can be no denying that Chinese science has "arrived."

RICHARD BAUM
Department of Political Science, University of California, Los Angeles

Technonature

Science et Politique. JEAN-JACQUES SALOMON. Editions du Seuil, Paris, 1970. 408 pp. Paper, 29 F.

It is difficult to render an honest assessment of a book written for a European audience by a European. But it is important to attempt an assessment when that book seeks to judge the significance of events and patterns that are largely Anglo-American in origin, and when the author's experience and background so uniquely lend themselves to the effort of synthesis. For the past ten years, Salomon has participated in the work of the Directorate for Scientific Affairs of the Organization for Economic Cooperation and Development. Since 1967 he has been Director of the Science Policy Division, and has guided the series of statistical and policy reviews of European and North American industrial nations conducted by that organization.

Salomon's perspective on science, technology, and public affairs is primarily historical and philosophical. This characterization applies to the intellectual perspective as well as to the organization of the book. The book has three major sections. In the first, he reviews the European origins of the relations between knowledge and power, choosing Bacon's *New Atlantis* as his point of departure and emphasizing the relationship of changing views of the utility of science to changing views of the function of government and definitions of the public interest. Needless to add, the impact of the French and Russian revolutions constitutes an important part of his analysis.

The second section deals with organi-

zational characteristics and typical policy instruments that relate the scientific to the governmental enterprise in contemporary industrial nations. In this portion of his analysis, Salomon performs a useful and overdue service in deflating the claims for "scientific decision making" exemplified by the proponents of planning, technological forecasting, and criteria for scientific choice. In the third section of the book, he considers the emerging sociopolitical consciousness of the scientist. In his view, scientists in modern society constitute a new professional category, distinct from that of the scholar whose role is contemplation. Scientists have become inextricably involved in problems of power resulting from the utilitarian priorities of industrial nations.

This book will fail to satisfy some of its American readers for reasons that are largely the result of a different set of expectations. For example, social scientists will expect a more empirical approach to the allocation of resources to science and the legitimization of science policy making structures. Salomon, however, is less concerned with specific programs of action that have expanded the public involvement of science and technology than with the philosophical question why science expresses the characteristic relations of public authority with the public interest in industrial nations.

A different sort of problem for American readers results from the author's effort to expose his European audience to a new range of literature and unfamiliar conceptual schemes. The demythification of rational decision making, and the reassertion of politics as usual, are a welcome corrective to some of the enthusiasms of the past decade. But the long synopses and detailed critiques found in the central section of the book will probably seem superfluous to those who have followed the course of the game from the sidelines, and to many who were in the thick of it. Yet as Salomon points out,

> If a good part of our references are taken from the U.S., it is because this relation [between knowledge and power] achieved there an institutional form sooner, and on the scale that it is coming to have in all industrial countries, together with the problems and more acute consciousness, the greater public debate and richer effort of understanding, that reflect the same problems everywhere [p. 27].

Salomon's significant contribution to our understanding of the relation between knowledge and power is also the source of some conceptual confusion. He begins by proposing the concept of "technonature," variously described as a condition of industrial society, the locus of action within industrial society, and an intellectual construct designed to resolve the permanent ambiguity of science seen as a value in itself and in utilitarian terms.

On the other hand, in the chapter concluding the historical section of the book, Salomon proposes that war, in the sublimated form of technological competition, had become the condition and the object of relations among advanced industrial nations. Though less elegant, this notion goes much further toward explaining and linking in historical sequence the new style and scale of relations between knowledge and power. It has the additional advantage for Salomon's argument of reducing the apparent divergence of Western and Communist governments, capitalist and socialist market systems, and their respective ideological biases.

There is a third, implicit level of analysis that emerges from Salomon's treatment of the Manhattan Project as the signal event separating the old situation of science and scientists from the new one. At this level, the flux of events provides the major principle of organization. No serious student in the field of science and public policy should be in ignorance of the comprehensive, critical, and judicious analysis that constitutes the central chapters of this book (3 through 8). Quite apart from questions of theoretical perspective, they demonstrate subtle discrimination and insight by one who was both actor and observer.

T. DIXON LONG
Program on Science, Technology, and Public Policy,
Case Western Reserve University, Cleveland, Ohio

Literacy for the Favelas

Pedagogy of the Oppressed. PAULO FREIRE. Translated from the Portuguese (1968) by Myra Bergman Ramos. Herder and Herder, New York, 1970. 186 pp. $5.95.

Cultural Action for Freedom. PAULO FREIRE. Harvard Educational Review and Center for the Study of Development and Social Change, Cambridge, Mass., 1970. viii, 56 pp. Paper, $2. Reprinted from the *Harvard Educational Review*, May and August 1970.

Paulo Freire is a Brazilian revolutionary, pedagogue, and social scientist who first became known to Latin Americans in the early '60's. Working in the poorest Brazilian *favelas* and peasant villages, he was remarkably successful in teaching adults to read and write after a few weeks of participation in seminars combining linguistic technique with the "analysis of culture." When the military regime took charge in 1964, Freire was exiled from Brazil. Invited to Chile, he developed his methods of adult education further with support from Unesco and the Chilean Institute for Agrarian Reform. As far as I know, no count has been made of the educational experiments based on Freire's methods, but they are numerous throughout Latin America. In 1969 he taught at the Harvard School of Education, and as a result his method is being tried in the United States. At the present time Freire is working with the World Council of Churches in Geneva.

Freire's method employs "generative words" chosen from the "minimal linguistic universe" of the prospective pupils. For Spanish and Portuguese he has found 17 such words to be sufficient. The first word is always trisyllabic, so that the learner can at once manipulate the syllables to form new sounds and thus new words. All the words must be relatable to "existential situations familiar to the learners," which provide the framework of their discussions in the *círculo de cultura*:

> What is important is that the person learning words be concomitantly engaged in a critical analysis of the social framework in which men exist. For example, the word *favela* in Rio de Janeiro, Brazil, and the word *callampa* in Chile, represent, each with its own nuances, the same social, economic, and cultural reality of the vast numbers of slum dwellers in those countries. If *favela* and *callampa* are used as generative words for the people of Brazilian and Chilean slums, the codifications [themes for discussion] will have to represent slum situations.