```
        AND NOW THERE ARE NONE LEFT IN
        THE BERTH.
17      SHIPIN(X) EQ 2   &20
        BERTH.X FROM FULL INTO PART
        GOTO 20
        IF SMALL SHIP IS LEAVING AND BERTH
        WAS PREVIOUSLY FULL, RECORD FACT
        THAT IT IS NOW ONLY PARTLY FULL
        IN EITHER CASE GO BACK TO SEE IF
        ANY MORE SHIPS ARE READY TO
        LEAVE THIS SAME BERTH
15      DUMMY
     DUMMY
     END

SECTOR ENDING
    THIS SECTOR IS CONCERNED WITH
    OUTPUT OF RESULTS
T.FINISH EQ 0
    WHICH IS TO BE DONE AFTER TIME
    HAS BEEN ADVANCED SO THAT T.
    FINISH HAS BECOME ZERO

THE REST OF THE SECTOR CONSISTS OF
OUTPUT STATEMENTS AND IS OMITTED.
STOP
END
```

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Book Reviews

Switching Theory, by R. E. Miller. Vol. I, *Combinational circuits*, 1965; 351 pages. Vol. II, *Sequential circuits and machines*, 1966; 250 pages. (London and New York: *John Wiley and Sons Ltd.*, 98s. and 87s.)

There exists considerable uncertainty in the computer design world as to whether switching theory is properly a pursuit for mathematicians or engineers. Although there are those, including the reviewer, who believe that too mathematical a motivation is a widespread fault in the literature of this subject, it is an undeniable fact that progress cannot be made in it without recourse to a considerable range of mathematical methods. Probably only one previous book (Caldwell, 1958, *Switching circuits and logical design*, Wiley) can fairly be claimed to have given a thorough treatment from a largely engineering standpoint, and so much new material has emerged since then that there was a definite need for a more up-to-date text. Dr. Miller's two volumes appear to satisfy that need to a great extent, and whilst couched in quite rigorous mathematical form, nevertheless display strong awareness of the engineer's requirements.

In his preface the author states that the books were written primarily for "advanced undergraduate and graduate study" and if this is so we in this country can only marvel at and admire the high standard of knowledge in this rather specialized corner of the electrical engineering field expected of even advanced undergraduates in America. These volumes, particularly the second, contain details of ideas and methods which have appeared in technical journals only during the past two or three years, and which can by no means be considered as completely developed.

Volume I on combinational circuits commences with a general discussion of digital systems, as a sort of *hors d'oeuvre*, which is the best of its kind the reviewer has seen. Chapter 2 develops the idea of abstract Boolean algebras and shows how such an algebra having only two elements relates to the requirements of switching circuits. It includes also a brief discussion relating Boolean algebra to group and lattice theory, a section on graphical and cubical function representation, one on some special groups of functions (symmetric, unate, threshold) and one on functional decomposition. This chapter also is admirable both in coverage and treatment. The remaining three chapters deal thoroughly with normal form design, multi-output and multi-level circuits and bilateral networks, respectively. There are one or two grounds for criticism in this volume; first is the complete omission of any serious consideration of the important NOR and NAND universal decision functions, round which most modern computers are designed; second is the almost exclusive use in Chapters 3 and 4 of the somewhat unfamiliar cubical representation of functions. All the known methods of representation and minimization of functions are fundamentally similar and share a common failing in that the visualization of functions of more than a few variables is extremely difficult. If anything the cubical representation is worse than others in this respect and apart from a few special concepts (*e.g.* that of linear separability of threshold functions) does not appear to offer any great compensating advantages over, for example, a purely algebraic approach. Dr. Miller's preoccupation with the cubical approach causes him to give only cursory attention to the widely used graphical (*e.g.* Karnaugh map) and tabular (Quine-McCluskey) procedures.

This volume contains a number of typographical errors, which are not serious, and a few mistakes and omissions sufficiently serious to cause temporary confusion. For example on page 33 the symbol x_o is suddenly redefined as a dividend after it has been used for three pages to mean the sign bit of a binary number. Again on pages 110 and 111, two partially ordered lattices are apparently upside down, since the vertices quoted as being least are in both cases at the top. A final example is on page 146, where ø is used without

(*Continued on p.* 166)

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Book Reviews (*Continued from p.* 143)

definition to indicate an empty set, the symbol having previously been widely used as a functional operator.

Volume II is the more valuable of the two providing, as it does, the first unification in book form of important developments in the analysis and synthesis of sequential machines which have appeared during the past ten years. The well-known Moore-Mealy model is explained in Chapter 6 (numbering continued from Vol. I) and used thereafter as a basis for discussion of state minimization techniques in Chapter 7, and state assignment in Chapter 8. Minimization techniques described are based upon the work of Mealy, Unger and Paull and also upon the author's own publications, whilst the chapter on assignment shows first how combinational logical expressions are obtained from a given assignment, continues with an elementary rule-of-thumb assignment method, and finishes with descriptions of the state-partition approach of Hartmanis and, more briefly, the mapping method of Armstrong.

Chapters 9 and 10 deal with asynchronous and speed-independent circuits, respectively, including a fairly full discussion of the principal hazards encountered and how to deal with them.

The partition theory of Hartmanis for state assignment is an indirect approach to the choice of efficient assignments, and Dr. Miller's very few words (page 112) on the motive for partitioning (reduced dependence) give no suggestion of the doubts which exist about the likelihood of achieving near-optimum designs of complex machines by this method. The more direct approach of Armstrong has the advantage, again not clearly indicated by the author, of providing programmable algorithms, a virtual necessity when dealing with multi-state machines.

The reader of this volume must be prepared to work through some extremely closely-reasoned and concisely expressed arguments, particularly relating to distinguishability and minimization. A general criticism of the volume as a whole is that the solid mass of theory is too rarely leavened by simple illustrative examples, a fault the reviewer has noted in many papers on this subject but which, if anything, Dr. Miller has carried to greater extremes.

To sum up, the two volumes, in spite of the above criticisms, form an extremely valuable addition to the existing books on switching theory, of which there are relatively few, and in particular can be recommended as complementary and supplementary to Caldwell. Two specially attractive features are the background notes provided with each chapter as guides to the excellent reference lists, and the numerous exercises.

G. H. STEARMAN

Programming, Games and Transportation Networks, by Claude Berge and A. Ghouila-Houri, 1965; 248 pages. (London: *Methuen and Co. Ltd.*, 55s.)

This book is concerned with an underlying theory of many mathematical programming problems. The authors have divided their book into two parts which cover the general theory of convex programming and Problems of Transportation and Potential.

In the first part the convex programming problem of maximizing a concave function of variables which are restricted by linear inequalities is considered. Ideas of set theory and vector space are developed and used to determine properties of n-dimensional Euclidean space and convex sets. The theory of various programming problems is described but the computational algorithm is not given in any detail. A final chapter in this part deals with zero-sum two-person games.

The second part of the book draws together a number of problems in the areas of mathematical programming, classical mathematics, *e.g.* dissecting a rectangle into n different squares, electric circuits and logical pastimes, *e.g.* maze problems. This half of the book is concerned with describing problems as examples of graph theory and for many of them a step procedure is found. The description of the problems and solutions usually outlines the existing method and then shows how it may be applied or adapted to graph theory. The theory of graphs is very fully developed for planar and non-planar graphs and for flows on a graph. It is unlikely that a programmer will find in this book sufficient detail of the algorithms to enable a computer program to be written.

The treatment of problems is, however, very complete and their theoretical background is fully discussed and referenced. The book will provide an excellent reference to a theoretician and to the practical worker who wishes to (*a*) understand the proofs, (*b*) have available a bibliography which describes the principal results and methods and (*c*) requires a source which guides him in the development of a method for a new problem. The great strength of the book lies in the last feature. It is possible to obtain a thorough grounding in the ideas of set theory and of graph theory, and the very large number of illustrative examples will simplify the task of designing new solutions.

K. B. HALEY

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