

close of our Civil War. The million soldiers who had been engaged on the northern side in that great struggle were, after their release, a great factor in peopling the agricultural west, and swelling the labor force of a manufacturing east. More important, five millions of immigrants flocked to the United States during the two decades 1860 to 1880, and another five millions in the single decade 1880-1890. This occupation of our public domain closed the frontier safety valve for turbulent or ambitious spirits, and brought the east, for the first time in its history, face to face with a serious labor problem.

The manufacturing industries into which the nation's surplus energy then turned had, before the middle of the century, been scarcely a promise. But by 1870, the number of wage earners had already increased from less than one million to more than two millions. By 1890, the new army had reached a total of four and a quarter millions; while the capital invested had grown from scarcely more than a half billion in 1850 to six and one-half billions in 1890. That is, less than one-twelfth of the capital invested in manufactures in 1890 had originated earlier than 1850. The two periods of great gain were the Civil War decade, and, more especially, the eighties. From 1880 to 1890, the number of wage earners in this country increased by one and a half millions, a growth twice as great as in any preceding decade, and fifty per cent greater than that which was to mark the nineties. The gain in capital during the eighties was three and three quarters billion dollars, or more than three times as great as in any preceding decade, and greater by about half a billion than the advance that was to be made between 1890 and 1900.

Even more phenomenal and significant than the expansion of manufacturing was that revolution in method known as the introduction of large scale production. Government reports and general opinion unite in placing the date for this transformation at about 1880. In the iron and steel industry the movement was well under way in the seventies, but in a greater number of industries the apex was reached in the eighties. Neither before nor after this period was there anything like as rapid a swing towards concentration, perhaps not even after 1900. It is remembered that the first trusts were also formed at this time, the Standard Oil Trust in 1879, and the first sugar and whisky trusts in 1887. In short, for the first time in American history it had now become common for large numbers of workmen to be employed under one management.

Another aspect of industry, significant in its bearings upon the origin of scientific management, was the new foreign element employed in the shops. The year 1882 was to mark the flood tide of a great wave of immigration, the 789,000 who came in that year

setting a record which had never before been rivaled, and which was not again to be equaled for twenty years. Very nearly one-third of all the persons engaged in manufacturing, mechanical, and mining pursuits were already in 1880 natives of foreign countries, with the greatest immigration yet to come. The foreigners were mostly unskilled laborers, occupying the lower places in the industrial scheme, and that rapid shift in the source of immigration from northwestern to southeastern Europe, later to be so noticeable, had already begun.

It is seen, in short, that by 1880 or shortly after, most of the industrial problems of our time were on hand, and in that initial period when they were the most likely to do mischief, and to excite alarm. The rapid elimination of the frontier, which was to be practically complete before the end of the decade, was already beginning to confine ambitious workmen to subordinate positions in the east. The rapid increase in the size of many industrial plants was separating the employer from his employees. The foreign third of the workmen, many of them newly arrived immigrants, were not capable of ready co-operation with their employers, even had other conditions been favorable.

The resultant of these new forces was, on the one hand, the beginning of the modern labor movement. Prior to the Civil War, there had been in this country no union movement of other than transitory importance. Unions began to become influential in the latter part of the Civil War period, and, barring a few years of depression following the crisis of 1873, their membership steadily increased in numbers and influence. Especially after 1878 a period of growth set in, many of the unions finally merging themselves in the Knights of Labor, which by 1886 claimed 600,000 members. The first strikes of national importance which the country had ever had were the violent and widespread railroad strikes of 1877. During the eighties the losses arising from strikes increased rapidly, reaching a climax in 1886. The few years prior to 1886 constituted, indeed, the greatest strike period in our history. Since 1886, the number of strikes has not kept pace with the growth of population, much less with the growth of industry. But more important than the strikes of this period was the chronic disloyalty and inefficiency which marked the daily activity of thousands of workmen. The lack of contact and sympathy between employer and employee had weakened and perverted the entire industrial system. Limitation of output, soldiering, carelessness, these were the first fruits of the new large scale employment, and they constituted a problem which caused worry on all sides.

The other great development of the period, but one which was not to be at first so noticeable, was the

creation of scientific management. The system which now bears this name started as the personal reaction of the late Dr. Frederick Winslow Taylor to the above described labor spirit. Taylor was born of upper-class American stock five years before the outbreak of the Civil War. As a boy he had been educated in France, Germany, and Italy, and prepared to enter Harvard. Trouble with his eyes, however, prevented his continuance in college, and we find him during four years of his youth working out apprenticeships in a small Philadelphia shop as pattern maker and machinist. He entered one of the new large scale establishments, the Midvale Steel Company, as a laborer in 1878. From laborer he successively rose through the positions of clerk, journeyman machinist, gang boss, foreman, and chief draughtsman until he finally became chief engineer. It was when he became gang boss in 1880 that Taylor first determined to discover by scientific methods how long it should take each man to do each given piece of work; and it was in the fall of 1882, shortly after he had been elevated to the position of foreman, that he started to put the first features of scientific management into operation.

Before proceeding to an analysis of the principles of scientific management, let us first perfect our idea of Taylor by noting the other outstanding features of his life. In 1889, Taylor left the Midvale Steel Company in order to apply his ideas in a wider field. For three years he served a corporation operating large pulp mills in Maine, and then he attempted in various parts of the country a reorganization of industrial plants. This involved a variety of manufacturing, structural, and engineering work. His most celebrated personal undertakings were in connection with the plant of the Bethlehem Steel Company between 1898 and 1901. By 1901, Taylor had acquired a fortune which enabled him to retire from work for pay.

Dr. Taylor took the degree of mechanical engineer from Stevens Institute of Technology in 1883. In 1906, he served as President of the American Society of Mechanical Engineers. Besides his writings on management, he contributed to this society several notable papers on mechanical subjects, of which the greatest was his president's address in 1906 on "The Art of Cutting Metals." He took out about one hundred patents, his greatest invention being the discovery between 1898 and 1900, jointly with Mr. Maunsel White, of the Taylor-White high-speed steel. He was honored by the University of Pennsylvania with the degree of Doctor of Science in 1906, and was claimed as a friend by some of the highest officers of the navy, and by prominent engineers, manufacturers, and public men. Dr. Taylor died March 21, 1915.

To return now to the youthful Taylor of 1880, and his beginnings of scientific management. Taylor's observation had been that his neighbors in the Midvale shops failed to produce more than about one-third of a good day's work. Wages were on a piece-work basis, and the men were afraid to let the management guess how large a product they could really turn out because it might mean a cut. This tendency on the part of the workmen had resulted in a war between Taylor, the gang-boss, who was trying to induce the men to work faster, and the workmen under him, who were determined that by fair means or foul they would avoid working faster. As a result of this struggle, life to Taylor had become hardly worth living. Accordingly, shortly after he was given the greater authority of foreman, he determined to work out some system of management by which the interests of the workmen and of the management would be made the same.

The basic principle of the scientific management which he evolved is that the management shall determine very carefully just how much work a man ought to do, and on the other hand, that the man should then be offered a premium sufficient to induce him to perform the task. From this simple idea all of scientific management has grown, and to this idea most of it may still be reduced. The classic illustration of the scientific determination of the task was Taylor's twenty-six year study in the field of cutting metals. The regular method is to make a study of every element entering into a job; and then add together the times which it takes to perform the necessary elements, to find the time required to perform the entire job. A margin of safety is ordinarily left, to cover delays. The stop watch is the instrument ordinarily used in making the time studies.

The methods by which men are induced to perform the task are Taylor's differential rate—and, among later developments, Gantt's task and bonus system, and other special bonus or premium systems. The amount of reward to the workmen varies considerably, but most often amounts to twenty or thirty per cent higher wages than they have been accustomed to earn. Such a reward is usually sufficient to induce workmen to attain the tasks laid out for them, and the tasks can often be so set as to increase production one hundred per cent or more.

It is not to be supposed, however, that scientific management is based upon the overspeeding of workmen. The goal is reached largely through a more perfect utilization of machinery and tools, the elimination of actual idleness or wasted motions on the part of the men, the withdrawal from a job of operations that can more fittingly be performed some place else, and only to a very limited extent by means of speed-