The bulk of Sherwood's *Exploration* deals with government-sponsored research, the major purpose of which was to open up new land. The explorations of Raymond, Allen, Abercrombie, Cantwell, Stoney, and others are discussed in detail as are the more specifically scientific contributions of Nelson, Turner, the Krause brothers, and Jacobsen. The role of prospectors and missionaries is also examined, and in the last chapter there is emphasis on the work of the United States Geological Survey and the important contributions made by A. H. Brooks. The author concludes, as he began, by noting that the "progress of discovery was consistent with social attitudes in the United States, the remoteness of the territory, the economic interest expressed in the country, and the popular interest as evidenced by the population of the region" (p. 187).

The very excellence of Sherwood's book, which will surely be a basic source for many years to come, serves to call attention to the fact that there is nothing comparable on the exploration of Russian America. A really thorough, well-documented history of Russian exploration in Alaska is badly needed. Although the scientific contributions of Russian explorers were less notable than those of their American counterparts, important and significant observations were nevertheless made on the native peoples, the geography, and the resources of the country. Much of the archival material for such a study is available in this country, and Soviet historians are increasingly turning their attention to Alaska and have published useful material in recent years. Perhaps the approaching centennial year will provide the impetus for a history of Russian exploration. If it does, and if the resulting volume is as carefully researched and well written as the one reviewed here, the cause of Alaskan history will be very well served indeed.

JAMES W. VANSTONE
*Department of Anthropology, University of Toronto*

## A History of Mathematical Approaches

**Ways of Thought of Great Mathematicians.** An approach to the history of mathematics. Herbert Meschkowski. Translated from the German edition (Berlin, 1961) by John Dyer-Bennett. Holden-Day, San Francisco, Calif, 1964. x + 110 pp. Illus. Paper, $3.95; cloth, $5.95.

Meschkowski selected nine men whom he felt illustrated "the ways of thought of mathematicians of earlier centuries"—the Pythagoreans, Archimedes, Nicholas of Cusa, Blaise Pascal, Gottfried Leibniz, Carl Gauss, George Boole, Karl Weierstrass, and Georg Cantor.

As the author indicated in the preface, most of the choices were somewhat arbitrary, but some were selected to support the thesis that earlier mathematicians were willing to investigate problems that could not be resolved solely by mathematical methods.

In the first chapters of the volume, the "way of thought" is identified and mathematical examples are used to illustrate it. For example, Archimedes is used to demonstrate that mathematicians could be both "pure" and "applied" in their thinking. Two examples from the work of Archimedes are used to support this observation: the first is a rigorous, geometrical proof of a theorem concerned with the area of a spherical surface, and the second is a heuristic argument that involves the determination of the equilibrium state of a lever in order to find the volume of a sphere. In the chapters that follow, the examples speak for themselves in illuminating the particular "way of thought."

The chapter on Gauss illustrates the principle of *pauca sed matura*, and the major portion of the chapter contains an analytic proof of the fundamental theorem of algebra published by Gauss in 1816. This proof demonstrates the Gaussian ability to compress a mathematical discussion into its most simple and elegant form. Some historians may feel that the works of Gauss better illustrate other avenues of thought of a great mathematician, but it is doubtful that any would quarrel with the claim that Gauss was truly a master of elegance in mathematical proof.

This brief volume is an excellent complement to the many comprehensive histories of mathematics.

DONALD J. DESSART
*Department of Mathematics, University of Tennessee*

## Solar Energy: Future Research

**Direct Use of the Sun's Energy.** Farrington Daniels. Yale University Press, New Haven, Conn., 1964. xviii + 374 pp. Illus. Paper, $2.45; cloth, $7.50.

The enormous amount of solar energy falling on large areas of the earth's surface is impressive and frustrating, for man feels that he should utilize this energy with reasonable efficiency. Indeed, by planting and harvesting crops, man does utilize it, but at low efficiency and in relatively short time. Or man burns rapidly fossil fuels that have required eons to accumulate. But what one really wants is a large amount of energy, spontaneously regenerated as rapidly as it is utilized and converted to power at a reasonable efficiency.

Farrington Daniels is an authority who writes lucidly and logically on the utilization of solar energy. He recognizes clearly the challenge, the limitations, and the practicalities. To anyone who desires a concise and readable review of the subject, with complete references, this book is highly recommended.

Daniels, professor emeritus of physical chemistry at the University of Wisconsin, clearly demonstrates his years of wisdom, knowledge, and versatility to write a thoroughly stimulating and informative book on solar energy. Naturally, the author is at his very best in the chapter on the photochemical conversion of solar energy. In order to utilize photochemical reactions for the use of sunlight, the chemical reaction must be endothermic with high quantum yield and reversible. For conversion to electrical energy, electrons must be transferred photochemically from a low energy to a high energy level. The author points out a number of promising avenues of research on the photochemistry of solar energy conversion.

Although the total amount of solar energy incident on the earth is impressive, it will not be utilized, except in special cases, because of the high cost of collecting it and the high investment required for solar devices. Daniels expects that, as fossil fuels are depleted and as mass production of solar equipment reduces costs, solar energy will compete favorably with fossil fuels. He honestly recognizes that this utilization will come slowly at first and primarily in economically

starved areas of the world where solar energy is abundant. Distillation of seawater is one of the most promising applications of solar energy. The primary difficulty constantly encountered with respect to the utilization of solar energy is the large collection area required, the construction of equipment to cover such an area, and the subsequent maintenance of the equipment. The areas of the world where the use of solar energy can be an economical proposition are obvious, the applications—for example, in distilling water, heating homes, and cooking—are evident, and the difficulties confronting researchers are known. However, many new avenues of research, particularly of chemical research, exist where a dramatic advance would greatly change the outlook. It could readily be that the plant scientist will clearly excel the engineer in the utilization of solar energy available on a per capita basis for most of the world.

A few of the topics to which chapters are devoted include the history of the subject, a description of solar energy and its distribution, collectors, cooking, heating water, heating buildings, the distillation of water, solar furnaces, cooling and refrigeration, thermoelectric, photovoltaic, and photochemical conversion, and the storage and transportation of power. The well-bound book, with a garish cover of "sunlight" yellow, a comfortable print on good paper, and halftones on glossy paper, represents a pleasing contribution to the literature on solar energy. It is a fine summary of the research and applications to date, and it should be read by layman and scientist alike. Daniels is to be congratulated.

DAVID M. GATES
*Institute of Arctic and Alpine Research, University of Colorado*

## Education, Manpower, and Economic Development

**Manpower and Education: Country Studies in Economic Development.** Frederick Harbison and Charles A. Myers. McGraw-Hill, New York, 1965. xiii + 343 pp. $9.

This volume contains the background studies for *Education, Manpower, and Economic Growth* by the same authors [reviewed in *Science* **145**, 917 (1964)]. Following a brief introduction, there are analyses by 11 other authors of the history, current status, trends, and problems of planning for improvement in the education and utilization of trained manpower in Argentina, Peru, Chile, Puerto Rico, Iran, Indonesia, Communist China, Senegal, Guinea, the Ivory Coast, Nyasaland, and Uganda. A final chapter contrasts manpower issues in East Africa and Southeast Asia. Each chapter (except the one about Communist China) was written by an American social scientist who has spent considerable time working on manpower and education problems in the country of which he wrote.

The nature and amount of information available about the countries varies, and so, necessarily, do the coverage and treatment. In general, each country (except Senegal, Guinea, and the Ivory Coast, which are treated together in one chapter) gets about 30 pages. The analyses are praiseworthy, but each author must often have wished for better data. There is no index.

Foreign aid programs and plans for economic development depend for their success upon many factors. Certainly among these factors must be included the knowledge that the planners and administrators have of the resources, economic conditions, educational status, cultural setting, and the motivation and organization of the country involved, and a sense of the fitness or appropriateness of a particular program or activity to the setting and stage of development into which it is being introduced. A reader interested in a particular country will find a certain amount of information about that country (if it is one of those included) and, with due caution because of the substantial differences, may also be helped by learning about some of the things that have been tried, how goals have been met, what obstacles have been encountered, and what suggestions can be drawn from experience in other countries. In the introduction, Harbison and Myers summarize a number of major principles of economic planning that emerge from the diverse experience they and their chapter authors have had in working in many countries.

DAEL WOLFLE
*American Association for the Advancement of Science*

## Science, Technology, Society

**Science as a Cultural Force.** Edited with an introduction by Harry Woolf. Johns Hopkins Press, Baltimore, 1964. x + 110 pp. $3.95.

This book consists of four essays originally delivered as the Shell Companies Foundation Lectures on Science, Technology, and Society at Johns Hopkins University. Two of the lecturers, James R. Killian, Jr., and Jerome B. Wiesner, who have been intimately associated with governmental activities in science and technology, deal with the outer, public life of science and technology; the other two lecturers, Michael Polanyi and Gerald Holton, deal with the inner, private world of scientific thought.

Both Killian and Wiesner have already expressed in other lectures and publications many of the points that they make in this volume, but the points are important enough to merit restatement, and here they are concisely and well put. Killian's essay, "Toward a research-reliant society: Some observations on government and science," stresses the growing importance of the "innovation industry" (research, development, test, and evaluation) in our national life. He is properly concerned with the government's role as the dispenser of funds for science, with the methods of handling scientific research conducted under governmental auspices, and with the problem of scientific advice to policy makers. Because the flourishing state of American science might lead us to relax our efforts and might tend to obscure areas of weaknesses that may develop in the future, Killian stresses the need to review our present practices and establish future goals so that the innovation industry can continue in its role as one of the "principal energizers of our society."

In his essay, "Technology and society," Wiesner gives handy guidelines for judging public investment in science and technology: "Technological development should only be undertaken to fulfill specific needs, and only if the proposed new development gives promise of being economically justifiable as well as technically sound. Basic research should be judged primarily on scientific merit and supported at a level which permits all meritorious work if available funds permit." He then proposes an annual budget of $1 billion for the productive allocation of R&D funds, with the major items ($100 mil-