

THREE CONCEPTS OF QUALITY CONTROL

We may distinguish at least three concepts of quality control in the literature and underlying practice. The simple statement that the quality of product is controlled may have at least three distinctly different interpretations depending upon which concept is implied. Considerable confusion often exists because of a failure to differentiate between these concepts in writing and talking. Clear thinking demands such a differentiation.

Operation of Control

We start with a discussion of the concept of quality control as an operation. Ask any manufacturer today if he controls the quality of his product and you can rest assured that he will answer with an emphatic "Yes". He may tell you about his research department that keeps abreast of that part of scientific progress bearing on his problems, of the work of his design and development engineers which is boiled down by them to a practical specification of the quality requirements of raw materials and finished parts and of the work of the purchasing department in securing the best materials at the least cost. He may even invite you to go with him on a tour of inspection of his production plant where he will point out, among other things, devices of many kinds, some automatic and others not, to control such characteristics of the production process as temperature, humidity, and a host of others; he may show you various testing or inspection groups stationed at strategic points in the production process and busily engaged in gauging and measuring to a gnat's eyebrow certain quality characteristics of piece parts and partial assemblies, rejecting the bad and passing the good. He may then show you the operation of final assembly of the parts and partial assemblies which have passed the various stages of inspection. From this it would seem that what a producer means by the statement that his quality is controlled may be simply that he employs some specific operation of control.

Control of Verifiable Quality

Granting that every manufacturer controls the quality of his product in the sense that he practices a more or less definite operation of control, as a consumer I am interested in knowing if all the processes produce the same results. It is by the fruits that the consumer judges the operation of quality control. In other words, it is not so much what the producer does in controlling the quality of product

as it is what he accomplishes thereby that is of interest to the consumer. Quality of a piece of product just turned out by the production process from this viewpoint is always something yet to be experienced, something that is of interest to someone and something that the user or consumer of the piece of product expects to experience if he uses the piece of product in a given way. In other words, quality of a thing in this sense is something to be verified as a result of some definite operation.

What then does it mean to say that quality is controlled in this sense? Obviously such a statement is a prediction which may or may not be verified. It can have definite verifiable meaning only in so far as the operation of verification,  $S_q$  let us say, is definite. Such a prediction is probable only and the degree of probability  $p'_b$  depends upon the evidence  $E$  made the basis of the prediction. To the consumer the degree of belief  $p'_b$  which he may rationally entertain in the prediction is of outstanding significance. The fact that a producer has carried out a certain operation of control in the production of the particular piece of product is likely to be considered insufficient for the consumer as evidence in itself that the prediction will be verified. Hence for such a statement to be definite, both from the viewpoint of verifiability and the degree of belief with which it should be entertained, it is necessary not only that the operation of verification  $S_q$  be definite but also that for each such statement there be associated a definite amount of evidence  $E$ .

#### State of Control

In the first place, any statement about control implying a prediction must rest upon some assumption as to the existence in nature of a state of causal relationship between events making prediction possible in the statistical sense. In the second place, there is the question which may be raised in comparing operations of control as to whether or not control has proceeded to the limit we can hope to go. From both of these viewpoints the concept of the existence of a state of statistical control<sup>1</sup> is vital, because 1) it is a state admitting of rational prediction, and 2) it is a limiting state to which it is believed feasible to go.

The statement that the product is controlled may imply that the one who makes it believes that he has attained a state of control of the production process such that observed variations in the specified quality characteristics are the result of a constant system of unknown chance causes so that statistical prediction is possible.

1. Cf. Q. M. 1.

ble. In other words, it may imply that the one making the statement believes that he has removed all assignable<sup>1</sup> or findable causes of variability in his operation of control of the given set of quality characteristics or that he is able to repeat the operation of control "under the same essential conditions" at will.

Such a statement is a probable inference as is the one of the previous section. It differs from the latter, however, in that it is in terms of "causes" which cannot be observed and hence cannot be verified. In the same way one cannot verify Newton's first law of motion that force  $f$  equals mass  $m$  times acceleration  $a$ , or that  $f=ma$ . All that one can say is that such an equation has served to correlate more or less satisfactorily certain observed quantities or pointer readings called  $f$  with the product of others called  $m$  and  $a$ . Nevertheless, this law, together with the other two, plays a very important role in physical science. In fact, such concepts of abstract states of causal relationship serve as the constructs upon which we hang the observables of nature. They may or may not be real and they cannot be observed but they do and must guide our thinking.

#### Conclusion

The simple statement that the quality of product is controlled may have any one of the three following interpretations depending upon the concept of control that is implied: 1) It may simply refer to a specific operation of control, 2) it may amount to a prediction about the quality of a thing as it may be experienced in the future, and 3) it may signify the belief that a state of statistical control in the causes of variation in quality has been attained. In the first sense it is a statement about something that has been verified, in the second sense it is a statement about something yet to be verified, and in the third sense it is a statement that cannot be verified in an experimental sense.

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1. Cf. Economic Control of Quality of Manufactured Product by W. A. Shewhart

