Computers, by G. R. Stibitz, 2 pp., 12/24/47. Operating Characteristics of the Aberdeen Machines, by F. L. Alt, 2 pp., 12/29/47. Reduction of Doppler Observations, by Dorrit Hoffleit, 1 p., 1/11/48 (see MTAC, v. 3, p. 373–377) General Principles of Coding with Applications to the ENIAC, by J. von Neumann, 1 p., 1/17/48. Adaptation of the ENIAC to von Neumann's Coding Technique, by R. F. Clippinger, 2 pp., 3/15/48. Census Applications for High-Speed Computing Machines, by J. L. McPherson, 1 p., 3/30/48 (see MTAC, v. 3, p. 121–126). The Raytheon Computer, by R. V. D. Campbell, 2 pp., 4/6/48.

Naval Research Lab., Washington D. C.—On 17 Nov. 1948, Prof. H. H. Aiken, of the Harvard University Computation Laboratory, discussed design features and operational characteristics of the Mark I, II, and III relay computers. The discussion was supplemented with slides.

The first two computers were developed at Harvard University under the leadership of Prof. Aiken and have been placed in service—the Mark I at Harvard and the Mark II at the Naval Proving Ground, Dahlgren, Va. Up to the present time they have performed with excellent reliability (the Mark I has averaged 60 to 75% successful operation and in some cases as high as 95%, and the Mark II has averaged about 85%). A comparison of the operation speeds of the two machines was given as follows:

	Mark I (23 dig. nos.)	Mark II (10 dig. nos.)
Multiplication	5 seconds	750 milliseconds
Addition	300 milliseconds	200 milliseconds

In addition it was pointed out that the Mark II machine could be mathematically cut in half (a valuable facility in the case where trajectories, arising so frequently in the work at Dahlgren, are to be handled).

The talk was highlighted by a discussion of the Mark III calculator, now being developed by Professor Aiken's group. It is expected that this machine will also be available for operation at Dahlgren, by June 1949. The fundamental components of the machine, like those of the Mark II, are the latch, the 2-coil, and the 3-coil relays. It will use a magnetic drum memory and will have a memory capacity of approximately 4000 16-digit-numbers. Magnetic tape is to be used in the eight input-output tape mechanisms. The addition and multiplication times quoted for the Mark III were 4 milliseconds and 12.5 milliseconds, respectively.

Although the machine operation speeds mentioned are comparatively small, Prof. Aiken believes that they are sufficiently fast until more is learned about numerical methods to be used in problem programing. In the opinion of the speaker, one should strive for more expedient problem preparation techniques rather than for increased speed in the machine.

Office of Naval Res., Washington, D. C.—On 15 Dec. 1948, an interesting and informative lecture (with slides) on the Mark II Calculator was given by Dr. C. C. Bramble, director of Computation and Ballistics, NPG, Dahlgren, Va. The speech paralleled that of Prof. Aiken, although Dr. Bramble presented a more detailed description of many of the machine design features and a step-by-step explanation of a particular coding routine which had been used on the machine.

Errata.—*MTAC*, v. 3, p. 216, l. 8, *for* both of King's College, *read* respectively of Birbeck College Res. Labs., and The British Rubber Producers' Res. Labs.

OTHER AIDS TO COMPUTATION

Bibliography Z–VII

1. J. R. Bothel, "Slide Rule easily made for converting ram to sample pressures," *Chem. Engin.*, v. 55, Sept. 1948, p. 125–126. 21 × 28.5 cm.

In the use of hydraulic presses for different materials or under various pressure conditions, it is necessary to convert the pressure on the rams to pressure on the sample.

2. EDWIN A. GOLDBERG, "Details of the simultaneous equation solver," *RCA Review*, v. 9, Sept. 1948, p. 394–405, 14.6 × 22.5 cm.

"An electronic device for solving systems of linear simultaneous equations such as those encountered in circuit analysis work, quantitative chemical analysis, and a wide range of physical problems is described in this paper. Emphasis is placed on the actual electrical design employed in the execution of a practical model and the operation of the device is considered." See also *MTAC*, v. 3, p. 329–330, Bibl. Z–V, 2.

3. ARTHUR C. HARDY & EDWARD C. DENCH, "An electronic method for solving simultaneous equations," Optical Soc. Amer., *Jn.*, v. 38, 1948, p. 308–312. 19.6 × 26.6 cm. See *Math. Revs.*, v. 9, 1948, p. 535.

4. LO-HO, "Construction of alignment nomogram from empirical data," Franklin Inst., *Jn.*, v. 245, 1948, p. 227–244. 16 × 24.2 cm. See *Math. Revs.*, v. 10, p. 621 (R. CHURCH).

5. CARL P. NACHOD, "Nomograph for the square root of the sum of squares," *Product Engin.*, v. 19, Nov. 1948, p. 155. 21 × 28.4 cm.

6. F. K. RUBBERT, "Zur Radizierung mit der Rechenmaschine," *Z. angew. Math.*, v. 28, June 1948, p. 190–191. 20.8 × 29.4 cm.

7. RUFUS F. STROHM & ARCHIBALD DEGROOT, *The Slide Rule. How to Use It.* Second ed. Scranton, Pa., International Textbook Co., 1948, viii, 95 p. 13 × 21 cm. First ed., 1939.

Extract from Preface: "No attempt has been made to show all the various forms of slide rules or to explain all the ways in which they may be used. However, the fundamental principles underlying the operation of the types of slide rules that are in common use are explained fully, and a person who knows how to operate these types will have no difficulty in learning how to use a slide rule intended for a special purpose."

"Slide rules with folded scales and log log scales," p. 68–84.

8. ANTONÍN SVOBODA, *Computing Mechanisms and Linkages, edited by* HUBERT M. JAMES. Office of Scientific Research and Development, National Defense Research Committee. (M.I.T. *Radiation Lab. Series*, no. 27), New York, McGraw-Hill, 1948, xii, 359 p. + plate in pocket. 15.1 × 22.7 cm. $4.50.

This book deals specifically with the analytical design of bar-linkage elements for continuously acting computing mechanisms. Bar linkages have many advantages in this application, particularly with respect to compactness and cost. They are limited somewhat in the field of functions covered and in inherent structural error. If an inherent error of not over 0.3% is tolerable, it is relatively easy to design a linkage computer; to reduce the error below 0.1% is relatively difficult. The author presents extensive numerical tables and an intersection nomogram (in the pocket) to aid in the design of practical slider-crank and "three-bar" linkages, which singly or in combination may be used to generate the functional relation between two variables within given tolerances. The author also presents a design procedure for developing star linkages to generate functions of three variables. The detailed mathematical design is usually difficult and laborious. Practical mechanisms rarely fit exactly the function to be mechanized; in order to obtain the desired degree of fit between generated and given functions, it becomes necessary to adjust a number of linkage parameters by a method of successive approximations. The author has rendered a distinct service in setting up rational design procedures and in removing much of the drudgery involved in developing preliminary approximations. He has obviously taken great pains to present clearly and concisely a subject in which confusion and misdirected effort might easily attend the inexperienced designer. The book is exceptionally well written; the material is logically and harmoniously developed. Designs are carried out for each type of mechanization considered.

There are ten chapters and two appendices in the book. The intersection nomogram for designing three-bar linkages is inserted in the back cover. In Appendix B (p. 333–352) the author has tables from which an enlarged nomogram may be constructed for design purposes.

A brief review of standard continuous computing elements in Chapter 1 is followed in Chapter 2 with a brief survey of bar-linkage computing elements, including harmonic transformers (slider-crank mechanisms), the more versatile three-bar linkage, bar-linkage adders, bar-linkage multipliers and dividers, and combinations of these elements for solving any problem that can be expressed in a system of equations involving only these operations. Chapter 3 defines the terminology to be used for linkage parameters and for the related variables.

Chapter 4 discusses in considerable detail the use of harmonic transformers for mechanizing over a limited range functions which are sinusoidal or approximately sinusoidal. The ideal harmonic transformer (infinitely long connecting link) serves as the starting point for the design of a nonideal (finite) harmonic transformer. Use is made of the tables in Appendix A (p. 301–332) for a rapid determination of the ideal transformer and for a rapid evaluation of the structural error involved in going to the nonideal transformer.

Chapter 5 discusses the design of three-bar linkage computing elements. It illustrates thirty-two curve classifications generated by such linkages. The relations between crank positions and the geometrical properties of the linkage are incorporated in an intersection nomogram. This serves as a powerful tool in designing linkages to mechanize given functions when it is possible to preassign values for two of the design constants. The author also develops a geometric method for designing linkages in the rare case that only one design constant can be preassigned.

Only rarely can one mechanize a given function with high accuracy by means of individual elements. Chapter 6 discusses combinations of elements. The nonideal double transformer has seven adjustable parameters as against five for the three-bar linkage and four for the nonideal single transformer. If a three-bar linkage is interposed between two transformers, the number of adjustable parameters becomes twelve. The double three-bar linkage is governed by nine parameters. Such combinations obviously can mechanize satisfactorily a much greater field of functions.

Chapter 7 discusses the final adjustment of linkage constants. The accuracy of the graphical methods hitherto discussed is limited; when high accuracy is required the final adjustment must be carried out by numerical methods. The generated function is made to fit a predetermined set of precision points analytically. Adding eccentric linkages serves to increase the number of adjustable parameters and hence precision points.

A function of three variables may be represented by a grid structure consisting of three families of curves such that a curve of each family passes through every point of intersection. Chapters 8, 9 and 10 discuss the mechanization of such a grid structure. The basic idea is to make use of a topological transformation which transforms the given grid structure into a form which suggests a satisfactory mechanical form of grid generator. The star linkage is a satisfactory grid generator.

Any functional relation that can be generated by a star linkage can also be represented by an intersection nomogram consisting of three families of circles. Consequently the desired transformation should carry the given grid structure into this form, or into one closely approximating it in a limited region. Final adjustment of the constants is carried out analytically as in the other linkages.

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