duces some theory but goes very little beyond Arrhenius. As a result, the generalizations and simplications that come from a thoroughgoing application of statistical mechanics to reaction mechanism are lost.

The first 11 chapters treat most of the available experimental methods for measuring fast reactions. In the first chapter, which is the introduction, the theoretical treatment of diffusion controlled reactions is quoted. Typical of the methods of measuring reaction rates, which are treated in considerable detail, are quenching methods, flow methods, relaxations from temperature, pressure and voltage jumps, ultrasonic-adsorption, flash photolysis, electron spin, and nuclear magnetic resonance. The book is an interesting and useful presentation of the rapidly growing field of fast reactions.

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Agricultural Research

The Principles and Practice of Agricultural Research. S. C. Salmon and A. A. Hanson. Leonard Hill, London, 1964. xii + 384 pp. Illus. 75s.

The authors are senior, capable, United States agronomists. As a basis for their book they have used largely agronomic material liberally spiced with horticulture, animal husbandry, range management, animal feeding, animal breeding, farm management, and marketing.

The book consists of five parts plus a bibliography and an index. The parts are Historical (3 chapters, 73 pp.); The Philosophy of Research (5 chapters, 67 pp.); Statistical Methods (6 chapters, 104 pp.); Techniques of Agricultural Research (6 chapters, 103 pp.); Appendix, Statistical Formulae, and Tables (7).

The book is intended for undergraduate students who are preparing for careers in research, especially for students in or from developing countries. Those who study it will be well repaid; so will their teachers, who perforce may read or even study it. Nonstudents and nonteachers seriously concerned with agriculture, whether in the rather limited scope of this book or in broader terms, will also profit from reading this concisely written volume. The first chapter, "Agriculture and the development of civilization," covers the topic in 16 pages; covers it with enough specific illustrations to provoke interest and to verify the essential limitation placed on civilization by the available supply of food and the determining role played by technology resulting from discovery, experience, and systematic research on the abundance of that supply.

The second chapter describes the origin and development of agricultural research. Major beginnings were formulated by Leibig, who (about 1840) developed the mineral theory of plant nutrition and by Boussingault, who demonstrated by field experiment and chemical analysis that legumes are able to obtain nitrogen from sources not available to other plants. Boussingault's work was carried out at Alsace, the first agricultural research station, in 1834.

The third chapter, "The twentieth century revolution in agriculture" sketches the research-based events that have enabled agriculture in the developed countries to increase food production more rapidly than required to meet domestic requirements. In the United States, the farm population dropped from about 60 percent of the total population in 1860 to less than 10 percent in 1960, but the amount of food and fiber produced on the farm showed a fivefold increase. Mechanization, the control of insects, weeds, and diseases, commercial fertilizers, improved animal health and nutrition, hybrid corn, rust-resistant wheat, and adapted soybeans are among the items described.

Part 2, on the philosophy of research, is excellent, and sometimes provocative, material for new and old researchers. The authors consider the nature of basic and applied research, and identify the essential interdependence of the two, although this is done by describing basic research as an inseparable part and concomitant of all effective research. There are sections on science and mathematics; science and art; science and politics; science and certainty. The senior author is a devotee of statistics but at the same time properly skeptical about placing too great reliance on such data.

Chapter 5, "Methods of research" describes, defends, and criticizes many methods—the scientific, the empirical, the experimental, the case, the survey, the historical, and the synthetic method. I doubt that there are so many distinct roads to Rome, but it is interesting to read about them. Of particular validity and importance are the author's criticisms of the scientific method. Subsequent chapters deal with how discoveries are made, perhaps better with how they were made. Illustrations are attributed to accident and observation (including serendipity) as well as to planned research. There are chapters on the reasons for error and the nature of proof. The argument is not always persuasive, but it is always provocative.

Part 3, Statistical Methods, is adequate through the description of Fisher's methods. Since research is learned by doing it, the treatment is necessary as a part of research training. It may be questioned whether in the future agricultural, even agronomic, research will use the methods that are described here or newer ones, which are not described. The same question may be raised with respect to part 4, on the techniques of agricultural research. In any case, these techniques must be understood in order to understand much of the research literature on agronomy.

In summary, I recommend this book, although it describes agricultural research in a narrow sense that was. The implication that, as it was, so it is and should be, I question.

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Colorimetry

The Measurement of Colour. W. D. Wright. Van Nostrand, Princeton, N.J., ed. 3, 1964. x + 291 pp. Illus. $11.

The second edition of this highly praised work on colorimetry was rewritten in a logical and lucid manner [reviewed in *Science* **128**, 588 (1958)]. Wright's treatment of the algebra of color-mixture equations, the greatest contribution that book made, and all other parts of the second edition—radiation, photometry, color-vision theory, the Commission International de l'Eclairage (CIE) tristimulus system and the applications of that system—were so directly and succinctly written that specialists and nonspecialists alike found the science of color understandable.

In this third edition Wright continues to increase his selection of references from among the multitude of recently reported works, although at times he, unfortunately, credits the wrong authors and overcredits others. He correctly resists an urge to include, prematurely, a discussion of "degree of metamerism" which, although extremely important in color evaluation, has not yet been firmly resolved. The inclusion of an enlarged treatment on colorimetry applications to color television may be considered superfluous by American readers who have enjoyed color telecasts for about a decade. The largest of the new additions is the discussion of the "10° co-ordinate functions" that consist of three color-matching functions derived from the data of Stiles and of Speranskaya which the CIE Colorimetry Committee recommended for adoption in 1963. Had release of the book been delayed one month the statement, "This system has still to be officially approved," would not have been needed.

I regret that important inadequacies in the earlier edition have not been corrected and that the author continues to ignore the most important development in colorimetry: its consideration as part of metrology, with principles of limitations and uncertainties in measurement processes. Exclusion of this concept was excusable in the 1958 edition when relatively little was applied to colorimetry, but continued omission in 1964, when much has been accomplished, detracts materially from the utility of the third edition.

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Education and Manpower

Education, Manpower, and Economic Growth: Strategies of Human Resource Development. Frederick Harbison and Charles A. Myers. McGraw-Hill, New York, 1964. xiii + 229 pp. $7.50.

The authors set themselves a large task: to describe the procedures that could be used by any country in planning the educational and manpower development policies that will best contribute to economic growth. Few people could write such a book, but these authors have had extensive experience in other countries and they had access to a number of unpublished and sometimes confidential studies to supplement the varied and inadequate records that are generally available. The book they have produced will be of interest to educational and economic planners, and simply must be studied closely by anyone with responsibility for manpower planning.

The authors start by dividing most of the countries of the world into four levels of development: 17 underdeveloped, 21 partially developed, 21 semiadvanced, and 16 advanced. Because the most desirable indices are not available, and after trying out several alternatives, they based this classification on a simple index consisting of the sum of the percentage of the 15- to 19-year-old age group enrolled in secondary school (adjusted for length of the secondary school) and five times the percentage of the appropriate age group enrolled in higher education. The resulting rankings correlate well with economic measures, .89 with GNP per capita and −.81 with the percentage of the active population engaged in agriculture, but lead to some anomalies—for example, Argentina is listed as an advanced country and Norway as a semiadvanced one.

The next step was to describe the typical country of each level in terms of its economy, educational system, training opportunities, and stage and quality of human resource development. Then follows the strategy the authors propose for such a country. Their recommendations cover economic planning, on-the-job training, the use of expatriates, and the use of pay differentials and other incentives, as well as changes in the formal educational system. An illustration of the differing recommendations at the four levels is given by the following proposals for first-priority changes in formal education:

1) For underdeveloped countries, expansion of secondary education.

2) For partially developed countries, expansion of free or public secondary education and reform of the curriculum.

3) For semiadvanced countries, a shift in emphasis at college level from law and the humanities to science and technology.

4) For advanced countries, improvement in quality of higher education and postgraduate education.

How well these and other recommendations can be carried out will depend upon political pressures, national values, economic resources, the wisdom of the leaders, and the kind and quality of information available for detailed planning. The closing chapters discuss methods of selecting targets and formulating specific plans for an individual country.

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Mathematics

Linear Algebra. Paul C. Shields. Addison-Wesley, Reading, Mass., 1964. xii + 288 pp. Illus. $7.50.

Linear algebra is usually approached through one of two viewpoints—matrices or linear transformations. Roughly speaking the approach through matrices is more algebraic in character, and the approach through linear transformations is more geometric. This book leans toward the geometric in its orientation. The author's purpose is to bridge the gap between elementary and advanced calculus by providing a basis for discussion in multidimensional calculus. Thus, there is considerable emphasis on linear dependence and independence, inner products, and linear operators, especially linear operators with a diagonal matrix representation; on the other hand a secondary role is given to linear programming, convex geometry, quadratic forms, and group theory.

Shields approaches his subject in a gradual way; the presentation of elementary material is followed by concepts and generalization. The book is an attempt to reveal the inner workings of the subject, with a minimum of formalization. This leads to definition by illustration once or twice (the Gram-Schmidt process on p. 125, for example), but this is a minor flaw. At many points there are paragraphs labeled "Remarks" in which the author comments on related ideas, extensions of the theory, and computational methods. At the ends of the chapters notes are provided in which other sources are cited and other approaches are outlined for the benefit of the reader.

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