chapter describes an alternative recording method, using the discharges of a spark chamber to set ferrite cores which can then be read conventionally. The second chapter tells of some uses of small computers to acquire and analyze experimental data.

The contributions are as follows.

"Automatic Retrieval Spark Chambers," by J. Bounin, R. H. Miller, and M. J. Neumann.

"Computer-Based Data Analysis Systems," by Robert Clark and W. F. Miller.

"Programming for the PEPR System," by P. L. Bastien, T. L. Watts, R. K. Yamamoto, M. Alston, A. H. Rosenfeld, F. T. Solmitz, and H. D. Taft.

"A System for the Analysis of Bubble Chamber Film Based upon the Scanning and Measuring Projector (SMP)," Robert I. Hulsizer, John H. Munson, and James M. Snyder.

"A Software Approach to the Automatic Scanning of Digitized Bubble Chamber Photographs," Robert B. Marr and George Rabinowitz.

This volume is a valuable documentation of the efforts of the authors. Even those who do not know what PEPR means may find that it and other techniques described here may have other applications (Precision Encoder and Pattern Recognition).

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71[P, W, X].—WILLIAM R. SMYTHE, JR. & LYNWOOD A. JOHNSON, *Introduction to Linear Programming, with Applications*, Prentice-Hall, Englewood Cliffs, N. J., 1966, xiii + 219 pp. 24 cm. Price $7.50.

This is an extremely well written introduction to linear programming and its business applications. Of the many textbooks dealing with this subject which are now available, this is certainly one of the clearest expositions which this reviewer has read. Although it requires very little mathematical background on the part of the reader, it is remarkably thorough in its coverage and includes discussions of degeneracy, finding initial solutions and other similar areas sometimes omitted in a first course. It is highly recommended as a text for a one-semester course.

Since computers have played such a large part in the development of the applications of linear programming, it is a little disappointing to find the use of computers completely ignored in this text. Instead, the authors dwell on tableaus and detailed calculations with them. It would have been preferable to change to computer programs about halfway through the text and relieve the reader from the tedium of numerical calculations. This would also have opened the possibility of discussing much more realistic applications.

Chapter 1 contains an excellent geometrical introduction to linear programming in two dimensions. All of the possibilities such as an unbounded constraint set with a finite solution, infinitely many solutions, and the like are covered in a logical, coherent way.

Chapter 2 is an introduction to linear algebra including matrices, vectors, linear dependence, rank, etc. Indeed, the reader will have an algorithm for determining

the rank of a matrix after he has completed this chapter. This is in distinct contrast to most introductions to matrices where rank is defined and used in subsequent developments without giving the reader any method by which he can find the rank. With all of this elegance, however, it is rather surprising to find the transpose of a matrix conspicuous by its absence. The authors use row and column vectors interchangeably, and the use of the transpose would have made for less ambiguity in places.

Chapter 3 develops the simplex method first from a purely algebraic point of view. The geometrical ideas are discussed later in that same chapter. Problems of convergence are treated quite carefully and the appropriate theorems are proved rigorously.

Chapter 4 discusses network problems and includes the important max-flow, min-cut theorem. This chapter closes with a discussion of the transshipment and transportation problems.

Chapter 5 covers applications including the caterer problem, the cutting stock or trim problem (noninteger version), blending problems, production planning and distribution problems. It is somewhat of a disappointment not to find any engineering applications.

There are a few other minor criticisms which this reviewer had. (1) Duality is buried in Section 4-4 on the transportation problem and is discussed in a rather cursory way. Such an important idea deserves better treatment. (2) The authors never point out that a minimization problem can be changed to a maximization problem by changing the sign of the objective function. Omitting this observation keeps them concerned about whether the problem is a maximization one or a minimization one and forces them to consider two separate cases at several points. (3) The authors define a standard linear programming problem, but never say why that particular form is "standard." The observant reader will draw his own conclusions, but he could have been saved some worry with a sentence or two. (4) Early in the text (p. 5) the set of points satisfying $x_2 \leqq mx_1 + b$ is said to be those points lying on or below the line $x_2 = mx_1 + b$. The choice of the word below is unfortunate. If m is very large, it may be difficult to decide which half-plane is below the line. (5) When treating unrestricted variables, the authors make the standard substitution of $x_j = y_{2j-1} - y_{2j}$ where the $y_i \geqq 0$. However, they do not point out that this produces two columns in the tableau which are identical except for sign and the final entry. This observation can be used to reduce the number of columns which need to be carried, and hence computed, at every stage.

The work is remarkably free of typographical errors. The only one which this reviewer noticed occurred on p. 101, where the fourth line of the proof should read "Lemma 2" rather than "Theorem 2."

All in all, the criticisms raised here are of a rather carping nature and are really rather minor compared with all of the excellent features of this book. It will be difficult to improve upon this treatment of the subject. It should please both mathematicians and engineers.

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