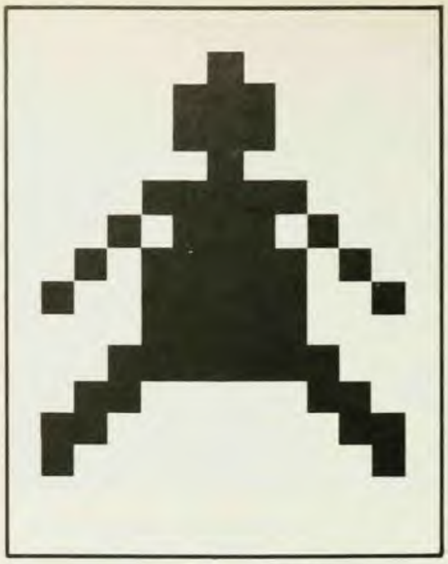
into a communicative phase and L is the communicative lifetime of such technical civilizations. This probability equation ranges across all fields of science and touches on aspects of psychology, anthropology and sociology. The discussion at the conference focused on these various factors in turn, and then went on to the issue of techniques of communication.

It is a natural expectation that those who would participate in a conference such as this would tend to have a rather optimistic view concerning the prevalence of intelligent civilizations throughout the galaxy. For the most part this was true. Most of the participants made rather optimistic estimates of the various probability factors involved, leading to an overall expectation of something like 10^6 intelligent civilizations in the galaxy in their communicative phases, with distances to the nearest few from the Earth being of the order of a few hundred light years.

In general I share this optimism, but some of the discussion of the conference made me realize upon what shaky grounds it rests. It may be noted that the first few probability factors are basically astronomical in character, and thus that with the present state of development of our scientific knowledge we might expect that these factors could be estimated with a greater quantitative assurance than the later ones. But these factors involve the probability of planetary-system formation, and the only information that we have in this respect concerns our own solar system. It is well known that the problem of the solar system's origin is a major unsolved scientific issue. This is discussed by Tom Gold. I find myself in general disagreement with practically every point that Gold makes, except for his final conclusion that the formation of planetary systems should be very common in space. If there can be that much disagreement about the astronomical factors, what faith can we have in the estimates of the nonastronomical factors?

What we see operating here is a certain philosophical outlook toward cosmogonic and biological evolution. This is the philosophical principle that we are not unique, and that the evolutionary pathway that led to our existence is not accidental, but is the inevitable outcome of physical and chemical processes operating over long periods of time. This is the logical outcome of the scientific revolution started by Copernicus; the establishment of communication with an extraterrestrial civilization would be the ultimate test of its validity.

One qualification is necessary relative to the above remark. The practicability of interstellar communication



does indeed depend upon the existence of something of order 10^6 communicative extraterrestrial civilizations in the galaxy at any one time. This, in turn, requires that the average interstellar civilization should have a communicative lifetime of the order of millions of years. But if ecological or political disasters terminate the communicative phase of a planetary civilization in a time some orders of magnitude short of millions of years, then there become sufficiently few extraterrestrial civilizations in the galaxy in their communicative phases at any one time so that the round-trip time for communication becomes comparable to the communicative phase lifetime. Thus, if we do not succeed in establishing communication with extraterrestrial civilizations, this will not necessarily negate the Copernican principle, but it bodes ill for the future prospects of our technological civilization.

This book contains a large number of very stimulating ideas, presented in the context of a high-level discussion that has been skillfully edited to focus on the essential points. Many parts of it are great fun to read, particularly if one indulges in the "willing suspension of disbelief" that is necessary to enjoy a science-fiction tale. Among these I might mention the suggestion by Freeman Dyson that big trees might grow on comets, and that the human race may in the future spread out to inhabit the interiors of comets that cluster in large numbers on the outskirts of the solar system. He explained that one of the advantages of this would be that people could get away from their government. (I would be curious to know how this remark will be translated in the Russian edition of this book.) Another amusing suggestion is that of N. S. Kardashev, that interstellar civilizations may inhabit "interstellar hotels" that propagate from one cycle of the expansion-contraction of our universe to another by diving through the interiors of black holes.

Many parts of the discussion of communications technology are also very fascinating. If we only knew where to point our antenna, all that is necessary to communicate with another fellow across thousands of light years is that each of us should possess an Arecibo radio telescope. Unfortunately, we do not know where to point the antenna, but for the expenditure for a few billions of dollars with our present technology (Project Cyclops) we can build an antenna array that would allow us to eavesdrop across thousands of light years on the normal electromagnetic emissions of a civilization such as our own, and at the same time we will, of course, transform the science of radio astronomy. Maybe our descendents will convince the government that this would be a worthwhile activity.

The participants in this conference were generally familiar with the basic discussions on the problem of interstellar communication which have been presented in a number of books during the last few years. Their discussion takes off from this level of familiarity. Thus, a prospective reader should also familiarize himself with one of these earlier books before trying to tackle this proceedings volume. Many of these are mentioned by the editor in his introduction. If the reader has done so, this book can provide a few stimulating hours of enjoyment.

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Introduction to the Physics of Electronics

M. F. Uman
416 pp. Prentice Hall, Englewood Cliffs, N.J., 1974. $16.95

The proliferation of solid-state devices in the last few years has left many electrical engineers concerned with device usage and circuitry gasping for breath. Although these engineers are quite knowledgeable in the use of these new devices for their specific application, the physical concepts behind them are not always well understood. This book, although written as a college text, is also designed with these users in mind.

M. F. Uman of the University of California, Davis, has done a commendable job in treating a complex and involved subject lucidly and interestingly. The opening chapter introduces nonlinear devices as circuit elements. This opening discussion and the examples given attempt to place in perspective the material in the remainder of the book. It also indicates why an understanding of the physical processes underlying the devices is important. However, in the total scheme of the book this chapter appears out of place and I felt it was put in more to whet the appetite than for any other reason.

The rest of the book proceeds logically through statistical mechanics, elements of quantum mechanics, the behavior of electrons in solids, semiconductor theory and then into the various classes of devices. Uman treats single-junction devices including rectifiers, microwave diodes and optical diodes, multijunction devices, field-effect devices and finally, integrated circuits.

At the end of each chapter are a number of questions relating to the chapter subject material. These questions are well chosen and range in difficulty from what a college freshman might do to some that would try the patience and competence of a professor—or so it seemed to me. Answers to perhaps half the questions are given at the back of the book.

The author states the book is aimed at undergraduate students who have had several years of introductory physics, specifically electromagnetics, thermodynamics and quantum mechanics. To cover the material adequately would appear to require two semesters. It would be a useful text for graduate students in physics or electrical engineering who are not majoring in this field.

As might be expected from a textbook, nearly all the references are books, rather than periodicals. This causes the book to lose some sense of immediacy. For example, in the charge-coupled devices discussion, why isn't the original work cited?

In summary, this book is certainly recommended for workers in the field of electronic devices and it would also appear to be a useful textbook.

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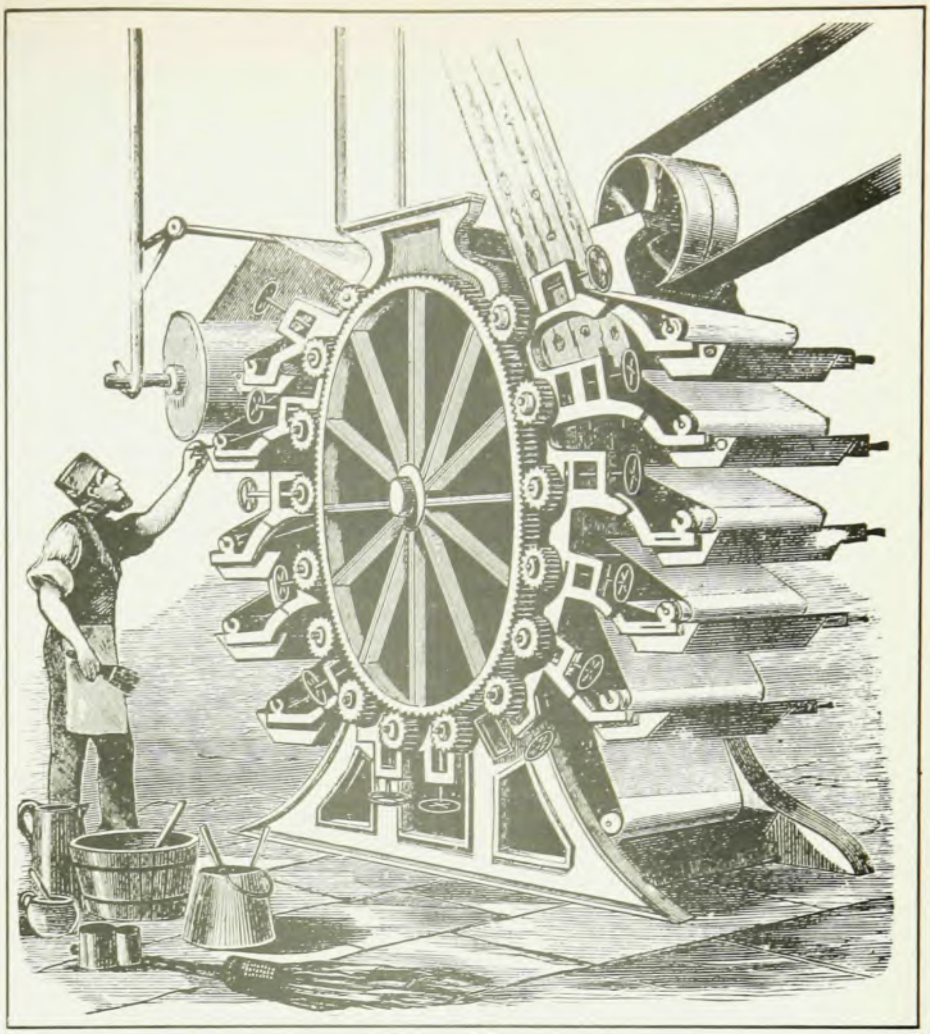

Physics for Technicians

Ernest Zebrowski Jr
585 pp. McGraw-Hill, New York, 1974. $10.95

The clarity of presentation and thought in this book is refreshing. The author, Ernest Zebrowski Jr, carefully uses dimensional analysis in the worked examples, and he reports units with the numerical answers (given for odd-numbered chapter problems). The English engineering and metric systems of units are used interchangeably. He adequately covers the major areas of physics of most use to technicians (force, torques, energy, fluids, sound, thermodynamics) in 28 of the 30 chapters. The material is both historical and current—the Carnot, Otto, Wankel and Diesel cycles are discussed in the chapter on heat engines. Two chapters on the perspectives of physics, four appendices and a good index make the book self-contained.

Zebrowski, however, does not cover accuracy, precision, statistical treatment of data and the nature of measurement. These topics are at least as important for the practicing technician as the basic principles of physics. It is the technician who makes the measurements: he must understand their relationship to the principles of physics. A treatment of the techniques of measurement and data handling in the same style as *Physics for Technicians* is needed. It is unfortunate that it was not included in this text.

Pedagogically, it is an interesting book. Zebrowski often leads the student in a way that the understanding reader catches on quickly, but the unwary student is admonished for taking too much for granted.

Overall, the text is well designed for its audience: the junior- and community-college student who wants to advance in a technician's career. It has been "student tested" by Zebrowski at the Community College of Beaver County, Pennsylvania.

Because of its clarity, this text is also recommended as a supplementary study guide for problem solving in advanced high-school and first-year-college physics courses.

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The Logical Analysis of Quantum Mechanics

Erhard Scheibe
204 pp. Pergamon Press, New York, 1973. $19.50

The logical analysis of quantum mechanics has generally been a subject of more interest to philosophers than physicists. Yet few in either field have had the technical competence in quantum physics, abstract mathematics, formal logic and the epistemological analysis of ontological issues to handle the complex of diverse problems involved. Erhard Scheibe seems to have mastered all of these fields and has raised the logical analysis of quantum