measures aimed at creating a national climate favorable to innovation."

Schon's venture into social philosophy is far less thorough than his analyses of invention and innovation; nevertheless it contains some provocative ideas. Curiously enough, the jacket bears the subtitle "The impact of invention and innovation on American social and economic development," while the subtitle within the book itself is "The New Heraclitus." Neither subtitle is wholly apt. The book cannot in any sense be said to be a critical analysis of technological change in American industry and its impact on society; that would require another entire book (or books), and quite a different one. As for "The New Heraclitus," a quotation from this ancient Greek philosopher appears in the book's introduction, but only to provide us with the truism that everything is in process of change, and that change in industry through invention and innovation is an element in change in our society as a whole.

In his final chapter, An Ethic of Change, Schon points out that the conventional view of technological progress is based upon the Parmenidean concept of stability; change is considered only as a series of transitions from one stable state to another, and technology is regarded as a neutral instrument of change that can be used to enable men to march steadily forward toward a good society whose objectives remain clear and unchanging. This conventional view of technological progress has recently been subjected to doubts. We sometimes gloss over these doubts by claiming that the defects in our society come from the improper use of technology. But Schon is more concerned about the fact that technological change "has been eroding established identities . . . undercutting the sense of self . . ." The changing nature of work, caused by technological development, has created a threat to identity because it makes it difficult for us to classify ourselves in terms of our jobs, and this has led in turn to an erosion of our conception of human needs. There has thus been progressive disillusionment with the notion of technology as an instrument for human well-being.

How are we to react to this changing situation? Schon calls for a new ethic—a set of principles for change. Our old norms no longer suffice; we must renounce our past myths and develop new norms. These norms are not only for the individual but also for the corporation, and, above all, for society. Schon suggests that the process of invention might provide a model for such norms. It places the emphasis on process, contribution, and discovery as against the stable states of success or failure, and thus allows for experimentation and for new objectives to emerge in the process. To ask whether these new objectives are better than the old would, of course, be the mark of the outmoded Parmenidean approach, so we can only hope that the future will indeed justify Schon's "new Heraclitus."

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Plant Substance

The Chemistry of Lignin. IRWIN A. PEARL. Dekker, New York, 1967. 355 pp., illus. $15.75.

Ligninology is a field where organic chemistry ceases to be an exact science. This is an opinion undoubtedly shared by Pearl and most of his prospective readership among researchers working on current problems in lignin chemistry and the related fields of wood science and technology. Polymeric lignin molecules are encountered in most terrestrial plants but show little uniformity, not only from species to species, but even between individual members of single species, between the heartwood and sapwood of individual trees, between the springwood and summerwood of a single year's growth, and ultimately between the various wall layers in an individual plant cell. The association of lignin with plant polysaccharides and the alterations in its structure that occur during its isolation or removal from plant tissues, for example by pulping, complicate this already unsurveyable situation. The approaches adopted by scientists to attack the lignin problem—so acute because of the monstrous amounts of lignin wastes disgorged annually from the world's pulping industries—are probably equally variegated.

Pearl has undertaken the gargantuan task of assembling, ordering, and critically presenting the results of recent years of work on this inchoate natural product. Of necessity, an author of a book on lignin must assume a position of bias that will be enthusiastically acclaimed by some workers in the field while vehemently disparaged by others. Assumption of a controversial stand of this kind—here a preference for the empirical over the biochemical approach—does, however, have the benefit that the resultant survey of lignin literature is more vivid and intriguing than the mere compilation of facts, theories, and dubious implications that might otherwise be made from the flood of publications on lignin.

Pearl's book is intended as an edited wide selection of the significant results garnered over about the last decade on lignin and allied topics. As such, it is a worthy sequel to its predecessor volumes, F. E. Brauns's *The Chemistry of Lignin*, and *The Chemistry of Lignin: Supplement Volume*, edited by F. E. and D. A. Brauns (Academic Press, 1952 and 1960), and does in fact build upon these classics as foundations. For information on earlier work, the reader is frequently referred to the pertinent sections in "Brauns."

At the Institute of Paper Chemistry in Appleton, Wisconsin, Pearl has had access to numerous publications, translations, and abstracts not readily or punctually available to most workers in the field. Broad coverage of articles originally published in Russian or Japanese is one outstanding asset of the present volume. Occasional erroneous interpretation or representation of facts from more familiar sources may imbue some readers with skepticism toward the accuracy of the reports from obscure journals, however. Moreover, although the literature has been finely gleaned up through 1965, some papers that well merited inclusion have been overlooked.

One of the best features of the book is the delicate balance struck between the technological and academic aspects of the subject. Discourses on the biogenesis of lignin and on laboratory methods of isolating and assaying lignins are complemented by descriptions of wood pulp and spent liquor analyses and of the behavior of lignin in the main pulping and pulp-bleaching methods. Current concepts of the chemical constitution of lignin provide a sound basis for the discussion of the reactions of lignins, the individual formulations by various authorities being carefully related to experimental observations. Other chapters important to industrial workers cover the physical properties of lignins and their derivatives, the biological and thermal decomposition of lignin, lignin-carbohy-

drate bonding in plants, and the uses of commercial lignin products.

The author's familiarity with and attention to both the scientific and technological accomplishments in this difficult field will make his volume useful not only as a reference work but as a textbook; it should be appreciated by lignin investigators in both the academic and industrial spheres.

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Parts and Wholes in Biology

Molecular Organization and Biological Function. JOHN M. ALLEN, Ed. Harper and Row, New York, 1966. 255 pp., illus. Cloth, $9; paper, $5.

This multi-author volume contains eight essays which were presented as a lecture series at the University of Michigan in the spring of 1965. Thus from the start the reader faces the twofold disadvantage of a substantial publication lag (which is of considerable significance for some of the fast-moving areas reviewed here) and the discontinuities in style, approach, and orientation which often afflict books written by several authors. Moreover, similar treatments of the same subjects, often by the same authors, have appeared elsewhere. So why this book? In my opinion its chief value lies in the collection of these essays into one small volume which can be read as a unit. For the "vertical sectioning" of molecular biology which this book as a whole represents drives home forcefully the basic notion that while cellular organelles and structures are made of molecules, the functions of these multimolecular structures are often much more than the sum of their unorganized molecular parts. Yet it is also clear that the parts contain within them the implicit interaction potentials needed to bring about, under appropriate conditions of environment and perhaps sequential availability of components, the self-assembly of the whole into a functional array.

This theme is clearly stated in the editor's preface and can be traced through the book by the appropriately oriented reader. The book opens with a discussion by Anfinsen on the "self-structuring" of protein conformations on the basis of information contained in the amino acid sequence, followed by a review by Rich on the mechanisms whereby the nucleotide triplets of DNA are transcribed onto messenger RNA and then translated into sequenced polypeptide chains. Anderson then deals with the simplest type of multimolecular self-assembled system, represented by the bacteriophage, in which the whole is already much more than the sum of its parts. From here things become progressively more complex, and these complications correlate (of necessity) with a progressive loss of focus on the details of the molecular structure which is presumably responsible for the ever more complex edifices described: first Robertson on cell membranes, then Lehninger on mitochondria, Bogorad on chloroplasts, Dowling on visual receptors, and Gibbons on cilia and flagella.

The chapters are uniformly well written and profusely illustrated and provide something of value for each reader, be he a beginning student just becoming acquainted with molecular biology or a full-time research worker in one of the fields under discussion. However, it is likely that only the latter class of readers will be able to wring dry some of the more complex chapters.

But I hope that most readers will go through the entire book, for only in this way does the impact implicit in its organization come through. Both students and practicing investigators whose major interests fall on various parts of the spectrum of complexity presented here should be impressed and sobered: the molecular people with what an incredibly delicate balance of forces must be sorted out to "explain" the self-assembly of the complex structures from their constituent macromolecular parts, and the morphological people with the many levels of interacting organization which still remain to be fathomed before the beautiful structures they look at can be considered to be "understood."

It is a pity that even the paperbacked version of this book is expensive, since it is the sort of work that, if read by students, could help prevent the development and hardening of the "black boxes" which are often built around certain areas of subject matter as a consequence of the "horizontal" organization of many of our classical courses and research disciplines.

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