the type of training represented in America by technical institutes. There are in the U.S.S.R. something like 1500 of these institutions, which offer training in engineering, science, medicine, pedagogy, law, and agriculture. The courses are generally 4 years in length, with admission being highly competitive and based on the completion of at least 7 years of instruction. Entrance requirements are being raised, and in the near future the Soviets may require a full secondary education. Graduates in recent years have numbered about 60,000 per year in the field of engineering alone, as compared with about 11,000 in the United States.

College-level engineering education in the U.S.S.R. requires many more hours of class attendance than in the United States, and a much greater degree of specialization. Approximately a quarter of the time is spent on the general sciences, and another quarter on general nonspecialized engineering. Only about 6 to 8 percent is allotted for political and socioeconomic courses, which could probably be better called indoctrination courses. Narrow specialized engineering instruction takes the rest of the time except for physical training and military instruction.

The inescapable conclusions to be derived from the book, with all due allowance for possible errors, are that in technological areas the Soviet Union is graduating more trained personnel than is the United States, and that from a purely technical viewpoint Soviet training is probably at least as good as, and quite possibly better than, that received by American engineering and science students.

One ray of comfort may be drawn from the possibility that the extremely high degree of specialization in scientific and engineering fields may carry with it such a lack of flexibility or adaptability that the individual who cannot work in the field of his immediate specialization may be considerably less useful, or perhaps frustrated entirely. However, in view of the high degree of selection in the Soviet educational system, it seems probable that many of those in the field of science and engineering have sufficiently able minds so that this result will not occur. Still, it does represent one possibility that may limit the effectiveness of Soviet technology.

Another possibility is that the great emphasis in the U.S.S.R. on education may lead to changes in the Soviet philosophy. It is conceivable that the emphasis on education may sufficiently emancipate enough minds in the U.S.S.R. so that the seemingly widespread acceptance of the present official Soviet philosophy will no longer be possible.

On the whole, this volume presents a study that is challenging in its significance to American educators, both technical and general, to American industrialists, and to American citizens generally.

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The Soviet Academy of Sciences. Hoover Institute Studies, Series E: Institutions, No. 3. Alexander Vucinich. Stanford University Press, Stanford, Calif., 1956. 157 pp. $2.

One by-product of the cold war has been our realization that what goes on in the U.S.S.R. affects us directly. Thus it is only prudent for us to keep ourselves informed on things Russian and for our scientists to keep a constant check on their colleagues in the Soviet Union. Fortunately, most scientists can learn the status of their specialties in the Communist countries without taking too much trouble, and the scientists as a whole can evaluate the accomplishments of Soviet science quite accurately. We know, for example, that Soviet mathematics, atomic physics, and engineering are truly excellent but that Soviet biology, medicine, and agriculture are backward and permeated by quacks. But over and beyond such information, there exists a mass of background knowledge that can be made available to us only by those who are experts on the Soviet Union. Alexander Vucinich, the author of *The Soviet Academy of Science,* is such an expert.

The work begins with a historical account of the Academy of Science from its founding in 1725 by Peter the Great to the latest tasks imposed on it by the current reigning syndics. The Soviet Academy has now become unique and is quite unlike any academy of science outside the Communist world. Today it plans, organizes, and supervises all scientific research in the Soviet Union. It controls numerous lesser scientific institutions, employs a large staff of scientists and administrators, and dispenses an enormous budget. It has recently acquired a number of new functions, one of which is the training of future scholars and scientists. The individual academicians have great social prestige, receive large salaries, and have many perquisites that are highly desirable.

The academy, however, is subordinated to the Council of Ministers, and the academicians both individually and collectively take their orders from the political authorities. They must be ready at all times to shift their ideology whenever the party line changes. When necessary, they must attack the science and the scientists of the West, rewrite the history of science, and search out the heretics in the ranks of the scientists below them. This latter function is important, for the academicians are responsible for the ideological purity of all Soviet scientists.

The Soviety Academy of Sciences contains a great deal of factual information that is not found elsewhere. It describes the internal organization of the Soviet Academy, its attitude toward pure and applied science, and its role in planning the activities of scientists in the various 5-year plans. The appendixes list the scientific organization of the academy, the different academies of the several Soviet republics, the periodicals published by the academy, and the names of the academicians. The whole is a small but useful compendium. It also gives an exceptionally clear picture of the conditions under which scientists have to labor in the new, socialist Utopia.

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The Mighty Force of Research. Editors of *Fortune.* (15 articles reprinted from *Fortune*) McGraw-Hill, New York, 1956. 308 pp. Illus. $4.

Fifteen articles that appeared in *Fortune* between January 1953 and August 1955 are here brought together in a hard cover. The resulting book gives a well-integrated and easily readable account of the state of applied and basic research and research support by foundations, universities, government, and industry. Several chapters are mainly concerned with technology. The chapter titles give some idea of the scope of the treatment: "The strange state of American research" (support of applied and basic research, research by the General Electric and Bell Telephone Companies, and the role of private foundations and the government); "The young scientists" (a survey by interview of the opinions and characteristics of 20 outstanding scientists under the age of 40, ten from industry and ten from universities, supplemented with the results of a questionnaire of 87 additional young scientists; the generalizations about scientists, derived from so small a sample, are of questionable validity); "Science for sale" (contract research and development with special reference to Arthur D. Little, Inc.); "The inventor in eclipse" (decline of the free-lancer and the rise of the industrial research team; decline in number of patents); "New light on the brain" (an account of recent research on the brain with special reference to H. W. Magoun, H. H. Jasper, Guisseppe Moruzzi, C. S. Sherrington, K. S. Lashley, W. R. Hess, E. D. Adrian, W. McCulloch, W. Pitts, D. McKay, and Percival Bailey, among others); "How are we fixed for water?" (a survey of water resources; the per capita consumption of fresh water is estimated at 1500 tons annually in the United States); "Tomorrow's weather" (short-range and long-range forecasting; cloud seeding: "For some curious reason most meteorologists have refused to be optimistic"); "Farming's chemical age" (insecticides, herbicides, fertilizers); "Power from the sun" (photosynthesis, solar engines and heating); "The peaceful atom" (atomic power plants, private and governmental); "The new metals age" (light metals and new alloys); "The transistor"; "The automatic factory"; "The information theory" (a clearly developed exposition of the elements of information theory).

There is an index, but no bibliography, which is regrettable inasmuch as the general reader for whom the book is intended might well want guidance to some of the sources for the articles.

In summary, this is a good journalistic job. The dominant note is perhaps more hopeful for the future than it would be in a similar book written by scientists.—G. DuS.

What Is Science? Twelve eminent scientists and philosophers explain their various fields to the layman. James R. Newman, Ed. Simon and Schuster, New York, 1955. vii + 493 pp. $4.95.

Einstein once wrote, "If you want to find out anything from the theoretical physicists about the methods they use, don't listen to their words, fix your attention on their deeds." In *What Is Science?* this advice is taken seriously, not only with respect to physics, but for a variety of fields of knowledge from astronomy through biology to psychoanalysis. This is a wide-ranging collection of essays by distinguished practitioners of the arts of securing their respective kinds of positive knowledge.

A brief review can do no better than to list the contributors: E. T. Whittaker on "Mathematics and logic," Herman Bondi on "Astronomy and cosmology," E. U. Condon on "Physics," John Read on "Chemistry," Ernest Baldwin on "Biochemistry," W. C. Allee on "Biology," Julian Huxley on "Evolution and genetics," E. G. Boring on "Psychology," Clyde Kluckhohn on "Anthropology," and Erich Fromm on "Psychoanalysis." Bertrand Russell, in a prefatory essay, points to the disparity in progress between man's knowledge of the physical world and his values, habits, and beliefs—a disparity that has brought the human race to the brink of possible self-destruction—while Jacob Bronowski supplies a postlude called "Science as foresight," an account of those electronic marvels, the modern calculating machines, that can reason deductively and also explore numerous alternative possibilities within a given logical frame, but, so far at least, cannot trespass on the distinctively human activity of creating new ideas.

What must strike the lay cover-to-cover reader (and what scientist will not be a layman in some of the fields covered?) is the variety of basic concepts in the several sciences and, frequently, their specification to a given subject matter. The "mass-luminosity diagram" identifies astrophysics as definitely as the "subconscious" marks psychoanalysis or "Grimm's law" marks linguistics. The biochemist has his "enzymes," the geneticist his "genes" (of course), the physicist his "particle-wave dualism."

If science has a unity, it seems to lie only in the insistence that theory have observable consequences, that it be susceptible, to quote Bondi, of "empirical disproof." This is not intended to gainsay the remarkable degree of reduction, for example, of astronomy and chemistry to physics, or of some parts of biology to chemistry. Nevertheless, if a new and unique concept or relationship will correlate or explain phenomena, scientists will adopt it in order to carry forward their search for understanding. "Intuitive reactions (such as would cause people to reject implausible conceptions) are of secondary importance," writes Bondi. The testimony for this lies in the voluminous deeds of scientific achievement that are so ably recorded in these essays.

An appended bibliography enables the interested reader to pursue the question, What is science? more broadly and deeply.

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Atomic Power. 180 pp. **Automatic Control.** 148 pp. **First Book of Animals.** 240 pp. **The New Astronomy.** 243 pp. **The Physics and Chemistry of Life.** 270 pp. Editors of *Scientific American*. Simon and Schuster, New York, 1956. Paper, $1 each. (Reprints from *Scientific American*.)

Science, like music, has its skilled performers and its audience. With the growing power and importance of science, an increasing number of magazines and books, as well as college courses, are offering the general reader instruction in what might be called science appreciation. The latest venture in this subject is a paper-back series of five books, each on a different field of science, put together by the editors of the *Scientific American* from articles they have published in their magazine since 1948. The result is an account of many recent discoveries that manages to convey something of the method by which scientists find things out, and something of the delight they experience in doing so.

Interpreting research findings to the general public is not the only problem of communication in science today. The rapid appearance of new specialties has made it more and more difficult for one scientist to talk to the next. This series is sufficiently authoritative and detailed to interest scientists who want to know what is happening on preserves other than their own.

The authors of the 90 articles are scientists who can write, many describing their own investigations, and journalists who understand science. Since each article is complete in itself, there is some repetition. But when a topic is new to the reader, explanation in different contexts by different writers may provide understanding where fuller development by one author fails. Of course, browsing is no substitute for systematic study, but the first may lead to the second. Each book has an introduction, some notes about the authors, suggestions for further reading, and a few illustrations—not the original ones, unfortunately.—J.T.

The Biology of the Spirit. Edmund W. Sinnott. Viking Press, New York, 1955. ix + 180 pp. $3.50.

Both author and publisher regard this as an unusual book. And so, in a way, it is. For Sinnott, with his wide knowledge of professional biology, has looked at life and its reasons and justifications, and has concluded that "all problems of life are ultimately biological problems." All living matter, all protoplasm, shows a biological goal seeking, without an appreciation of which it cannot be understood. Now, if once we admit that "life" is the striving of protoplasm to fulfill its goal, we may soon be led to agree that even the mind itself, although it may be "the highest of biological phenomena . . . is a biological process nevertheless"; and then to conclude that "if a man's mind has a biological basis, his spirit must have one also." Protoplasm becomes the place where spirit and matter meet, and "soul is the highest level of that goal-seeking, integrating process that is life."

It is all very nice to find a unifying principle in biology that will help poor human man to relate the tumultuous ex-