information is given concerning the actual corrosion behavior of metals and alloys in various types of waters. Several chapters on methods of preventing or reducing corrosion are included. In the light of a series of books on corrosion published in the past few years and directed more towards the university student or research worker, *Corrosion and Its Prevention in Waters* is useful as a guide to the practical engineer.

Considering its function and nature, the authors are to be congratulated on not allowing the text to become littered with endless tabular data on the quantitative corrosion behavior of metals and alloys in a multitude of specific environments. Instead, the large amount of information is well presented with good continuity and in very readable form. A major omission, however, is a consideration of corrosion in sulfide-containing waters; this problem is particularly serious in the US with oil-well equipment corrosion.

Although the authors' stated intention is to keep theoretical aspects to a minimum, at times this policy has been followed with such zeal that some of the mechanistic sections are too depleted to be of much value. To state, for example, that "the criterion of pitting is the oxidation-reduction potential" and to quote some arbitrary value for this, is so out of context and so limited in scope as to do more damage than good. The new venturer into the field of corrosion would find himself both at once intrigued and confused, and would be well advised to obtain a sound background in corrosion principles from some other source before attempting to use the practical information given in *Corrosion and Its Prevention in Waters.*

As a whole, the book is to be praised as serving a genuine need. It is recommended for plant and field engineers, and the student or research worker may find the practical approach to corrosion a pleasant and enlightening change from the usual theoretical texts. At a cost of $12, both the library and private individual will find the purchase of this book a worthwhile investment.

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## A SIGNAL SERVICE OF SIGNIFICANCE

*Title* Technological Innovation and Society

*Editors* Dean Morse, Aaron W. Warner

*Publisher* Columbia University Press

*Pages* vi + 214

*Price* $6.00

*Reviewer* Lloyd V. Berkner

This new book is an important addition to the growing list of significant discussions of the impact of the present technological revolution on society, and of specific problems inherent in that impact, The basic thesis is derived from the now almost limitless power of technology toward either good or evil. "The shift from the industrial age to the cybernetic age is as big as the shift from the agricultural to the industrial. . . .the former is taking place over a generation or less. . . the latter took centuries to work out." How can our institutions cope with such rapid rates of change; how can man "control unlimited power, something he has never really been forced to do." Will the unlimited capability to do good be warped by man to generate unlimited evil. What, indeed, is *good* in an era when new value judgments can and must be made.

The book consists of eight essays presented before the Third Columbia University Seminar on Technology and Social Change, together with the ensuing seminar discussions of those essays. The editors have done an unusually effective job in editing the discussion, so that the central ideas emergent from the discussions are clearly elaborated.

The first four essays by Wiesner, Land, Hershey, and Piore (scientists with both substantial industrial and government experiences) deal primarily with the derivation of technological innovation from science. The second four essays by Sebrell, Michael, Vallard, and Clark are concerned with the major social problems raised by the new technology. Each group of essays is introduced separately (and knowingly) by the editors.

The participants agree on Wiesner's basic premise that "if we had not done a great deal of *basic* research, and thus created the scientific knowledge on which our technology is based, we would not have our growing industrial society." But there is equal agreement on the ever more widely accepted observation that scientific research, however successful, does *not automatically* lead to new technologies. There must be a series of intermediate steps between scientific discovery and the consequent emergence of new products and services—new technologies useful to mankind.

While the symposium participants refer to the various intermediate steps between science and a successful technology, there is nowhere an attempt to organize these ideas systematically. That this important information and knowledge remains unorganized becomes apparent when Piore remarks, "I have yet to see one case in which there has been a profound growth of a company by means of the procedures which are being taught in the nation's business schools these days."

Yet one can cite instances of science-based companies, whose average growth of 30% per year over two decades or more, has arisen from systematic and institutionalized translation of science into new technologies—so certainly the institutionalized process of innovation has been and can be rather precisely defined. This leads a listener to ask Wiesner, "Is a new institutional development coming to

the fore?" But missing from the discussion is the systematic list of measures involved in innovation from the procedure for adoption of a company strategy out of basic scientific ideas through the tactics of development, finance, and introduction to the market, describing responsibilities and decisions at each level of the heirarchy.

Throughout the discussion, the importance of incentives and motivation at every level of the innovative process is emphasized. Wiesner believes neglect of this point has led to failure of the innovative process during British and Russian ventures into applied research sponsored by government. Likewise, Piore emphasizes the role of an intelligent, imaginative, and enterprising management in the innovative process. As a consequence, half of American production comprising mostly the oldline companies spend only five percent of the total commercial research and development budget—showing a serious imbalance in the application of innovative process.

The unusual evolution in the character of science-based industry is set forth in the inspiring essay of Land. This development, now apparent in some 30 or so of the new American science-based industries, is perhaps a herald to the eventual change in attitude of industry as a whole to its total social responsibilities. In contrast, Hershey's blunt statement, "The Company has to be run in such a way as to make a profit" tends to imply the isolation of "the Company" from the interests of society. One is reminded here of the more acceptable attitude often expressed by Pat Haggerty (President of Texas Instruments), "The objective of TI is to invent, make and sell useful products and services to people—the incentive to do this successfully is a profit." Thus the essays of Land and Hershey in certain respects offer an illuminating contrast. The discussion penetrates the basic question of the responsibility of a Company "as an essential element of society." Hershey brings out that the successful Company of today cannot avoid a wide range of social responsibilities, yet his essay still carries a little of the old "Charlie Wilson philosophy" that "what is good for GM is good for the country." Perhaps a major byproduct of the technological revolution is the broader social attitudes of our new science-based companies (which incidentally are no less profitable). As Land summarizes the new attitude, "We, who hold the responsibility for leadership, have a choice between a greedy self-contained preoccupation with fighting among ourselves for superiority, or, on the other hand a deliberate undertaking to develop a program for sharing the richness of our intellectual life with the mass of people around us." It is this new and growing intellectual content of our private innovative industry that is so impressive (and so often ignored or neglected by today's humanist). The second group of essays turns to the problem of social adaptation to technological change, because, as Michael puts it, "It is the potency of technology, its capacity to do wonderful good or monstrous evil. . ."

The basic problems emergent from the technological revolution are well known. While bowing to the dangers of nuclear destruction, the central problem seen by all is the population explosion, because its consequences are certain, inevitable, inescapable. Beyond this lie problems of growing inequalities among peoples, urban development, pollution, war, technological unemployment, and so on down the long list we know so well. Frequently, the questions are asked—"What kind of world do we want, how many people, what social goals?" Recognition is given that the world could now have what it wants if it could organize, direct, and channel the technological power already at hand. The roadblocks, as Sebrell puts it, are "illiteracy and ignorance." The need, as expressed by Michael is that "We do not know how to produce wise men."

Underlying the discussion is the failure of today's humanist (and to some extent the social scientist) to inform himself of the true character of the world as it really exists, and to enter intelligibly into the dialogue. Repeatedly in discussion, the questioner would place the blame for inaction elsewhere—"until the computer companies state very clearly what they know about the consequences. . .; until the generals state very clearly what they know about modern warfare." Michael emphasizes, "We do not now understand, nor are we systematically trying to, what alternatives are or will be available to us". . . . "One direct effect of the new technologies is to challenge deeply the adequacy of our academic disciplines for dealing with the kind of world they are producing." . . . "It seems to me that we belong to one of the institutions of society (the university?) whose members and operating styles need to be shaken up quickly." . . ."I yield to no one in my reservations about the ability of the behavioral sciences to deal with the complex issues at the present time" although, says Michael, the tools are at hand. Yet, he continues, "We have not studied, and again we have not tried to lay out the implications in a sufficiently elaborate social and technological context." . . ."Many, probably most of what may be called the significant issues are *not* being explored effectively and on a scale and with the attention they deserve." These are serious indictments of a substantial portion of our academia and deserve self-critical rather than pharisaical replies. Who in the university *should* be responsible for thinking out man's adjustment to a new world? Who must master the knowledge of our institutions as they really exist, that their evolution may be channeled toward the greatest social good? Yet Michael concludes, "We know all too little about the character of our major social institutions."

There is general agreement with Villard's thesis (echoed by Clark) that from our present situation, the only short term hope is more technology at a faster rate to bail mankind out of some of the more serious difficulties into which he is already precipitated. But there is equal agreement that, in the longer term, certain major social attitudes must change, certain new value judgments be made, certain new human goals be generally established and accepted. Clearly a society of growing plenty must be very different in its values from the traditional society dominated by poverty.

Villard's statistics are sobering, though necessarily somewhat oversimplified. One questioner comments, "I have the impression that one reason some of us have criticized (his) statistics and his arithmetic is to give ourselves some

comfort." Yet one must leave the discussion with a considerable note of pessimism. As Michael concludes, "Certainly ours would not be the first society that disappeared because it could not find a way to accommodate in time to changes generated within it by its own momentum and style." To which Clark adds, "The limiting factor is not technology; it is our lack of imagination and our indecisiveness in allocating our resources," and Michael replies, "The question really is how to change institutions so that leadership arises in a given situation and then acts". . . "We need to know how to provide (wise men) with an environment that will encourage their wisdom to blossom and act."

As with all edited volumes involving multiple contributors, there are substantial gaps in the presentation (which will, perhaps, be elaborated in subsequent volumes). Some of the questions and comments are so penetrating, one wishes the discussants had been identified by the editors. Their ideas are significant and quotable.

On the whole, Morse and Warner are doing a signal service in organizing and publishing these seminars.

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*With over 100 scientific and technical papers to his credit, he has authored a recent book,* The Scientific Age *(Yale, 1964) and edited two others,* Rockets and Satellites *(Pergamon, 1958)* and Science in Space *(McGraw-Hill, 1961).*

## IMPRECISE AND INPUT ORIENTED

*Title* Measurement and Analysis of Random Data

*Authors* Julius S. Bendat and Allan G. Piersol

*Publisher* John Wiley & Sons, 1966

*Pages* xv + 390

*Price* $17.75

*Reviewer* Emanuel Parzen

Time series analysis has a long and complicated history. It has for many years been of interest to an advanced fringe of researchers in such diverse fields as communication theory, control theory, aerospace studies, structural vibration studies, acoustics, oceanography, seismology, medicine, economics, management science, and operations research. Recently, however, the interest seems to be growing exponentially. Indeed, it seems that we are about to enter the golden age of time series analysis—when its possibilities will burst upon the popular consciousness, when it will be systematically and routinely applied, and when its instrumentation and application will be an important industry.

There seem to be two worlds of time series analysis which hardly interact. On the one hand, there is research on time series analysis as part of applied mathematics concerned with blending probability theory (as needed to study stochastic models of processes evolving in time and space), statistical theory (as needed to develop methods of inference for analyzing and synthesizing models), numerical analysis (as needed to develop methods of handling large masses of data and efficient computer algorithms), and system theory (as needed to describe time series as inputs and outputs of systems). On the other hand, there is engineering activity concerned with the collection and processing by special purpose instruments of time series that arise in actual applications in real time.

The book under review is "directed toward the goal of bringing together and clarifying the various disciplines required to properly measure and analyze random physical data." The first four chapters (171 pages) present standard introductory material on probability and stochastic processes, linear systems, and statistical inference. Chapters 5-7 (130 pages) present techniques for estimating first-order probability distributions, autocorrelations and power spectra, and cross-spectra for frequency response functions for multiple time series. Chapter 8 (11 pages), which should have presented an illustrative "detailed analysis" of a set of real data, seeks to provide a practical proof of a theoretical formula. Chapter 9 (45 pages) is on analysis of non-stationary data and provides very little insight.

The unique parts of the book, Chapters 5-7, may be useful to an engineer to orient him to the kinds of calculations that might be performed to describe the statistical characteristics of time series. However, the discussion is input oriented rather than output oriented; it is concerned with what to compute rather than how to gain insight from the computations made. These chapters would be of value if read in conjunction with a survey by a time series statistician, such as the excellent paper, "A Survey of Spectral Analysis," by G. M. Jenkins, *Applied Statistics,* Vol. 14, pp. 2-32 (1965).

The applied mathematician and statistician may find the exposition too imprecise for his taste; for example, the author's notation for random variable $x(k)$ is not standard, and his four conditions on page 91