# BOOK REVIEWS

## Simulating Systems

*Simulation: Statistical Foundations and Methodology*. By G. Arthur Mihram. (Mathematics in Science and Engineering: a Series of Monographs and Textbooks, Vol. 92.) Pp. xv+526. (Academic Press: New York and London, July 1972.) $24.50.

IN spite of the continued growth of computer simulation as a means of understanding the behaviour of complex dynamic systems, there is a dearth of books about the subject.

Serious students, therefore, welcome each new book in the hope that it will fulfil a need. Usually they are disappointed: the book turns out to be a statistical textbook in disguise. Now, of course, it is important to recognize that simulation is an experimental method. Each run of the simulation is an experimental result and it is important to use valid and powerful methods of analysis of the results of such experiments. Statistical theory provides just such methods and should be used by simulators more than seems to be the case at present. But this has been recognized for a decade, and in spite of books and papers advocating the application of statistical theory, it still is only applied in a minority of studies. One reason is that the difficulty of obtaining a valid single result involves so much effort that the experiments performed are used to convince one emotionally about the behaviour of a system rather than objectively "prove" anything.

Books about how to simulate a system, however—how to get one experimental result—remain unwritten. Until efficient techniques to do this are widely used, statistical treatment of those results will remain a theoretical possibility. One reason for the absence of books on a systematic treatment of simulation seems to be that it is hard to find any unifying principles which can be applied to any system. The subject seems to degenerate into a series of *ad hoc* tricks and devices to deal with particular systems. The title of Mihram's book does not fill one with much hope. It openly announces that it is a statistical treatment and, sure enough, a large part of the book is just an account of modern statistical theory re-dressed in simulation terms. Part of the book does, however, describe very well the logic of the simulation experiment, emphasizing the way in which the simulator can "play God" by the manipulation of the random number streams used to pump variability into the system. He is enabled to perform experiments with more control over the random or perturbing elements than is possible in real experiments and yet still make valid deductions about real world behaviour. The advantage of all this is economy—more can be deduced from fewer observations.

The book opens with a good philosophical account of the problems of model building and introduces a concept of the Uncertainty Principle of Modelling which demonstrates the inevitability of the introduction of probabilistic elements into a model as it becomes more defined and detailed. There then follow two chapters of the statistical textbook, followed by one on Monte Carlo methods—a curious mixture of history and more probability theory. The next two chapters deal with the methodology of simulation, and, although very sound, have a theoretical flavour about them which may leave the more practical man floundering a little. These are followed by three chapters from a book on statistical design of experiments which do not pretend to be original, and the book ends with a chapter on stochastic processes—very relevant as most simulations are of such processes.

A good feature of the book is a series of exercises which, if actually tried, would help to redress the emphasis on theory which pervades the book. For those who want advice about how to simulate, the book offers no help. Simulation languages are dismissed in six pages (out of more than 500). Those who want statistical help would do better to talk to a statistician.

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## Electromagnetic Physics

*Electricity and Magnetism*. By John Yarwood. Pp. 675. (University of London: London, 1973.) £3.90.

BOOKS on electricity and magnetism are of two kinds. On the one hand, in the tradition of Maxwell and Jeans, they are essentially mathematical, so that the details of experimental measurement are regarded as irrelevant to the development of a good theory. On the other hand, they are based chiefly on the experimental aspects of the subject, and use mathematics chiefly as a tool. This book by John Yarwood is firmly in the second category; it deals fully with experiments, contains hundreds of diagrams to illustrate the equipment used, and always uses realistic numbers, together with the names of the units in which they are measured, for all the quantities described. In the best spirit of a textbook of nonspecialist character, there are many worked examples, as well as others to be tackled by the student.

The text is clear, though—perhaps because of repeated use of the symbol ∴ for "therefore"—it sometimes seems to have a slightly old-fashioned appearance. It is, however, quite modern in its consistent use both of SI units and of vectors. The student who works his way through this volume should have enough knowledge to cope with the first two years of most university physics courses. In all this Professor Yarwood is able to draw on his experience as Professor of Physics at the Central Polytechnic of London.

But what a lot there is—675 pages in this volume! One wishes that somehow it could have been shortened, since there is a companion volume on atomic and molecular physics, in which much of the present volume is needed. It could have been abbreviated if a good deal of the algebraic manipulation, here set out in full, line by line, had been cut. The clever student would not be disturbed by this. It follows that this is a book for the average physics student, and not so much for the budding specialist. The specialist ought to be given a more convincing proof of the flux theorem in electrostatics than the traditional flow-out-of-parallelopiped discussion, which lacks all rigour when the little box shrinks to zero. He would also deserve a more thorough discussion of the mechanical force at the surface of a conductor, where again the question of limits is crucial. He might also ask for more information about the use of a vector potential, which is introduced, without application, only at the end of the book.

On the more positive side, this book has very little that is inaccurate in it (though a statement on page 526 that in beryllium metal there are overlapping bands, of which the electrons in the L-shells of the atoms completely fill one band, which overlaps with another, empty, band, is open to some question.) This is a clear, workmanlike account of a great deal of the physics of electricity and magnetism, at not too high a level. It is likely to do well, and is unusually cheap for so large a volume.

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