neither dreamer nor theorist. He was a doer. Most things he asked of a worker he could do himself with sufficient degree of skill to establish that he knew what he was talking about; and occasionally for purposes of instruction he relieved a workman at a machine. The mechanisms he advocated or the principles he formulated had either actually been proven by experiment or experience, or they were reasonable deductions from experiment or experience.

This was the kind of man who at the age of twenty-four became a foreman at Midvale.

III. THE FIRST ELEMENT OF TAYLOR'S PROBLEM
DETERMINING THE BEST WAY OF DOING EACH JOB

"In the fall of 1880, the machinists in the small shop of the Midvale Steel Company, Philadelphia, most of whom were working on piecework in machining locomotive tires, car axles, and miscellaneous forgings, had combined to do only a certain number of pieces per day on each type of work. The writer, who was the newly appointed foreman of the shop, realized that it was possible for the men to do in all cases much more work per day than they were accomplishing. He found, however, that his efforts to get them to increase their output was blocked by the fact that his knowledge of just what combination of depth of cut, feed and cutting speed would in each case do the work in the shortest time, was much less accurate than that of the machinists who were combined against him. His conviction that the men were not doing half as much as they should do, however, was so strong that he obtained the permission of the management to make a series of experiments to investigate the laws of cutting metals with a view to obtaining a knowledge at least equal to that of the combined machinists who were under him.[1]".... "the original object, for which in 1880 the experiments were started (was) taking the control of the machine shop out of the hands of the many workmen, and placing it completely in the hands of the management, thus superseding 'rule of thumb' by scientific control.[2]"

These words from Taylor's own pen, adequate for a scientific article, do not tell the whole story. He had been worker with the workers and carried into his foremanship positive knowledge that there was systematic restriction of output; also he believed his new duties required the securing of better production. He adopted, naturally, the then usual foreman's methods,—suasion of the drive type (it was 1880 and the *steel* industry!) This led only to bitterness, occasional physical violence, no improvement in production and apparently no possibility of improvement. Taylor thought hard about it and conceived a reason for the difficulty and a way out; he decided he was at a disadvantage because the workers knew more about their skill than he (or management) did; he would learn to know more than they collectively did; then perhaps by advantage of that superior knowledge he could secure what he wanted by its use in negotiation with them. He had no "system;" no philosophy; he had simply a not unusual practical problem of a foreman; and he set out to solve that problem.

To learn the content of the workers' skill, he began what has come to be known as job-analysis by the method of unit time study. He did not set up a laboratory, but did what amounted to the same thing; selected a machine and a worker or workers, controlled the conditions around the machine,—power delivery (which led to "Notes on Belting"), uniformity and availability of materials, control of feeds, speeds, depth of cuts, etc., (which led to "On the Art of Cutting Metals") and made precise and thoroughly scientific (variables under control) observations and records. In a short time he had sufficient data, for certain operations, with which to determine how long a given operation should take under specified conditions.

He also observed that if operations were performed under these conditions the output would be increased per unit of cost; that there would be a net gain, part of which could be added to the wage rate, thereby securing an incentive for increased output to replace the conventional ineffective and disagreeable foreman's method of suasion.

Thus was the first element of the problem solved;—specifications for operations based on precise knowledge of the best methods and of times necessary for their performance, and an extra possible profit, part of which could be used in a higher wage rate to secure the cooperation of the workmen. He sold the idea to enough of the workers to begin to try out the new method of work according to specifications which indicated the "best way" of performing an operation, the participation in the experiments on the part of some workers and the watching of them on the part

[1] *Ibid*, p. 33.
[2] *Ibid*, pp. 39-40.

of others having interested the men and cleared the ground for harmonious relations.

IV. THE SECOND ELEMENT OF TAYLOR'S PROBLEM
STANDARDIZING CONDITIONS IN THE SHOP

Taylor had apparently seen from the beginning that there was a second element of his problem, and that a solution of it was necessary before the new methods of work could be inaugurated. The methods and the times embodied in the specifications were based upon particularly favorable conditions surrounding the machines on which the investigations had been made. If those specifications were given to men on other machines, machines not operated under the precisely controlled conditions of the machines upon which the experiments had been performed, then work in accordance with the specifications would be impossible. Here was a bigger problem than that of learning the content of skill, and Taylor did not refuse to face it. He at once attacked the problem of *standardizing the conditions* in the shop. He would give every worker the perfect opportunity.

To give every worker the perfect opportunity was, therefore, to bring the conditions throughout the shop to the same standard as the conditions surrounding the machines on which the standard methods had been worked out. Before Taylor left Midvale in 1889 he had devised most of the fundamentally important mechanisms of what came later to be known as scientific management;—not in their subsequent finished form and not coordinated into a system, but merely to an extent necessary in a shop of large machines on which the operations were relatively simple and took considerable time. But more important than the mechanisms is the fact that the point of view, the spirit, which inspired this development was as thoroughly scientific management as it came at any later time to be.

We know from the records that during that period there were developed: unit time study[1]; elementary rate fixing[2]; "tables" for tasks and the assigning of tasks[3]; standard conditions for belts[4]; tools[5] and machines; planning in advance, "lists" of work ahead and "chasers" to follow-up work[6]; the shop bulletin board[7] the differential piece rate[8]; and the following elements of functional foremanship—time clerk, instruction card clerk, inspector and disciplinarian (the modern employment manager), each of whom had supervision over workers which was direct and not through the gang boss[9]. In general terms Taylor says there were "all the fundamentals of task management[10]," "the best way of managing men on day work[11]," and the idea that the big losses of poor management came from "incidental delays[12]," to remove which was a principal objective of good management. There was as yet no planning department, separately organized[13], for the shop was so small and the machine work so simple that the planning function did not have to be functionalized. For the same reason probably, there was no functionalized routing and route sheets. It should be borne in mind that the shop in which scientific management had its beginnings at Midvale was engaged chiefly on turning out locomotive axles and tires, and there was none of the complexity and minuteness of scheduling of the machine shop which does miscellaneous work. It was the application of scientific management to this latter type of shop which later compelled refinement and coordination of the mechanisms.

V. THE THIRD ELEMENT OF TAYLOR'S PROBLEM
MAINTENANCE OF STANDARD CONDITIONS

It is well known to experienced executives and foremen that good conditions do not automatically "stay put." A shop or office well tuned up today will begin to become slack next week. So it was in Taylor's experience with the standards established throughout the shop at Midvale. Immediately he had before him the third element of the problem,— *the maintenance of the standards set.* It should be observed that, in fact, although these three elements of the problem were both logical and chronological, they were more logical than chronological. All were crowded upon Taylor practically at the same time.

The maintenance of standards is a much more complicated element of the management problem than either job analysis or the establishment of standards, for the obvious reason, among others, that the latter

[1] *A Piece Rate System*, §44.
[2] *A Piece Rate System*, (Introduction)
[3] *Notes on Belting*, § 43.
[4] *Notes on Belting*, § 42, 111.
[5] Reported in interviews with persons now living who were acquainted with conditions in Midvale.
[6] *A Piece Rate System*, (Introduction).
[7] *Shop Management*, p. 107.
[8] *Shop Management*, p. 44.
[9] *A Piece Rate System*, (Introduction).
[10] *Notes on Belting*, § 4.
[11] *Shop Management*, p. 118.