STATISTICAL PREDICTION WITH SPECIAL REFERENCE TO THE PROBLEM OF TOLERANCE LIMITS[1]

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1. Introduction. Statistical methodology is becoming recognized in industry as an effective tool for dealing with certain problems of inspection and quality control in mass production. Quality control experts have found statistical methods useful in detecting excessive variation in a given quality characteristic of a product from a series of observations on the given quality characteristic, and in isolating the causes of such variations back in the materials or operations involved in manufacturing the product. By a process of successive detection and elimination of causes of variability, a *controlled state of quality* is established. A practical statistical procedure for establishing a controlled state of quality has been developed by Shewhart.[2] More recently, manuals for routine application of this procedure have been issued by the American Standards Association.[3]

In this paper we do not propose to go into a discussion of the application of the well known Shewhart procedure. The reader may refer to the literature mentioned in footnotes 2 and 3 for such discussion. It is sufficient to remark that experience shows that the application of this procedure leads to a controlled state of quality. Such a state of control provides a basis for making statistical predictions about measurements on the given quality characteristic in future production.

More specifically, suppose a given quality characteristic of a given product is measured by a variable X, such that X has a specific value for each individual product-piece. For example, the product may be a given type of fuse and X may be the blowing time in seconds. A product-piece would be a single fuse, and X would take on a value for each fuse. Thus, for a sequence of n fuses taken from the production line, there would be a corresponding sequence of values of X, say $X_1, X_2, \cdots X_n$. If a state of control has been established with respect to blowing time as measured by X, then the sequence of values of X will "behave like a random sequence." By this we mean that the sequence will be such that we can safely assume that it can be described mathematically by regarding X as a *continuous random variable*, i.e., such that there exists some

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[1] An expository paper presented at a joint session of the American Mathematical Society and the Institute of Mathematical Statistics at Poughkeepsie, September 9, 1942.

[2] W. A. Shewhart, *Control of Quality of Manufactured Product*, D. Van Nostrand Company, New York, 1931.

[3] *Guide for Quality Control and Control Chart Method of Analyzing Data (1941)*, and *Control Chart Method of Controlling Quality During Production (1942)*, American Standards Association, New York.