

## BOOK REVIEWS

*Cybernetics*. By Norbert Wiener. The Technology Press; New York, Wiley; Paris, Hermann, 1948. 194 pp. \$3.00.

As most of the readers of this review are aware, the word cybernetics has been coined to serve as the name of the new branch of science which deals with control and communication generally. The first problems that were considered in this field were, naturally, problems concerning control and communication in the inanimate systems of physics and engineering. However, it now appears, more or less clearly, that cybernetics may also have important applications in biology, psychology, and perhaps other sciences. Before beginning to comment specifically on Professor Wiener's book, it will be well to say a little about the subject of cybernetics itself.

In its present state of development cybernetics is concerned with three main themes.

First, consider the problem of control in its pure form. We desire, let us say, to make some physical variable a prescribed function of time, or, equivalently, to make some "output signal" equal to a given "input signal." In general it is impossible to achieve the desired equality exactly, but we can achieve approximate equality in various ways, depending upon the particular case in hand. Now in many cases the best way of achieving a good approximation to the desired result is by using a system which measures the difference between the input and output signals continuously or intermittently, and which operates so as to reduce the magnitude of this error. This leads us to the first main theme of cybernetics, the subject of feedback control systems. Linear feedback systems have a very attractive mathematical theory, which depends upon nothing more than the classical theories of linear differential equations and analytic functions.

The physical or other systems with which we deal in practice are always subjected to disturbances of one kind or another, and consequently the signals transmitted through the systems are accompanied by more or less troublesome "noise." The second major theme of cybernetics is concerned with the statistical properties of such noises, with means for protecting the signals against the noise, insofar as that is possible, and with the problem of correctly interpreting a received signal which is seriously perturbed by noise.

Finally, we have the part of the subject that is concerned with the nature of information itself, and with problems of coding, that is, with the selection of suitable signals for the most efficient transmis-

sion of information. Rather unexpectedly, this part of the subject turns out to have striking analogies with thermodynamics.

In Professor Wiener's book the reader will find these ideas, which we have only sketched briefly, developed at length, with ample indications of their applications to many different fields of science. In particular, it is shown that many phenomena which are familiar to biologists can very probably be explained in terms of the fundamental concepts and laws of cybernetics. Furthermore, very persuasive arguments are given for thinking that the same may be true of many psychological phenomena.

The book opens with an introduction, running to over thirty pages, in which the author gives a detailed account of the successive stages through which his own ideas on the subject have developed. If cybernetics does in fact come to have the great importance that is now predicted, this introduction will be of great interest to future historians of science.

The rest of the book consists of eight chapters, bearing the titles I. Newtonian and Bergsonian time; II. Groups and statistical mechanics; III. Time series, information, and communication; IV. Feedback and oscillation; V. Computing machines and the nervous system; VI. Gestalt and universals; VII. Cybernetics and psychopathology; VIII. Information, language, and society. These titles indicate the general character of the contents as well as is possible without a very lengthy analysis.

The most notable feature of the book is the astonishing number of diverse and highly suggestive ideas that it contains. It is clear that a rich mine has been located here, which will not be fully explored and exploited for a long time to come.

In the opinion of the reviewer the chief adverse criticism that can be made of the book is that the author seems not to have formulated any reasonable and stable concept of a class of readers for whom he is writing. He tries to make the book all things to all men. For the most part the exposition proceeds in a pleasant informal non-technical style. However, there are several occasions upon which the unsuspecting reader suddenly finds himself in the midst of a heavy downpour of mathematics, of a far from elementary character. These mathematical interludes are so closely connected with the accompanying non-technical material that they will inevitably cause considerable trouble for the non-mathematical reader. At the same time the pieces of mathematical theory are not developed far enough, or systematically enough, to be of any very direct benefit to the mathematical reader. Thus it seems that they can serve only as strong hints

as to directions in which things of value are to be found.

The second chapter affords a striking illustration of this tendency to introduce bits of mathematical theory without any adequate development. Here in the short space of sixteen and a half pages the reader is hustled through a discussion which touches upon Lebesgue measure, continuous groups (including the theory of group characters), and ergodic theory. It is hard to see how anyone, unless he be an expert in this particular set of subjects, can be expected to get much of anything out of this.

Similar criticisms apply to Chapter III, which deals with the theory of information. This new theory is elusive and subtle at best; and the hurried and mathematically complicated treatment given here seems to the reviewer to verge upon utter unintelligibility.

In conclusion, simple honesty and a decent regard for good workmanship compel the reviewer to remark that someone must bear the responsibility for what is truly a wretched job of proofreading. It would be hard to find another book having as high an average number of errors per page as this one has. The errors run all the way from trivialities, which are merely occasions for exasperation, to typographical errors in the equations and formulae which seriously impair the intelligibility of the exposition. Scientists, unlike philatelists, do not value documents for the errors they contain, and therefore it is to be hoped that in a second edition we shall see most of these errors corrected.

L. A. MACCOLL

*Topology of manifolds.* By R. L. Wilder. (American Mathematical Society Colloquium Publications, vol. 32.) New York, American Mathematical Society, 1949. 10+402 pp. \$7.00.

To give an idea of the scope of this book we shall begin with a brief description of a body of theorems in the topology of the euclidean plane that are referred to as the "Schoenflies program." Let  $M$  be the 2-sphere and  $K$  a closed subset of  $M$ . If  $K$  is a simple closed curve (=topological image of a 1-sphere) then  $M-K$  is the union of two disjoint connected open sets  $A$  and  $B$  such that  $K = \bar{A} \cap \bar{B}$  (Jordan Curve Theorem). It is further known that each of the sets  $\bar{A}$  and  $\bar{B}$  is homeomorphic to a closed disc. Converse theorems which give necessary and sufficient conditions on the set  $M-K$  in order that  $K$  be a simple closed curve or a Peano space (=locally connected continuum) also exist.

The objective of this book is to extend this program to higher dimensions, using homology theory as the principal tool. Thus  $M$  is