

standards scientific management could not exist as, without maintenance, there could be no standards, and standards are the foundation of scientific management.

To the worker the establishment and maintenance of standards in a shop means that the relations between management and men are likely to be good, as an important cause of disputes is removed. This is especially true if the worker is operating on piece work or an incentive system of wage payment.

Low-grade materials, lack of well-defined standards of quality, machines which are out of adjustment, poor working conditions, incentives based on standards which are not maintained, cause no end of ill feeling between the men and the management.

One cannot overstress the importance of constant vigilance in the maintenance of standards. Standards without maintenance are soon no standards at all, and their existence in the organization may prove most dangerous from the standpoint of shop operation and plant morale. L. C. Bryant in "Scientific Management in American Industry"¹² well stated the importance of the maintenance of standards when he said:

Factory operation standards are of value only as long as they are maintained. It is a human characteristic to follow the line of least resistance and be satisfied with something slightly poorer than the best, and if this characteristic is allowed to act there will be a sloughing off in the quality of standards. With the fall of the standards comes a similar decline in accomplishment and personal responsibility. The cycle repeats itself until the condition of the standards reaches a level slightly lower than the desires of the man in a rut. Eternal vigilance is required to maintain standards.

There can be little doubt but that importance of the maintenance of standards is recognized more at the present time than at any time in the past, and that with the development of scientific management in the future even more attention will be directed to this important phase of management.

Discussion

Henry Post Dutton.¹³ Mr. Karabasz' subject is a broad one and he has been wise to limit himself to two or three examples and to give specific data on those. The subject of maintenance of standards covers practically all fields of management, for every order is at least a temporary standard, and

¹²P. 226.

¹³Professor of Factory Management, Northwestern University, Chicago, Ill.

seeing that an order is properly carried out is a case of maintenance of standards.

Mr. Gates in his paper last night, I thought, brought out a point which also appears in this morning's papers. A standard may be thought of in two parts, which are supplementary. The real standard is, in most cases of performance at least, a habit which the members of an organization have perfected. After this habit is formed, maintenance of the standard is the passing on of the habit to new men as the personnel shifts, and the prevention of a drift from the standard which might result from forgetfulness or poor workmanship. Written procedures are a necessity because of the impermanence of a working force and the fallibility of human memory.

Human memory is particularly uncertain where the performance required is repeated intermittently rather than constantly, as in the case of maintenance inspection. Where the thought stream flows continually in a single channel there is a certain tendency to variation, but in the main the performance is relegated to the habitual, only half-conscious levels of thought. Where performance is occasional it depends wholly on memory. A great deal of effort is saved if the reminders for such performance are made automatic, as they are by a tickler file or set program. It is even better to make the regulation wholly automatic where this is possible, as by the self-replacing lamps used on flying fields, automatic temperature controls, relay switches and the like.

I would like to add one point to Mr. Karabasz' excellent discussion. Perhaps it applies more to the setting than to the maintenance of standards, but it is one of those points in which the setting of the standard will be influenced by the problem of maintenance. This point is the setting of tolerances.

We can lay it down as a general rule that for any mechanism to function, its parts must conform with a degree of variation not in excess of a certain critical value. If you take an ordinary pencil or pen cap, which is held in place by friction, there will be an upper limit of size beyond which the cap will be too loose to stay on, and a lower limit below which it will be too tight to go on. This much is elementary.

We can usually say further that the closer the tolerances beyond these critical limits, the better

the service given. One of the principal differences between good cars and cheap ones is presumed to be the finer workmanship, the closer and finer fit of bearing surfaces which eliminates vibration and wear.

It is also generally true that the permissible tolerance tends to bear a fixed ratio to size, rather than remain a constant quantity as size increases. In the field of psychology this relationship is known as Weber's Law, which is that the least perceptible difference between quantities tends to bear a fixed ratio to the quantity. An extension of this principle gives us the preferred number series, which makes each step in a series of sizes, as of tools, lots, coins, etc., bear a constant ratio to the next smaller size. This relationship is found practicable because the fitting of a stepped series of sizes to a natural series which is usually continuous, involves an application of the principle of tolerances.

Now, to produce an article mechanically involves the simultaneous application of a good many forces, and these forces are constantly varying slightly. The tool never cuts twice the same, for it wears slightly with each cut. Other forces enter in, making all sorts of combinations possible, just as natural series, the height of people, for instance, vary continually.

If, however, these forces are of constant tendency, the results tend to vary around a normal point, and the variations in product will be less frequent as the number of units is greater. This will give the well-known bell-shaped curve of probability. (Figure 3, a and a' .)

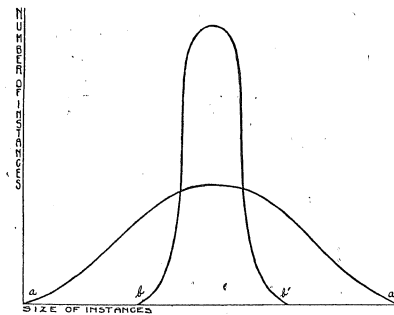


Figure 3

Now there is a fairly definite balance between the advantage of a close tolerance and its cost. Both may be appraised, if desired, in dollars and cents. The factor of desirability will reflect itself in increased value, price or service. The factor of cost will be reflected in one of two ways. A closer tolerance will either involve a larger percentage of rejections (for example, moving the limits from a and a' to b and b') or it will involve a closer and presumably more costly process control which would make rejections unnecessary.

There is evidently a balance also between rejections and the advisability of using a more costly process of manufacture. I assume that the operators have been trained and are being inspected to secure the full possibilities of the given process. Mr. Gates illustrated this point last night when he said that, if it was not practicable to meet quality requirements by teaching the operator, it should be the responsibility of the engineering department to work out new production methods.

This idea of tolerances and permissible limits has many applications outside the field of product inspection. It determines whether a time plan of schedule control, such as the Gantt chart, or a sequence plan like the Taylor planning board, shall be used. It applies to discipline and, in fact, like Mr. Karabasz' other principles, is applicable to the whole field of management.

Perry A. Fellows.¹⁴ In his paper on the "Maintenance of Standards," Professor Karabasz has demonstrated that it is possible to gain some valuable truths for general application from a study of particular phases of plant operation. He has also demonstrated that he knows his subject backward as well as forward by discussing standards of maintenance as fully as he does the maintenance of standards.

The thing we must not miss in following this valuable paper is the statement made that "all of the principles of good management which apply to the various production units, apply equally well in the maintenance department."

Management is leadership and the qualities of leadership are universally the same. The leader must have in view some definite goal toward which he is striving and he must be able to inspire others to follow him toward that same goal. To the extent that he fails in either of these requisites he will

¹⁴City Engineer, Detroit, Mich.