Standardized Conditions"; had he confined this paper principally to what was an epoch making advance in the art of industrial management, if not indeed the elevation of management from "rule-of-thumb" to an art, a scientific method of determining what represents a fair day's work or the time that a given job under given conditions ought to take; had he reserved the description of his novel pay system—the differential piece rate—for a later presentation, it is altogether probable that his message would have been better understood and more generally appreciated at its true worth.

This error of Taylor's, if it may be so characterized, is significant and shows that even he was not immune from the influences of the time. As is evident to anyone who studies Taylor's writing, and is well known to those who were associated with him, the Taylor System, or scientific management, had its genesis in an endeavor to establish *"standards of accomplishment—or in other words to set piece rates on a just and accurate basis."* This Taylor found necessitated an analytical study of the work to be done, which at once brought to light the fact that *there can be no standard or uniformity of accomplishment without standardization of all of the conditions under which the work is done.*

Let us take for example the boring and turning of steel tires for locomotive wheels, which I think was one of the first, if not the first, operation to be studied at Midvale. Having, as a result of experiment, arrived at and established as standard, proper combinations of feed, cutting speed and depth of cut, it soon became apparent to Taylor that unless the cutting tools used by the machinists were practically identical in quality and temper of the steel and ground to practically the same shape, clearance and lip angles, these standards could not be attained. In this we have the beginning of the long series of experiments and research described in Mr. Taylor's book "On the Art of Cutting Metals," which culminated in the invention of high-speed steel and the Taylor-White process for its treatment; the slide rules started by Mr. Taylor and Mr. Gantt and perfected by Mr. Barth, and the Taylor standard lathe and planer tools. He found that the time-honored practice of each workman grinding his own tools must be abandoned; and the development of an automatic tool grinding machine followed, insuring uniformity and eliminating the loss of production and a variable element in the time taken to do the job as a result of the time spent by the workman at the grindstone or waiting his turn to use it.

Likewise it became evident that not only tools required for cutting, but those required for setting and holding work in the machines and the tools for measuring, must be standardized and must be of the same kind and in the same good condition *as those used when making the elementary studies* upon which was based the method and time prescribed—the standard of accomplishment. It was found also that they must *also* be on hand *when wanted* in order that the workman might not lose time procuring them or be forced to make shift with less suitable or inferior tools. Result: a tool room from which standard tools were provided.

In 1893 Mr. Taylor in his paper entitled "Notes on Belting" made a contribution to the engineering profession of which Mr. Henry T. Towne said in discussing it: "The present paper is modestly entitled 'Notes on Belting,' but could be more fittingly described as a treatise on the practical use of belts. Its thirty-four pages contain more new and useful information than is to be found in any other paper that has come to my knowledge." Here we have a notable example of the establishment and maintenance of standards which determined, for a given set of conditions, the speed, the thickness and width and the tension of leather belts for the transmission of power, and further, the development of a system for their upkeep.

Why Taylor went into it he clearly states as follows: "While working as foreman of a machine shop, the tools of which were frequently driven to their maximum capacity, the writer became convinced that the belts, which were laced according to the ordinary rules, were a great source of loss to the company—*not so much from the cost of the belting and the labor of lacing as from the incidental delays to the machines* and the diminished output of the shop resulting therefrom. This was *particularly emphasized when piece work rates were established* requiring the machines to be driven hard and continuously. The belting was then shown to be by far the largest source of trouble in the shop."

It was also found in this early effort to set just piece rates that in order to reach the standard of accomplishment greater attention must be given to having the material to be worked uniform in quality, that a scheme must be provided to insure the worker always having his next job ready, and that the condition of the machines must be kept up to an established standard.

All of this Taylor covers in his paper "A Piece Rate System" by the brief statement:

> Not the least of the benefits of elementary rate fixing are the indirect results.
>
> The careful study of the capabilities of the machines, the analysis of the speeds at which they must run, before differential rates can be fixed which will insure their maximum output, almost invariably result in *first indicating* and *then correcting defects in their design*, and in the method of running and caring for them.
>
> But what is more important still, the rate-fixing department has shown the necessity of carefully systematizing all the small details in the running of the shop: such as the care of belting, the proper care for cutting tools, and the dressing, grinding and issuing same, oiling machines, issuing orders for work, obtaining accurate labor and material returns, and a host of other minor methods and processes. These details which are usually regarded as of comparatively small importance and many of which are left to the individual judgment of the foreman and workmen are shown by the rate-fixing department to be of paramount importance in obtaining the maximum output, and to require the most careful and systematic study and attention in order to insure uniformity and a fair and equal chance for each workman.
>
> While he (the writer) regards the possibilities of these methods as great, he is of the opinion that this system of management will be adopted by but few establishments in the near future, at least; since its really successful application *not only involves a thorough organization, but requires the machinery and tools* throughout the place *to be kept in such good repair that it will be possible for the workmen* each day to produce their maximum output. But few manufacturers will care to go to this trouble until they are forced to.

If Taylor failed to bring out more adequately in the first published description of elementary time study the importance and absolute necessity for standards, it is not strange that the engineers and managers of that day should have missed the point, but it is astonishing that such a lack of appreciation and understanding should exist today!

Notwithstanding all that has been said and written, relatively few people seem fully to grasp the signficance and the importance which reason and experience show should be attached to the subject. Even in shops in which the Taylor System has been applied the management comes to a complete understanding but slowly, as one by one things go wrong owing to imperfectly established standards or, more frequently, laxity or inadequate provision for their continuous maintenance.

Within the past six months I have been consulted by several managers who sought through the establishment of some sort of a pay system a cure for their industrial ills, but who shied off when I explained to them what a real remedy involved. Quite recently in a very large plant I had the pleasure of attending a meeting of the "rate setters" from every department. In this plant they had slowly progressed through the stages of setting rates for piece work, premium work and contract jobs, based upon old records, the judgment or opinion of foremen or plain guess, to those based upon some sort of analysis or study, and in a limited degree had arrived at setting rates based on elementary time study. Just where Taylor was between 1885 and 1890! It was interesting to hear these men describe the difficulties they were contending with and trying to overcome; all due to lack of standards. The same old story of trouble with belts, tools, machines, materials, inadequate planning and lack of control. If left to themselves these men would perhaps ultimately and in somewhat less time reach the same point to which the Taylor System has developed today; but what a waste of time and energy, going over the same ground that Taylor went over, when they might profit by his experience!

A successful installation of scientific management calls for the establishment of standards; its continued successful operation calls for their maintenance.

There is, of course, nothing permanent about standards; they must be modified, discarded and replaced to keep pace with progress and change; but the fact that under a system of scientific management changes may not be made without full knowledge of all that they entail is a fine safeguard against their being instigated unwisely. Taylor frequently called attention to the folly and danger of making what he picturesquely but forcefully designated as "damned improvements." In this category he placed those changes or innovations which impulsive people are wont to make without due investigation and consideration, or in some cases simply to satisfy a desire for something new, and as a result of which many businesses are kept in a constant turmoil. The installation of scientific management is, as only those of you who have gone through it can fully realize, of necessity a long and arduous undertaking, calling not only for