Book Reviews

Two-way radio. Samuel Freedman. Chicago–New York: Ziff-Davis, 1946. Pp. xxii + 506. (Illustrated.) $5.00.

This book treats of systems for two-way radio—that is, of systems for communicating between a fixed station and a mobile unit or between two mobile units. For this purpose both a transmitter and a receiver are necessary at each point.

The purpose of the book is to make clear the considerations which determine the choice of any particular system and to describe the necessary apparatus and its installation. The long experience of the author in microwave development and in the development of systems for ship and submarine communication and for police patrol enables him to speak with authority on the solution of such problems.

The book is not intended as a text on communications theory. Some small space, it is true, is devoted to an introduction to electric circuit theory and the propagation of electric waves, but the treatment is necessarily somewhat superficial. An occasional electronic circuit diagram appears, but no attempt is made to analyze its parts or to discuss its operation. The scope of the book is essentially general and descriptive, and the treatment of the central theme is thorough and masterly.

In the earlier chapters attention is paid to available power sources, types of antennae, and details of apparatus, both at the fixed and the mobile station. Chapters follow which deal clearly and exhaustively with the relative advantages and limitations of amplitude modulation, frequency modulation, induction and guided carrier systems, and possible future applications of microwaves to two-way radio. These chapters are particularly well done.

More than a hundred pages of the book are on two-way radio for railroads. In this discussion, considerable attention is paid to the arguments for and against the adoption of radio in place of visual signals. The author makes a strong case for radio as a supplementary and powerful auxiliary to the visual signal system, and considers at length the choice of radio systems applicable to the various complex problems of railroad operation.

The remaining shorter chapters on police, fire, and forestry systems, highway and public transport services, and marine and aeronautical applications deal with the special problems inherent in these services and not previously covered.

The book is well furnished with cuts of commercial apparatus and pictures of actual installations. The commercial aspects are not, however, unduly emphasized.

This is a mine of detailed information and should prove of value, not only as an aid in planning new projects but in furthering the application of radio in fields where its usefulness is just beginning to be appreciated.

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Sequential analysis of statistical data: applications. (Prepared by Statistical Research Group, Columbia Univ., for Applied Mathematics Panel, NDRC.) New York: Columbia Univ. Press, 1945. 6 sections & appendices. $6.25.

The procedure of sequential analysis is as follows: An item is drawn from the lot to be inspected, and it is inspected; on the basis of the evidence of the sample of one, (a) the lot is accepted, (b) the lot is rejected, or (c) the evidence is found to be insufficient for either decision. If decision (c) is reached, a second item is drawn and inspected, and on the basis of the sample, now of two items, the same three possible decisions are considered. This procedure is followed until the evidence of the sample is sufficient to warrant (a) or (b). Thus, inspection is continued until the cumulated evidence is sufficiently strong, one way or the other, for the inspector to call the lot acceptable or unacceptable. "Sufficiently strong" is made determinant by specifying acceptable risks of making incorrect decisions.

By this procedure, conspicuously good lots are quickly accepted, conspicuously bad lots are quickly rejected, and extensive inspection is needed chiefly by lots of doubtful quality, greatly increasing thereby the efficiency, and reducing the cost, of acceptance inspection. Mathematical analysis indicates that sequential analysis may yield a savings frequently greater than 50 per cent.

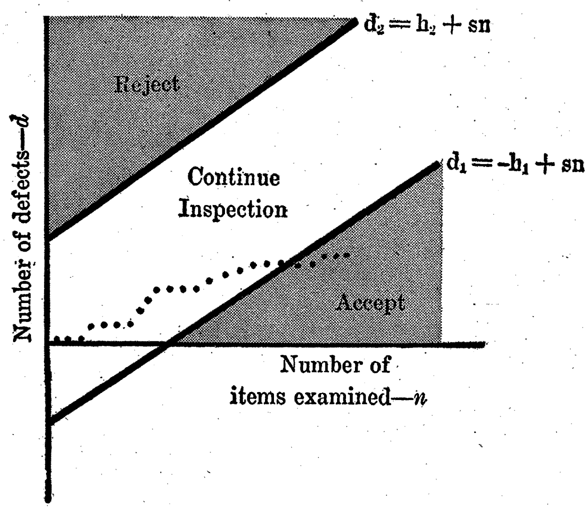
These studies make fascinating reading for those who have not been permitted, because of wartime secrecy, to follow the new developments in sequential analysis that occurred during the War. A beguiling and stimulating procedure has been devised that would seem to guarantee exciting vistas as one contemplates possible applications of great practical importance, such applications already having been extensively made by the various branches of the armed forces. The same procedure, modified to suit the problem, can be applied to reduce the cost of sampling analysis in connection with experimental work, presumably both in agriculture and in industry; and it can be applied to a series of multiple samples as well as to a sequence of observations.

While considerable mathematical patience is required to comprehend rigorous demonstration of the procedure, the intuitive explanation can be grasped by anyone trained in the fundamentals of the modern theory of sampling.

The procedure devised is such that a table can be drawn up; or an acceptance inspection chart, almost identical in form for a variety of problems, can be set up as a standard procedure. This chart is as simple in form and as broad in application as the widely used quality-control chart.

When this chart has been constructed, the procedure consists simply of the sequential plotting against n (number of items examined) of the number of defects observed, d, for which the vertical scale is used. This

Acceptance Inspection Chart



is continued until the plotted line runs either into the area of acceptance or into that of rejection. The dotted line in the figure shows how a set of results would lead, for example, to acceptance.

The equations for the two lines that mark the margins of acceptance and of rejection are derived from the following set of inequalities:

$$\text{B.14} \qquad \frac{p_2^d(1-p_2)^{n-d}}{p_1^d(1-p_1)^{n-d}} \begin{cases} \geqq A & \text{Accept } p=p_2 \\ \leqq B & \text{Accept } p=p_1 \\ < A \text{ and } > B & \text{reserve judgment, take additional observation} \end{cases}$$

By taking logarithms, this becomes

$$\text{B.15} \qquad d \log \frac{p_2}{p_1} - (n-d) \log \frac{1-p_1}{1-p_2} \begin{cases} \geqq a \\ \leqq b \\ < a \text{ and } > -b \end{cases}$$

in which $a = \log A$ and $b = \log B$.

From the first inequality in B.15, the marginal line is obtained by $d_1 = -h_1 + sn$; from the second inequality in B.15, the marginal line is obtained by $d_2 = h_2 + sn$. In these, s, h_1, and h_2 are parameters dependent on p_1, p_2, α and β.

In the inequalities, A and B (for which a and b are the logarithms) are so determined that, if H_1 is true, the probability will be α, or less, that H_2 will be accepted; and so that, if H_2 is true, the probability will be β, or less, that H_1 will be accepted. Thus, whenever H_2 is accepted, $p_2 \geqq Ap_1$ and the total probability of obtaining a sample that will lead to the acceptance of H_2 is at least A times as large when H_2 is true as when

H_1 is true. Now α is by definition the probability of accepting H_2 when H_1 is true; and $1-\beta$ is, by definition of β, the probability of accepting H_2 when H_2 is true. Thus, A must be so set that $1-\beta \geqq A\alpha$. From this the approximation follows that $A \doteq \frac{1-\beta}{\alpha}$. (An exact analysis of the discontinuities would permit a slightly smaller a; the use of a somewhat too large a has the effect of reducing the risks of error slightly below α and β.) By a similar line of reasoning, $B \doteq \frac{\beta}{1-\alpha}$, so that $a \doteq \log \frac{1-\beta}{\alpha}$ and $b \doteq \log \frac{\beta}{1-\alpha}$.

Tables are provided for obtaining values of a and b for selected values of α and β ranging from .001 to .40 Tables are also provided for finding the values of s, h_1, and h_2; these values can also be found by using the nomographs devised for that purpose. They are determined by the values of α, β, p_1 and p_2, which are fixed for the problem in hand. The acceptable quality limit is p_1; the unacceptable quality limit is p_2; α is the maximum risk or probability of rejecting lots of quality p_1 or better; and β is the maximum risk or probability of accepting lots of quality p_2 or worse.

Three other tools of analysis are supplied in the procedure: the operating characteristic (OC) curve, the average outgoing quality (AOQ) curve, and the average sample number (ASN) curve. The OC curve shows the relationship between the probability of accepting a lot and the true quality (fraction defective) of the lot. For most sampling plans it is unnecessary to construct these curves; but it is important to compute the average sample number for $p = p_1$ and $p = p_2$. Thus, in one of the problems illustrated the authors found $\bar{n}_{p_1} = 63$ and $\bar{n}_{p_2} = 61$. It could be assumed from these values that on the average the decision to accept or reject would be reached by the time 61–63 observations had been made. In the problem illustrated the decision was reached at the fifty-third observation. Being able to tell in advance approximately how large a sequential number of observations will be required to reach a decision is certainly an important advantage of the method.

Criticism is rampant on the question of acceptance sampling, but for the most part it deals with the validity of the tests, the relationship of the test to expected performance, the randomness of the samples, etc. However fine a method of analysis may be, it will remain impractical unless the data analyzed are suitable and in conformance with the assumptions involved in the method. Nevertheless, that criticism cannot detract from the importance of the contribution made by those who have developed the method of sequential analysis. The method is neatly and ingeniously contrived, and it is surprisingly simple in application as far as the primary requirements of any particular problem are concerned.

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War on Weeds

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