Science, the Index of Soviet Power: R&D in the U.S.S.R.

R&D (scientific research and development) is a generic term for "the range of activities directed toward the acquisition, refinement, systematization, and understanding of new knowledge about the world and society in which we live and the application of knowledge in perfecting the means and methods for advancement toward selected goals." It covers such activities as basic research, applied research, development, design, and research in the social sciences. The study of the complex system of functionally differentiated institutions dedicated to the advancement and application of scientific knowledge and of research and development as a vital component of the national economy is a 20th-century phenomenon. It is a modern effort to give Francis Bacon's dictum that "science is power" an empirical basis and a method of measurement.

Alexander Korol's volume, **Soviet Research and Development: Its Organization, Personnel, and Funds** (M.I.T. Press, Cambridge, Mass., 1965. 375 pp. $11), is the first study, and a remarkably thorough one, of scientific research and development in the Soviet Union. It is a well-documented and critical account of the major categories of Soviet scientific institutions and of the place of scientific work in the broader scheme of the national economy. It contains a body of carefully weighed and assembled information indispensable for an objective assessment of the realized and potential strength of the Soviet Union.

Korol shows clearly that the intricate structure of Soviet research and development has three sources: the gigantic system of complementary, parallel, or crosscutting bureaucratic mechanisms of the Soviet administrative system, the technological complexity of the U.S.S.R. as a modern industrial society, and the knotty logic and overlapping divisions of science, pure and applied. He holds that the bureaucratic apparatus of the Soviet state creates all sorts of handicaps under which the institutions and scientists engaged in basic research must labor, but that it is generally effective in advancing applied science.

It would be a grave error to assume that the bureaucratic nature of the administration and control of scientific institutions is the only, or the major, condition exercising a negative influence on "pure science" or basic research. A more ominous threat to the intellectual vitality and resourcefulness of basic research comes from drastic limitations on academic autonomy in Soviet society. In the U.S.S.R. the scholar is not the only custodian of the scientific legacy nor the only judge of scientific contributions *qua* scientific contributions. His legitimate and time-honored right to follow the inner momentum of science in determining the priorities of research topics has been seriously limited. The social valuation of research projects is a monopoly of the planning agencies of the central government. The relationship of science to philosophy is defined *for* the scientist rather than *by* him, and the same is true with respect to the relationship of science to ideology. The bureaucratic complexities and bottlenecks may slow down basic research; the absence of philosophical challenge and criticism may threaten to dry it up.

Korol gives due emphasis to the first open campaign by the leading academicians, headed by Peter Kapitsa and N. N. Semyonov, a Nobel Prize winner, in favor of a more precise functional and institutional definition of basic research and of a transformation of the Academy of Sciences of the U.S.S.R. from a "ministry of science" to a body of scholars dedicated to the search for fundamental knowledge in the major natural and social sciences. This is the campaign that led to the removal from the Academy of industry-oriented institutes and laboratories, a move that freed the country's leading scientific institution of many burdensome administrative and technological functions.

The two most common yardsticks for the measurement of the scope, effectiveness, and future prospects of R&D are the amounts of money expended for scientific work and the numerical strength of manpower engaged in its various phases. Official Soviet statistical data on the ruble valuations of the various components of the scientific endeavor are spotty, but the statistical coverage of scientific manpower is relatively rich and comprehensive. For this reason Korol's book deals mostly with the training, professional differentiation, and functional distribution of scientific manpower.

Korol's general discussion of the professional and semiprofessional manpower that serves as the base of Soviet R&D contains a wealth of collateral information throwing important light on the dynamics of Soviet society. His analysis of the distribution of "scientific workers" by sex, age, and nationality is particularly illuminating. It shows wide differences in the participation of various ethnic groups in the Soviet scientific effort. If the country is considered as a whole, there are 148 "scientific workers" per 100,000 inhabitants. The breakdown along ethnic lines shows significant deviations from the national norm: the corresponding number for the Kirghiz and the Tadzhiks is 54, for the Ukrainians 81, for the Russians 175, for the Armenians 260, for the Georgians 270, and for the Jews 1350.

Equally illuminating is the treatment of scientific institutions as component parts of the Soviet political system: the account of the successive steps in the decentralization and recentralization of the Academy of Sciences and related scientific agencies provides a significant glimpse of the dilemmas and tribulations that accompanied Khrushchev's efforts to give more flexibility and breathing space to the organic components of the Soviet system. The successive steps in the reorganization of the Academy of Sciences have led to the formation of new sections and to a regrouping of departments. They have streamlined the administrative apparatus of the Academy and have stimulated lively academic debate centered on various questions ranging from the modernization of collective research to the epistemological knots of quantum mechanics and the theory of relativity. However, the status of the Academy as a typical Soviet institution has remained essentially unchanged. Korol detects an unmistakable trend toward increased centralization in the organization, administration, and control of industrial research and development.

Korol has wisely decided to avoid

any comparative accounts of Soviet and American R&D. He argues effectively that much preparatory and basic work on the level of individual countries must be completed before significant comparative studies become feasible. The major difficulty at the present time lies in the imprecision with respect to categories of analysis. Such categories as *basic research, applied research, development,* and *design* are not discrete and precisely defined units but parts of an open-ended continuum and are also subject to tangible cross-cultural variation.

Unequal access to relevant data of different categories has made it impossible for the author to examine each major problem with the same thoroughness. And his task has been made more difficult by the fact that the book covers one of the most dynamic periods in the history of the Soviet scientific establishment. The volume does not treat in significant detail the institutional mechanisms facilitating a systematic and thorough inflow of scientific knowledge from abroad and its distribution among the interested agencies and scholars. The geographical decentralization of scientific institutions, a major development under Khrushchev, deserves much more attention than it has received in this volume. The rapid building of the Siberian Department of the Academy of Sciences into a new research giant could have been profitably correlated with the intensive economic development and demographic movement in Siberia.

Korol has written the most important book so far published in the West on science as a source and an index of Soviet power. He has established himself as a pioneer in the study of R&D—an academic field of vital importance.

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The Information Explosion: Aquatic Sciences Version

It has been suggested by someone (and I am unable to retrieve the reference at the moment) that Johannes Müller, the last great universal naturalist, died by his own hand out of frustration because he was unable to keep up with developments in biology. Such a possibility need no longer exist in our time, if we are to believe some of the publicity that comes with the descriptions of new information retrieval systems. For a modest $700 to $1250 per annum, one service is available which will tell us, if we are fortunate enough to remember the name of the author of a paper, whether his paper has been cited, reviewed, applied, extended, confirmed, or otherwise treated. Since this service has been previously reviewed [*Science* **145**, 142 (1964)] by Steinbach, little more need be said about it except perhaps to raise an additional eyebrow at the implication that this service will be of value in helping the user decide whether to read the entire paper and that it will convey to interested people (for example, deans and provosts) the comparative importance of an author as indicated by the frequency with which his paper or ideas have been cited. (How would Willard Gibbs have fared in this system for the first 20 or 30 years of his career, one wonders.)

It appears that the amount of published information is increasing exponentially at a rate exceeding that of the population explosion; when the world's population is doubled the "world's output of scientific and technical literature would be 16 times the existing output. There is little reason to think that this is an overestimate." [B. C. Vickery, "Scientific information: Problems and prospects," *Minerva* **2** (1), 21 (1963)]. Obviously no one will have time to look at the fraction of the information that applies to his own field or is of tangential interest to him, and some recourse to abstracting journals, reviews, and retrieval systems is necessary.

One of the fields that appears to be expanding more rapidly than the general rate of expansion is that of aquatic science, principally oceanography and marine biology, and there have been several attempts to cope with this. The most conventional, and still the most generally useful, is the "Oceanographic Extracts" section of *Deep-Sea Research,* which is supplemented by a listing of current papers, "Oceanographic Bibliography." But one can easily become mentally waterlogged reading abstracts no matter how well prepared they may be, and a number of services have been started to cut down the scanning and retrieval time by storing the information with coded indexes or thumbnail references.

The most comprehensive of these is the *Current Bibliography for Aquatic Sciences and Fisheries,* prepared under the auspices of the FAO (Food and Agricultural Organization of the United Nations) Fisheries Biology Branch and published by Taylor and Francis (Winchester, England) at $27 per volume. This bibliography lists journal contents alphabetically by authors for each journal examined seriatim, with paraphrased or translated titles. It goes beyond the scope of "Oceanographic Extracts" in that it lists mimeographed reports from meetings and the grey world (in the publication sense) of the flood of mimeographed and multilithed progress and technical reports that virtually all laboratories now produce to satisfy their granting fathers. It does not, however, clearly specify in every case whether the original publication or a review of the publication is being cited. The volumes end with a complete author index and solid phalanxes of numbers under the topics of the subject index. These numbers are not codes but the number of the paper as accessioned in the text of the bibliography. As a result, the information may be well stored, but it is not always simple to retrieve, especially when one is incautious enough to leaf through the bibliography, spot a comment that sounds interesting and then try to find it again if the author's name has not been noted. But as these things go, the bibliography is fairly inexpensive.

A somewhat similar compilation is the **Oceanic Library Coordinate Index** (Mission Bay Research Foundation, San Diego, Calif.; bi-monthly, $600 per year;