am's "Types of technology." An investigation into the meaning of the concept "technology," the chapter divides its subject into four reasonable parts—technology as object, technology as process, technology as knowledge, and technology as volition—and exhaustively analyzes various conceptual distinctions within each category. Thus, Mitcham identifies "(a) invention, (b) design, (c) making (in the sense of materially fabricating), and (d) using" as basic kinds of human activity contained within his technology-as-process category and discusses each in considerable detail. His ultimate goal is to discover the "essence" of technology, a task he does not complete here. Whatever the outcome of his investigations in that respect may be, Mitcham's painstaking analysis offers valuable help to anyone who wishes to transcend the sloppiness with which the term "technology" is commonly used nowadays.

Mitcham and his colleague Jim Grote have also written several book reviews and an annotated bibliography for the volume. Their work supplements the *Bibliography of the Philosophy of Technology* (1973) edited by Mitcham and Robert Mackey, already a standard reference in the field.

There is a crucial dialogue waiting to take place in the philosophy of technology, one that would involve not only philosophers but also historians of technology and practicing engineers. It is a conversation that would take up the question of the nature and extent of modern technological practice and, most important, the limits of such practice. Engineers and technical specialists have tended to shy away from such discussions, all too often misinterpreting the issues raised by philosophers (especially moral and political issues) as an attack on their character. Philosophers and historians, some of whom have begun studying the subject from their own points of view, have so far tended to be satisfied with narrow accomplishments recognized within their disciplines. It may happen, therefore, that some of the most urgent questions of our times—questions about who we are and what we are doing when we do technology—will be lost in academicism or pure timidity. The present volume makes a noble effort to enlist participants for the dialogue. But it is only a start.

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Models

Statistical Mechanics and Statistical Methods in Theory and Application. A Tribute to Elliott W. Montroll. Proceedings of a symposium, Rochester, N.Y., Nov. 1976. UZI LANDMAN, Ed. Plenum, New York, 1977. xii, 814 pp., illus. $59.50.

Perhaps the most fruitful scientific research is that of the "cross fertilizers" who transfer ideas and techniques that have been successful in one field to a completely unrelated field where no one has thought of using them before. Few scientists of the present generation can have achieved more in this respect than Elliott Waters Montroll, who seems equally at home in mathematics, statistics, physics, chemistry, biology, social science, and the study of traffic flow and has contributed significantly to all of them. He has trained generations of students and collaborated widely. Since he has also consulted frequently with government and industry his influence has indeed been widespread.

Montroll specializes in clean and elegant mathematics; the problems that occur in nature are usually dirty and intractable. To bridge the gap it is necessary to invent a model that is soluble mathematically and sufficiently close to reality to cast light on the phenomenon under study. Time and again Montroll has succeeded in developing such models, which have initiated a precise approach in fields in which only qualitative information was previously available.

The volume under review is a record of the lectures and written contributions prepared for a one-day symposium organized by Montroll's colleagues (led by Uzi Landman) at the University of Rochester to celebrate his 60th birthday.

The volume reflects Montroll's wide interests, and many of the papers are in fields in which he has made pioneering contributions. Statistical mechanics is well represented in all its aspects. The current situation in the thermodynamics of hard sphere fluids is reviewed by H. Reiss, and the Montroll-Ward technique for dealing with interactions of quantum particles is applied by A. Isihara to the calculation of electron correlations in two and three dimensions.

Several of the contributions are concerned with different aspects of critical behavior and the Ising model. B. M. McCoy, C. A. Tracy, and T. T. Wu have made remarkable progress in recent years in the exact calculation of correlation functions, and their contribution, which links their own approach with that of Montroll, Potts, and Ward, is very much in the tradition of Lars Onsager. (Onsager was one of Montroll's oldest friends and has recorded that it was Montroll who first kindled his interest in the Ising model; it is particularly sad that he died a few weeks before the symposium.) For lattice models in which no exact solution is possible, M. E. Fisher discusses a new type of approximant for series expansions in two or more variables that could be of great practical importance for crossover behavior and multicritical points. The renormalization group, which has had a considerable impact in the past few years, is applied by M. S. Green to a van der Waals fluid to identify a van der Waals fixed point. G. A. Baker, Jr., uses the concepts of critical phenomena to gain insight into a lattice boson field theory, and B. Widom considers the structure and thermodynamics of interfaces, particularly those near critical points.

Other contributions are concerned with nonequilibrium statistical mechanics. V. M. Kenkre deals with the Master Equation and incidentally provides an appendix entitled "Poor man's version of the explanation of the origin of irreversibility" that should be useful to the uninitiated. M. Kac discusses a law of decay that would be valid far from equilibrium. G. G. Emch discusses the more sophisticated problem of nonequilibrium quantum statistical mechanics, and R. H. G. Helleman shows how a simple deterministic mapping can apparently produce stochastic behavior.

Random walks and lattice dynamics are subjects to which Montroll has devoted attention throughout his career—in fact he was the first to appreciate that the two are closely related. M. F. Shlesinger shows how the use of a particular random walk that models photo currents in xerographic films has led to new inequalities for the gamma function. H. Silver, K. E. Shuler, and K. Lindenberg discuss two-dimensional anisotropic random walks with practical applications to transport processes in anisotropic crystals. M. Lax and W. J. Shugard consider a model for the capture of carriers at deep traps as a basis for understanding the transmission of laser light through highly transparent materials. A. A. Maradudin, R. F. Wallis, and A. Eguiluz investigate the surface contribution to the specific heat of a semi-infinite solid. I. P. Ipatova and A. V. Subashiev calculate by diagrammatic methods the optical spectra line shapes for mixed crystals.

During the past decade Montroll has become increasingly interested in the ap-

plications of mathematics to biology. The contributions of this sort vary widely in scope; T. L. Hill introduces a model of the steady state kinetics of a linear array of subunits (for example, enzymes), H. L. Frisch, M. Bishop, and J. Roth apply Monte Carlo methods to self-replicating macromolecules, L. Glass considers the dynamics of biological systems using the ideas of statistical mechanics and nonlinear differential equations, and R. M. Wartell deals with a biological "phase transition," the DNA helix-coil transition.

A number of unusual contributions fall in the category of applications of statistics. R. Herman and Montroll look at a 75-year run of Sears Roebuck catalogs in an endeavor to throw light on mechanisms of market dynamics. T. R. Smith devotes his attention to the commercial banking system of New York City in the 1850's, looking for a basis for explaining events that led to the crisis of 1857. G. F. Newell discusses the fluctuations of timing on bus trips and explains why buses so readily fall behind schedule. G. H. Weiss and R. A. Brooks describe the development of computer-assisted tomography for improving x-ray images and discuss the errors involved. More formally, M. D. Srinivas and E. Wolf consider the treatment of quantum mechanics as a stochastic process in phase space.

Finally there are the miscellaneous contributions. B. B. Mandelbrot discusses his ideas on fractal geometry and describes the remarkable way in which he has made practical use of the abstract mathematical concept of Hausdorff dimension. F. T. Hioe advocates the use of determinants and their expansions in a number of physical problems. M. Dresden speculates on the use of random considerations in particle physics. In considering the properties of the ballast resistor, D. Bedeaux, P. Mazur, and R. A. Pasmanter are led to solitary wave solutions of this nonlinear system. J. B. Keller formulates a general theory of the effective macroscopic behavior of a medium that exhibits microscopic heterogeneity. M. Ruderman writes of exotic and unfamiliar forms of matter that may play an important role in astrophysical phenomena. V. Khare and H. M. Nussenzveig review various theories of the glory—the appearance on a mountain peak under suitable atmospheric conditions of a human shadow with a halo around the head.

It is fascinating to see mathematics applied successfully to such a wide spectrum of real-world problems. The volume is indeed an appropriate tribute to Elliott Montroll, for many of the contributions are consequences of his own initiative. Any mathematician looking for a practical outlet for his or her talents will surely find something of interest in this volume.

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Fungal Mitoses

Nuclear Division in the Fungi. Papers from a symposium, Tampa, Fla., Sept. 1977. I. BRENT HEATH, Ed. Academic Press, New York, 1978. xii, 236 pp., illus. $16.

The small size and poor staining properties of their nuclei and chromosomes previously ensured that nuclear division was one of the least known or understood aspects of the fungi. Since about 1960 the innovatory light-microscopic studies of Robinow and the electron-microscopic study of serial sections pioneered by Girbardt have quite dramatically revealed a wealth of new details and an astonishing diversity of nonclassical behavior.

This book, an expanded record of a four-person symposium, describes modern developments. It is well worth reading by cytologist, mycologist, and general biologist alike. Despite its title, the work is concerned almost entirely with ultrastructural aspects of mitosis, so that data on and issues arising from the remarkable contrast between such unusual divisions and the apparently conservative, meiotic behavior of fungi are omitted: a pity. The book does provide a valuable and unique record of current studies of mitosis in fungi. Quite incidentally, it also reveals that two major constraints in this field are the few species of fungus studied and a dearth of investigators.

Heath's chapter, an excellent, comprehensive précis of published work on ultrastructural aspects of mitosis in fungi embellished by original unpublished observations, is central to the book. It is valuable for its factual coverage, for propounding controversial and speculative ideas, and for highlighting existing areas of obscurity. More issues remain unresolved than are resolved. What, for example, is the significance of the diversity of nuclear-associated organelles (spindle-pole bodies), of the diversity of spindle origination, organization, and function, of the relative infrequency of metaphase plates, or of the not infrequent loss of the nucleolus and much of the nucleoplasm to the cytoplasm? Many such topics are taken up by Kubai, who makes fascinating comparisons between different fungi and between fungi and algae or other protists. Are the similarities the result of convergent evolution or of common ancestry? Are the differences reflections of function or of phylogeny?

Girbardt's valuable introduction proposes a series of cyclical phases for nuclear-associated organelles and touches on the relationship between light- and electron-microscopic images. Such comparisons are, unfortunately, made rarely by the other contributors even though, for example, it is evident that the characteristic preanaphase "double-track" appearance of fungal cells cannot yet be interpreted satisfactorily by ultrastructural observations (despite Heath's ingenious suggestions). A chapter by Forer on the possible role of actin filaments in chromosome movement is provocative but is only tenuously related to the other contributions.

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Dentition

Development, Function and Evolution of Teeth. Papers from a symposium, Cambridge, England, Sept. 1974. P. M. BUTLER and K. A. JOYSEY, Eds. Academic Press, New York, 1978. xx, 524 pp., illus. $55.75.

A wealth of information about mammals is stored in their teeth. No other anatomical system records the combination of genetic, developmental, adaptational, and demographic evidence that teeth do. The hardness and density of dental enamel have caused teeth to be abundantly preserved in the fossil record, giving mammals a detailed evolutionary history unsurpassed in any other group of organisms. Hence a large amount of research is devoted to gaining a better understanding of teeth. To further interdisciplinary communication on the subject several international symposia have been held since 1965. The book reviewed here comprises the revised and updated contributions to a 1974 symposium in the series. The proceedings of the 1965 and 1968 symposiums were important in furthering understanding of dental morphology, and this well-produced new volume records another significant advance.

The 32 chapters of the book cover tooth morphogenesis, internal structure,