endocrinology, herpetology, experimental psychology, animal behavior, and natural products chemistry. Burghardt's definition states that "communication is the phenomenon of one organism producing a signal that, when responded to by another organism, confers some advantage (or the statistical probability of it) to the signaler or his group."

Butler's chapter on insect communication, emphasizing social insects, is comprehensive. Biologists certainly should take note of the chapter by Bedoukin, who presents convincing examples of the pitfalls encountered during the manipulation of chemical pheromones.

Rare insight and objectivity are shown by Stuart in his discussion of the complex social communication of termites. He ably points out some of the fallacy of attempts to classify chemicals precisely according to the type of induced behavior without regard to the other environmental stimuli that are acting concurrently.

The physiologist will appreciate Stürckow's painstaking and critical study of olfactory and gustatory cells as they control chemoreception in insects. Stürckow's comments on interactions among neural elements within single sensilla may persuade more researchers to consider the specificity of the entire sensillum, instead of individual neurons, as a basic sensing unit.

Ant trail and alarm pheromones are catalogued in extensive tables. Ants surely must have the most complex chemical communication system of any insects.

Chemoreception and chemical communication in fish, reptiles, and mammals provide an interesting contrast to those phenomena in insects. Terminology developed to describe invertebrate behavior is not always applicable to higher animals; for example, the "releaser" concept.

Most of the chapters are followed by frank and sometimes critical discussion. Many interesting questions are raised that will make some researchers more cautious. It is suggested, for instance, that distilled water used in many laboratories has contaminants in quantities sufficient to cause behavioral responses.

The layman will find some satisfaction in realizing that the contributors did not reach complete agreement concerning some of their own definitions. This is as it should be. Overall, the book is replete with excellent information that biologists and chemists alike can utilize in research and teaching. Indexing is adequate and bibliographies are comprehensive. Serious students and scholars will treasure this book as a reference on communication by chemical signals in diverse animal groups.

NORMAN E. GARY
Department of Entomology, University of California, Davis

Modeling on a Grand Scale

World Dynamics. JAY W. FORRESTER. Wright-Allen, Cambridge, Mass., 1971. xiv, 142 pp., illus. $9.75.

This book has one important message to deliver and delivers it excellently in five lines of page 123: "From this book the reader should glimpse the nature of multi-loop, non-linear feedback systems, a class to which all our social systems belong. The book has shown how these systems can mislead us because our intuition and judgment have been formed to expect behavior different from that actually possessed by such systems." Beyond that one perceptive statement, the book is blatant and insensitive advocacy for unsubstantiated model building on a very large scale—a scale larger even than the author has advocated in two earlier books, *Industrial Dynamics* (1961) and *Urban Dynamics* (1969). At least the latest in the series, *World Dynamics*, is mercifully short.

Forrester sees the world as a feedback system not far different from a complex RLC circuit in electrical engineering—as a system that is easy to describe but hard to compute (except for him and those who follow his advice). What we never find out from his three versions of almost the same book is that, unfortunately, many of the component parts of behavioral systems are extremely difficult to describe, let alone measure. What is the book for? Its behavioral-scientific content is virtually zero. Its engineering-scientific content is well known and has been said before, by Forrester and by others (for example A. Tustin in *The Mechanism of Economic Systems*, Heineman, 1953). It amounts to applying electrical engineering and servomechanism principles to social systems. But if that is to have any worth, it must depend on the validity of the behavior of the models as representations of social systems. And Forrester's insights and observations on political, social, economic, or bureaucratic processes are negligible. None of his books has any empirical content, yet the operation of all his models calls for large numerical inputs.

Forrester is an extremely energetic and gifted man, and one cannot completely dismiss the work that he has been doing for the last 15 to 20 years. What are the positive features of this and his previous books? The Dynamo language is a nice, easy computer language that is intuitively attractive and suitable for obtaining graphical output displays of the type that are so impressive in top-level briefings and that appear in all his books. Furthermore, Forrester and his disciples appear to be willing to model anything. They have no hang-ups. This is probably good, because the challenge they have offered to econometricians and economists is healthy for all concerned. Forrester argues, though not so much in this book, that econometricians act in an almost anal-compulsive manner, being afraid to try to model anything that they cannot measure with considerable accuracy. He himself adopts the courageous attitude that it is better to guess at the values of important parameters that are hard to measure than to leave them out of the model.

Forrester's dynamic models are certainly no worse than most mathematical economic models of growth. The major difference between Forrester and the growth-model economists lies not in the simplicity of the models but in how their authors use them. Most behavioral scientists even when they want to be "relevant" are not completely satisfied with a criterion of validation that amounts to no more than acceptance by top decision makers or use by those in power. Such a criterion can fast lead to a Lysenko style of science. And it appears to be the one that Forrester accepts.

Responsible behavioral scientists know that not all variables and parameters in the world are simultaneously dominant in guiding the dynamics of a complex system. They know that it is important to locate the few variables to which the system is sensitive and to measure the relationships that count. Forrester knows this too, but leaves this work to lesser men. He sees important difficulties, such as urban decay, industrial cycles, the vagaries of population growth, and the instability of

international affairs. It is a pity that he has learned nothing from the work of others about what may be the key elements in the study of such difficulties.

The Club of Rome, which sponsored this work, appears to have as members a considerable group of high-powered top executives who are concerned about the state of the world. Unless they regard themselves as nothing more than a fancy wine-tasting and entertainment society, I suspect they should be able to sponsor a somewhat less naive form of advocacy than this latter-day essay in technocracy; or they should provide some guidance.

With his three books Forrester has succeeded in publicizing the concept of the applicability of large computer models and feedback systems to human affairs. He has generated at least some enthusiasm and backing from individuals with power and money. If his next book deals successfully with how to identify the key variables and parameters in these large systems, and with an example or two with more than casual empirical content, perhaps the value of such models can be accepted as more than an article of faith. In the meantime, he has demonstrated how to approach the understanding of human affairs in an energetic, simplistic, and superficially attractive but nonetheless dangerously wrong manner.

MARTIN SHUBIK
Department of Administrative Sciences, Yale University, New Haven, Connecticut

Human Potential

The Uses of Talent. DAEL WOLFLE. Princeton University Press, Princeton, N.J., 1971. x, 204 pp., illus. $6.50.

This book deals with the selection, education, deployment, and utilization of scientists, humanists, professionals, and others of comparable talent. Making a biological analogy, Dael Wolfle, who was director of the first Commission on Human Resources, sees these processes in the context of a national ecological macrocosm, in which specialized talents enter into an evolving association with one another. The system generates specialists who work out various adjustments to one another, yet at the same time develop tensions and pressures which keep the whole system in a dynamic state. The book is an informative description and wise assessment of this ecological system, and of its strengths and maladjustments, together with carefully conceived and realistic suggestions for improvement.

Wolfle is dealing with a field, the economics of human resources, which is not nearly so well developed as its prototype, the study of the production and distribution of material wealth. Nevertheless, a great deal of information and many ideas are available. Much research is under way and has been reported by psychologists on the identification of abilities and on the psychodynamics of motivation, by sociologists on social structures and processes that influence individual performance and aspirations, by political scientists on how social policies and priorities affect educated manpower, and by economists on the changing relations between supply and demand of specialists.

Without pretending that such inquiries are sufficiently advanced to constitute a science of human resources, Wolfle nevertheless aims to make a start in bringing together and integrating this already formidable body of material. With the help of concise writing and numerous charts and graphs, he arrays his complex data simply and clearly, and produces a number of ingenious but well-validated interpretations. In the process, he examines such questions as the changing demand for college graduates, the personal and social return on educational investments, the relative influence of ability and social class in determining who goes to college, the effect of geographical and occupational mobility upon the utilization of talent, and the personal and social priorities in the uses of talent.

Among other things, he demonstrates rather convincingly that even if a nationwide effort is made to uncover and develop talented human potential in social classes and groups that are now submerged, including women, the nation is not likely to be overwhelmed with an army of overqualified people in the foreseeable future. Even if financial barriers and deficiencies of educational background are removed, the numbers of people motivated to advance educationally are not likely to increase so drastically as to seriously outrun increasing demands for talent caused by the combination of technological advance and higher standards of competence. However, the ways of utilizing talent are likely to change a great deal. For example, proportionately less of the pool of talent will be used in university and four-year college teaching; more will be used in activities in which an upgrading of present standards of competence may be expected.

Wolfle has written an excellent, illuminating book.

WARD MADDEN
Brooklyn College, City University of New York, New York City

Laser-Produced Plasmas

Laser Interaction and Related Plasma Phenomena. Proceedings of a workshop, East Windsor Hill, Conn., June 1969. HELMUT J. SCHWARZ and HEINRICH HORA, Eds. Plenum, New York, 1971. xiv, 510 pp., illus. $25.

For the present, at least, the laser-produced plasma is a seriously considered contender in the race toward controlled thermonuclear fusion. This is even more true today than it was when the Hartford Workshop of which this book is the proceedings was held, because in the last two years high-efficiency gas lasers have become engineering certainties. This book serves a particularly useful function, for it introduces the reader to the areas of research, the main contributors, and the problems that were evident at the time the symposium was held. It will be of great value to those planning to initiate research in this area, for the newcomer will be able to bypass the usual literature search and make use of the many references given at the end of each paper.

Unfortunately, the important problem of long-wavelength (10.6 μm CO_2 laser) interaction is barely mentioned. The currently exciting phenomena of nonlinear absorption and turbulent heating can most easily be studied at this wavelength, and a book of this type could stimulate more activity here.

The volume covers most aspects of laser plasma research, but some are covered in much more detail than others. Notable for completeness are papers by DeMaria *et al.* on "Picosecond laser pulses," by Guenther and Bettis on "Laser triggered switching," and by Shearer and Barnes on "Numerical calculations of plasma heating by means of subnanosecond laser pulses." The influence of Hora is evident in the book, as he presented four papers, three of which are rather detailed the-