treatments of extremely important phenomena in the life of plants, and they reveal a field of investigation that has received relatively little attention elsewhere. But, unfortunately, the third section contains a reiteration of the Lysenko theme of the inheritance of acquired characters. This is exemplified by the following quotation (page 222), "All hereditary changes in hardiness begin with the so-called phenotypic changes in individual development. If they arise in young cells, they become fixed in the individual development of the organism in all its parts or in specific organs depending on what develops from these cells. If changed cells become the source of sexual or vegetative cells from which new organisms originate, the newly acquired hardiness is transmitted to the offspring." An examination of the separate bibliography of foreign authors reveals no references on genetics after 1944, although the Russian edition of the book appeared in 1956, and the text certainly gives no evidence that the author is conversant with modern interpretations in this field. Despite these lapses in the field of genetics, this volume constitutes a distinct contribution to the field of plant physiology.

Although the committee is to be commended for this initial effort, one might suggest that future translations should have editorial comments that supplement, clarify, or correct the Russian text.

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Theory and Practice

Work-Study Programs. Appraisal and report of the study of cooperative education. James W. Wilson and Edward H. Lyons. Harper, New York, 1961. xii + 240 pp. $3.50.

Although the first college program in cooperative education (alternating periods of work and study) was initiated at the University of Cincinnati in 1906, the first comprehensive survey and evaluation of the results has just been made. Financed with foundation grants and planned by a nationwide committee of educators, the 240-page report, cited above, has now been published.

The survey was an intensive one involving selected colleges of liberal arts, business administration, and engineering, each of which was paired with a similar institution that had not used the cooperative plan. Data were gathered from students, faculty, and employers.

The findings are favorable toward the work-study idea; recommendations include those for improving and for extending the programs. The quotation from the introduction, by Ralph W. Tyler, chairman of the study committee, catches the optimistic tone of the report:

"Cooperative education has important values for colleges and universities, for students and employers. These values should be given wide publicity and cooperative programs in American higher education should be greatly extended" (page 14).

A few of the committee's conclusions may be of special interest:

"The academic potential of cooperative students is equal to that of noncooperative students" (page 155).

"The cooperative experience provides meaningful opportunities for the student to see the relevance of theory to practical situations and affords him opportunities to practice making applications. . . . It is the judgment of the committee and staff that this study lays to rest suspicion that cooperative education is anti-intellectual and over-practical" (pages 155–156).

"Cooperative education makes a positive contribution to society by attracting able young people to college who might otherwise never consider continuing their education beyond the high school" (page 156).

". . . the cooperative plan makes possible the more effective utilization of college facilities" (page 157).

An evaluation of any educational program is extremely difficult to make. For example, students and alumni tend to be biased in favor of whatever institution and type of program they attend. Hence the comparisons made on the basis of opinions do not reveal the full strength of the program in question. Subscribing as I do to the theory of the educative value of experience as advocated by Pestalozzi, Froebel, Dewey, and others, I believe the findings understate the values of the cooperative plan. The plan has significance for liberal education beyond that found in this study, which did not examine the liberal arts program as fully as it did the two more applied fields.

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New Approach

Industrial Dynamics. Jay Forrester. M.I.T. Press, Cambridge, Mass.; Wiley, New York, 1961. xv + 464 pp. Illus. $18.

Industrial Dynamics represents a radically new and different approach to the problems of industrial management. The author attempts to provide a common framework for the separate functional areas of management activity (production, marketing, engineering, and the like), in terms of flows of money, orders, materials, personnel, and capital equipment, all integrated by an information network. To accomplish this he developed a methodology for building mathematical models of industries or firms and a computer program to compute the complex interactions of the models. By varying inputs on the computer runs, the technique is supposed to reveal critical system variables that can then be manipulated to achieve better results in the management of an enterprise.

One strength of the approach advocated by Forrester is that he has not succumbed to the current craze of mathematical elegance for the sole sake of elegance. The parameters and constants used have meaning in the real world modeled, and he has not fallen into the trap of making unwarranted assumptions and elaborating on them. The concepts and techniques are not beyond the comprehension of a good engineering or science undergraduate.

The book provides the tools for the interested reader to challenge old management clichés, myths, and shibboleths —the author is an industrial iconoclast. Indeed, in the core analysis of a hypothetical production-distribution system, Forrester shows that "small changes in retail sales can lead to larger swings in factory production," owing to the internal characteristics of the system itself. This model also disclosed that "reducing clerical delays may fail to improve management decisions significantly," that "a factory manager may find himself unable to fill orders although at all times able to produce more goods than are being sold to consumers," and that "an advertising policy can have magnifying effect on production variations."

This book's major shortcoming is the lack of confirming data from the organizations modeled. For example, a model of an electronics firm produced evidence that a violently fluctuating

employment level was caused by a system instability inherent in the relationship between the purchasing practice of the firm's customers and the firm's own inventory, production, and employment practices. Suggestions for improving the situation were made on the basis of further model runs, but no evidence of their efficacy is presented.

In view of the very exciting beginning presented in *Industrial Dynamics*, one looks forward to further development of the techniques described and particularly to more evidence confirming the ability of the models to accurately point the way to improved managerial performance.

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Three-Dimensional World

IGY. The year of the new moon. J. Tuzo Wilson. Knopf, New York, 1961. xxi + 350 pp. Illus. $5.95.

As president of the International Union of Geodesy and Geophysics, J. Tuzo Wilson was intimately involved both in the preparations for the IGY and in carrying out its program. He traveled some 100,000 miles, visiting installations in such far-away places as Antarctica, China, Greenland, and Taiwan, as well as many others. His account of the IGY is, therefore, a sort of personal narrative which lends great charm to the recital of the tremendous accomplishments of this greatest cooperative scientific enterprise in man's history.

Here we see how the IGY opened up new horizons on the earth, above the earth, beneath the earth, and even beneath the sea. Verily, Wilson introduces us to the new three-dimensional IGY world, and he manages somehow to place things in their proper perspective. For instance, the most publicized aspects of the IGY program—namely, the satellites—fall into proper proportion as he recites the accomplishments of the Soviets versus the Americans.

Wilson's interesting comments on cosmic rays, aurora, and other atmospheric phenomena are especially clear and give new dimensions to our understanding of these phenomena. Being a trained geologist, Wilson gives much attention to the solid earth and the fabulous discoveries made concerning it, discoveries such as the greatest mountain chain in the world. This chain, which stretches along the bottom of the ocean from the north Pacific into the Atlantic and then south around Africa into the Pacific again, is a single chain, 40,000 miles long and with branches of up to perhaps 60,000 miles. The highest mountains in the world, the Hawaiian Islands, are a part of it.

Wilson does not neglect the importance of the human or the sociological aspects of the IGY. Indeed, he ends with the pertinent comment that the IGY demonstrated scientists are also good humanists.

One puts this book down with a realization that the prophetic statement made by Hugh Odishaw, executive director of the United States National Program of the IGY, was soundly true: "The IGY is the single most significant peaceful activity of mankind since the Renaissance and the Copernican Revolution."

Wilson's book is not only a mine of information for the scientist who wants to learn more about the overall achievements of the IGY, but it is written in such lively, clear style that it will intrigue any intelligent reader who wants to extend his knowledge about the manner in which the planet earth fits into the universe.

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Population Control

The Giant African Snail. A problem in economic malacology. Albert R. Mead. University of Chicago Press, Chicago, Ill., 1961. vii + 257 pp. Illus. $7.50.

Economic malacology is a discipline so new that few if any college courses are offered in the subject—this despite the facts that mollusks (both clams and snails) have been used as food by man for centuries, that public health officials must deal with an increasing number of diseases in which mollusks act as vectors, and that horticulturists have long been plagued by snails (usually introduced forms) with an appetite for choice plants. It was not until the Giant African Snail came on the scene, irresponsibly transported throughout the Orient by human agents, that the need for effective means of snail control became urgent. Entomologists, having met and solved similar problems with insect pests, were among the first specialists to be called upon to find a way of checking the burgeoning snail populations. Snail control, however, proved to involve factors more complex than one would suspect, and the control devices all too often set up unanticipated chain reactions.

Mead has the advantage of being a trained malacologist. Although he does not pretend to have found at once the answer to the large problem presented by this number one snail pest, which has been his special study for several years, in both the field and the laboratory, he can make very clear what steps must be taken if a solution is to be reached. In this book he assembles the basic data on what is known about the present dispersal of the Giant African Snail and its habits and on the various control measures that have been tried, with an evaluation of their advantages and disadvantages. He suggests some methods that merit further investigation and reports a population decline (perhaps through disease) in some areas, which may prove significant; otherwise the picture is bleak.

The 41-page bibliography reveals how many facets must be taken into account in the study of such an organism. A graphic summary chart showing the immensely complex relationships of this snail to associated organisms in the field should be required study for anyone contemplating the addition of a fresh predator to the web: a stern warning against further irresponsibility.

As a handbook on methods for a new field, this book sets a high standard. Layman and specialist alike can profit from it, and its interesting style makes it easy reading. The illustrations are clear and well chosen, adding to the general attractiveness of the book.

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Sunlight and Health Hazards

Photochemistry of Air Pollution. Philip A. Leighton. Academic Press, New York, 1961. ix + 300 pp. Illus. $11.

This book brings together the available material in the important but complicated field of air pollution. Sunlight causes photochemical reactions that convert relatively innocuous pollutants into health hazards and major nuisances. In an introductory chapter,