Book Reviews

Development of Research in China

Research and Revolution. Science Policy and Societal Change in China. RICHARD P. SUTTMEIER. Lexington (Heath), Lexington, Mass., 1974. xvi, 190 pp., illus. $15.

A major aspect of science policy in China after 1949 has been its continual change. More precisely, China has not pursued a single science policy since the People's Republic was founded. Rather, its policies have varied so over time that it makes sense to speak of six science policies: 1949–52, 1953–57, 1958–60, 1961–66, 1966–69, and 1970 to the present. Each is incisively summarized in this major evaluation of science policy in the People's Republic.

To be sure, certain underlying, though highly ambiguous, principles have persisted: the sociological or environmentalist view that the proper ideological and organizational context will guarantee scientific advance; the adherence to a "simple inductionism" that regards scientific theory as the aggregation, in abstract terms, of known practice; the emphasis on science in service to production; the subservience of science to Party and political dictates; the commitment to preserve and develop an indigenous science.

But what the Chinese do not adequately explain to their visitors, and what Richard Suttmeier properly stresses, is the evolutionary, almost cyclical, nature of the policy. The Chinese feel compelled to present current policy as highly effective, to condemn past policies undifferentiatedly, and in any case to emphasize principles to the visitor rather than detailing policy. Suttmeier's terse, analytical study argues that the ambiguous underlying principles of Chinese science policy are less crucial to understanding and evaluation than are the successive sets of policies and their relationship to each other. An essential ingredient of Chinese science policy, according to Suttmeier, has been the willingness of the leaders to abandon one set of policies and adopt a new set as soon as the costs of the old begin to outweigh the gains.

The key to Suttmeier's analysis is his recognition that any set of science policies maximizes some goals but not others. Given China's traditional cultural, social, and economic inhibitions to scientific advance on the one hand and her low technological level on the other, any long-run science policy must attack the environmental constraints while enhancing the nation's storehouse of knowledge. Not only must research be sustained but a demand for that research must be created. The problem, as Suttmeier notes, is that these tasks are not compatible over the short run. Hence, a successful science policy in China—and perhaps in other underdeveloped countries as well—must be flexible and evolutionary. When the nation's scientific apparatus is configured to solve the dissemination–cultural-constraint–market-demand nexus of problems (as during the Great Leap of 1958–60 or Cultural Revolution of 1966–69), little progress occurs toward the knowledge-creation–research-competence goals. Hence, science policies must be redesigned to pursue the latter goals, only to encounter difficulties in the former areas. The successive sets of policies are not merely cyclical, however. Developmental trends exist as well: increasing demand for science; increasing scientific competence; and increasing complexity.

Students of China will recognize Suttmeier's basic argument, for he joins a number of China scholars who argue for the underlying rationality of Mao's somewhat cyclical approach to development: periods of intense mobilization, social change, and ideological indoctrination alternating with periods of institutionalization, consolidation, and economic expansion. Each phase, it is argued, requires the other. Suttmeier presents the most subtle and balanced defense of this view now in the literature, and for that reason it is an important work.

As one can imagine, a long list of rather standard and by now tired objections can be raised to the Suttmeier view. The oscillations have been more extreme and disruptive than they need have been. The goals are not as incompatible as Suttmeier and those dealing in other policy areas have suggested, and hence could be blended into a more integrated, complex, continuous policy. China's zigzag developmental policy depends upon the wisdom, fortitude, and power of those at the helm who periodically reset policies; this places a perhaps intolerable burden upon the political leadership dimension of a developmental strategy, making development a dependent variable of politics. The psychic and human costs of continual policy shifts are not adequately considered. So too, Suttmeier—or others—may underestimate the long-term costs of periodic interruptions in scientific research, although to be sure Suttmeier recognizes this possibility in his balanced conclusion.

Suttmeier's thesis, however, remains generally compelling, particularly since most arguments against the Maoist cyclical strategy either turn out grudgingly to accept the basic idea but add qualifications (the swings have been wider than need be, the costs greater than necessary, the timing not always right, and so on), or are prescriptive (the strategy was appropriate in the past but is no longer so).

Any reservations about *Research and Revolution* must concern its data base. The bibliography and footnotes reveal a study based on the voluminous translated materials on Chinese science policy through 1972. While permitting an overarching view of general science policy, these sources do not facilitate a more detailed exposition of policies in specific sciences—hydrology, medicine, chemical engineering, nuclear physics, and so on. Further, these sources have been surveyed before; the study presents a fresh perspective but provides little new information to the specialist. Absent are references to interviews, trip notes of scientific delegations to China, or the less frequently translated Chinese-language specialist journals. The book conveys, therefore, the rather dry, official overview in Peking but lacks the vibrant detail of science policy as it appears in the lab or the experimental rice plot.

As a result, Suttmeier fails to emphasize the sectoral and spatial diversity in Chinese science policy. For example, nuclear physics has not been as subject to the cyclical phenomenon as have the social sciences. The need to create a demand for science is less pressing in Shanghai than in Tibet. In more than one field, recent visitors have discovered, a gap exists between the official rhetoric and the actual policies pursued—although for the gap to exist, it must be hidden.

Written at a distance, the research completed before the post-1971 direct contacts with Chinese scientists, Suttmeier's valuable study is already somewhat dated. The recent contacts have underlined how little we know about science in China. Awareness of the complexity of the subject and of the need for more information discourages efforts to generalize. As a result, the new,

direct contact with Chinese has shifted attention away from broad theoretical questions about China, such as the efficacy of policy cycles, toward a number of more specific ones. In the scientific realm, can scientists be adequately trained within the abbreviated, politicized educational system that has existed since 1966? Can scientific research and dissemination long persist in the absence of such vehicles for normal scholarly contact among scientists as professional associations, journals, and meetings? Have the severe disruptions in certain research areas affected China's capacity to absorb technology? What is the situation with respect to scientists in the 35-to-50 age bracket, many with Soviet training: their numbers, location, ability, and experience? How, in fact, is science policy made?

Overarching evaluations of the sort Suttmeier attempts, admirable given the limitations of the earlier data base he uses, will have to be made anew when answers to these and other questions are secured. One hopes that as new data become available Suttmeier will continue his stimulating and leading work on China's scientific progress.

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Nuclear Power in the U.S.S.R.

From Scientific Search to Atomic Industry. Modern Problems of Atomic Science and Technology in the USSR. A. M. PETROSYANTS. Translated from the Russian edition (Moscow, 1972). Interstate, Danville, Ill., 1975. xii, 370 pp., illus. $16.90.

During the past year there has been a sharp increase in concern over the proliferation of nuclear power plants throughout the world. This concern is due to the production of plutonium in nuclear power reactors and its possible use in nuclear bombs. The explosion of a nuclear "device" by the government of India together with the realization that many countries are turning to the use of nuclear energy as a means of meeting their energy needs has resulted in a widespread awareness of some of the problems associated with the peaceful use of nuclear energy. Those who for 30 years have tried to convince the governments and people of the world of the existence of these problems should, perhaps, offer a vote of thanks to the government of India for its contribution. It is becoming generally evident at last that the vast capacity for overkill possessed by the United States and the Soviet Union no longer suffices to ensure the continued serene development of peaceful uses of nuclear energy.

Under these conditions it is useful to have available a broad, not too technical discussion of the Russian view of nuclear power: what the Russians think of nuclear power, how they have been developing it, their future plans, and their concerns. Petrosyants, the chairman of the U.S.S.R. State Committee on the Use of Atomic Energy, offers us a summary of such matters that should be interesting and understandable to readers of *Science* who are not specialists in nuclear engineering. In the author's words, "The book more or less systematically and consecutively expounds the achievements of Soviet scientists and specialists in the field of peaceful uses of nuclear energy."

The author begins with the Russian scientific background for the development of nuclear energy (chapters 1 and 2), discussing, among other topics, work on accelerators, high-energy physics, and nuclear fusion. In chapter 3 he discusses the background of the nuclear power industry both inside and outside the U.S.S.R. The meat of the book is in chapter 4 ("Nuclear power in the Soviet Union"), which describes, in about 120 pages, work on nuclear power up to 1972. The course of this work, as described by Petrosyants, appears to have been rational and efficient. Uranium partially enriched in ^{235}U was chosen early as the fuel for the first stages of the Russian program. Two reactor types have so far been emphasized. One is the graphite-moderated, water-cooled reactor of the so-called "channel type," which avoids the use of a large pressure vessel. In the Leningrad nuclear power plant there are two of these reactors, cooled with boiling water, each producing 1000 megawatts of electricity (1000 Mwe). Reactors of this type and size are to be used in the expansion of the Russian nuclear power industry. The Russians have also developed pressurized water reactors (PWR's), which are water-moderated and cooled, and are generally similar to American PWR's. These have also reached 1000 Mwe in capacity and will have an important place in the industry. The Soviet Union is selling PWR's at the 440-Mwe level to countries in its sphere of influence. The next stage of the Russian program is to depend heavily on fast-neutron breeder reactors in which ^{239}Pu will be the fuel and ^{238}U the fertile material. The Soviet Union is ahead of the United States in the development of this type of reactor (as are the United Kingdom and France). A fast-neutron reactor is in operation at the city of Shevchenko on the Caspian Sea. It can produce either 350 or 150 Mwe and 120,000 tons of fresh water a day.

Other chapters deal with small-size nuclear power units, nuclear-powered ships (with no details about submarines), perspectives for the future of nuclear power engineering in the Soviet Union, radioactive waste disposal, other centers of atomic science and technology, international cooperation in atomic science and technology, and the "great future" of atomic science and technology.

The technical discussion differs little from that in official or industrial American material on nuclear energy. Great effort has been devoted to ensuring the safety of power reactors and to the disposal of radioactive waste. In the matter of safety, I found no mention of secondary (building) containment, on which much emphasis is placed in the United States; much attention is paid to instrumentation for safety and emergency core cooling. According to Petrosyants there is a strong conviction within the Russian government of the need for nuclear power and of the safety of nuclear power plants. He expresses satisfaction with past work and optimism for the future. There are no hints of the existence within the Soviet Union of any groups opposed to the development of nuclear power, nor is there any discussion on international political or military questions arising from nuclear energy.

The book should be useful to those interested in the history of technology or in the social aspects of technology. There are, unfortunately, no references to more specialized literature, but the book offers insights into how a new technology is undertaken in an economic and social setting different from ours.

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Organometallic Reactions

Organotransition Metal Chemistry. A Mechanistic Approach. RICHARD F. HECK. Academic Press, New York, 1974. xii, 338 pp., illus. $27. Organometallic Chemistry.

This book is intended for the synthetic organic chemist. The goal of the author is to give the reader enough background in organometallic chemistry to enable him to make intelligent decisions about the type of organometallic reagent required to effect a given molecular transformation. In order to achieve this Heck presents the reactions between certain organic (alkenes, polyenes, alkynes) and inorganic (primarily hydrogen and carbon monoxide) sub-