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Automating The Worker

Frederick Winslow Taylor brought efficiency engineering to the workplace. It was feared and fought, but it has never left.

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Frederick Winslow Taylor was only twenty-two when he got promoted to gang boss in a machine shop at the Midvale Steel Company, in Philadelphia, in 1878. A slender, intense upper-class young man, he found himself at once the target of undisguised threats from his new underlings. He recalled later, in his book *The Principles of Scientific Management* , one man's threatening words:

"Now, Fred, we're very glad to see that you've been made gang-boss. You know the game all right, and we're sure that you're not likely to be a piece-work hog. You come along with us, and everything will be all right, but if you try breaking any of these rates you can be mighty sure that we'll throw you over the fence."

Taylor's response was to state "plainly" that he was now on the side of management. And he picked up where the old boss had left off, bullying, threatening, and firing slow workers—in short, applying all the regular coercive techniques of American industry in 1878. The men retaliated in their own traditional way, by sabotaging their machines and advising him against walking home alone. In his book he recalled his reply: "They could shoot and be d——."

In the factories and machine shops of the 1880s, irreducible antagonism between management and labor was the norm. Wages were comparatively high in labor-short America, but class hostility was sharpened by the ethnic and cultural schism between factory workers, mostly immigrants, and the Anglo-Saxon managerial elite. Most factories operated on a vicious piecework system, under which management reduced the rate of pay per piece if production increased. The workers responded by soldiering—doing less work than they might, which was a point of pride into which new men were promptly initiated. Taylor secretly sympathized with the men, he later said: "I made up my mind either to get out of the business entirely and go into some other line of work, or to find some remedy for this unbearable condition."

Scion of two patrician Philadelphia families, the Winslows and the Taylors, Taylor had been drawn by chance onto the industrial scene when a temporary eye problem forced him to abandon plans to enter Harvard. His physician recommended manual work, and Taylor began with an apprenticeship at the Enterprise Hydraulic Works before switching to Midvale. By studying at night he earned a degree in mechanical engineering from the Stevens Institute of Technology while continuing his rise at Midvale to foreman, chief draftsman, director of research, and finally chief engineer. His gift for understanding machinery made him an ideal right-hand man for Midvale's mechanical-minded president, William Sellers. Taylor went on to patent many inventions in his career, but his confrontation with the Midvale workers turned Taylor's imagination in a direction no inventor had yet explored, away from the machinery of the shop and toward the workers who operated it.

Taylor began by asking himself whether the conflict of interest dividing management and labor truly was irreconcilable. Did gang boss and worker really need to conduct perpetual warfare over a proper day's work? What *was* a proper day's work?

Taylor saw a light. To management, a day's work was the most one could force a man to do in a day; to labor, it was the least the man could get away with. Taylor reasoned that there must exist a true technical measure of a day's work. As he mulled this over, it occurred to him that a worker's productivity in his ten-hour day depended not merely on how great an effort he made but on how he went about it. Now he began to see a brighter light: If a man could be taught a better way and be paid for his increased productivity, everybody would profit—labor, management, even the consumer. Taylor felt like Saul on the road to Damascus. A dazzling vision beckoned.

He had long since noticed that different workers employed very different techniques to do the same job. Some clearly used their muscles better than others. Machines, on the contrary, always did their work the same. It was management's responsibility, Taylor concluded, to teach men to be as efficient as machines: to find the best way to do a job, to provide the correct tools, and to train the worker, with the aid of appropriate incentives.

He argued his idea to Sellers with such impassioned enthusiasm that the skeptical older man acquiesced in an initial program of research. Taylor withdrew a skilled machinist and his machine from production, appropriated a stock of waste steel from the yard, and began his experiments. Quickly he arrived at what he considered a scientific method, holding all other variables constant while one was under scrutiny and controlling the variations of that one. In succession he observed the effects of changes in shafting, belting, machine speed, the temper and design of tools, the composition and feed of material, and the techniques of the operator. He deduced that the task of sharpening cutting tools should not be performed by the individual machinist and that downtime could be eliminated by assigning such work to a special crew on a continuous basis.

One by one he studied the jobs in the plant and redesigned the equipment, its operation, or both. As each job was rationalized and each worker trained, Taylor timed him with a stopwatch, breaking down every operation into individual movements. An instruction sheet was then prepared detailing for the worker exactly how he was to perform his job, listing the times allotted to each operation, the motions to be employed, and the tools to be used.

“What I demand of the worker,” Taylor said, “is not to produce any longer by his own initiative, but to execute punctiliously the orders given, down to their minutest details.” Man and machine were becoming one—at the cost of the worker’s autonomy.

Taylor had anticipated several months of experimentation, but as one insight led to another, his researches actually extended over the next twenty-six years. The Midvale results yielded such dramatic improvements in shop productivity that he sought to bring them to the attention of a wider management public. Here he ran into difficulty; there as yet existed no forum for disseminating ideas to management. A paper he read before the American Society of Mechanical Engineers drew little notice, so he resigned his post at Midvale to form the Manufacturing Investment Company, in which he pioneered the profession of consulting engineer in management.

He introduced what he began to call “scientific management” to a number of manufacturing companies, until in 1898 the Bethlehem Steel Company hired him on a permanent basis. Shortly after his arrival there, he carried out an experiment that came to be the most celebrated demonstration of his principles. The tale is remembered as the “pig-iron story.”

Taylor told the pig-iron story over and over and finally wrote it in considerably embroidered form in his book *The Principles of Scientific Management* . Seizing an opportunity “to show the workmen, as well as the owners and managers of the works,” the value of scientific management, he stood by with his assistants (one armed with a stopwatch) as a gang of men filed by carrying 92-pound pigs of iron up a ramp onto a freight car. At the end of the day each worker had carried an average of 12.5 long tons of iron. Loading 12.5 tons for $1.15 sounds like a fair day’s work—and Taylor conceded that it was done “about as fast and as cheaply as it was anywhere else at that time”—but he dissected the operation and concluded that “a first-class pigiron handler” ought to handle “between 47 and 48 long tons per day.” He resolved to elicit work at that rate “without bringing on a strike among the men, without any quarrel with the men,” and, in fact, “to see that the men were happier and better contented” loading at the much higher rate.

Seeking an ideal worker to begin with, he settled on a man he described as “a little Pennsylvania Dutchman who had been observed to trot back home for a mile or so after his work in the evening, about as fresh as when he came trotting down to work in the morning.” Schmidt (Taylor’s fictitious name for the man) was building himself a small house in the early mornings and late evenings and was known to be “close” with his $1.15-a-day pay.

Taylor and Schmidt had, according to Taylor, the following dialogue:

“Schmidt, are you a high-priced man?”

“Vell, I don’t know vat you mean.”

"Oh, come now, you answer my questions. … What 1 want to find out is whether you want to earn $1.85 a day or whether you are satisfied with $1.15, just the same as all these cheap fellows are getting."

"Did I vant $1.85 a day? Vas dot a high-priced man? Vell, yes, I vas a high-priced man."

"Oh, you're aggravating me. Of course you want $1.85 a day—everyone wants it! … Well, if you are a high-priced man, you will load that pig iron on that car tomorrow for $1.85. … You will do exactly as this man tells you tomorrow, from morning till night. When he tells you to pick up a pig and walk, you pick it up and you walk, and when he tells you to sit down and rest, you sit down. You do that right straight through the day. And what's more, no back talk. … I'll know before night whether you are really a high-priced man or not."

Taylor admitted that this was "rather rough talk" but held that it was "appropriate and not unkind" because Schmidt was "of the mentally sluggish type" and needed his attention fixed on the money he was going to earn rather than on his huge increase in work output.

The next morning Schmidt set to work under the eye of Taylor's assistant, who held a watch and directed: "Now pick up a pig and walk. Now sit down and rest. Now walk—now rest." By quitting time, half past five, Schmidt had loaded the 47.5 long tons of iron on the railway car. "And," Taylor concluded triumphantly, "he practically never failed to work at this pace … during the three years that [I] was at Bethlehem." Taylor said that 80,000 tons of iron were loaded for shipment in record time, and the men doing the loading received 60 percent more pay than they had been getting.

The science of pig-iron handling had been established. Its secret, according to Taylor, was that a pig-iron handler should be under load only 43 percent of the time and entirely free from load the remaining 57 percent. But while under load he should never be standing still, as had often been the case at Bethlehem, because merely holding the 92-pound pig caused nearly as much fatigue as walking with it.

The science involved was too esoteric, Taylor believed, to explain to a pig-iron handler like Schmidt because "one of the very first requirements for a man who is fit to handle pig iron … is that he shall be so stupid and so phlegmatic that he more nearly resembles in his mental make-up the ox than any other type." Taylor did not reflect that Schmidt was imaginative and energetic enough to save for and build a house.

That fall, in 1898, Taylor was analyzing Bethlehem's machine-shop operation when he became aware of a problem that led to his major invention. Studying self-hardening steels, he hit on a means of hardening a chrometungsten steel alloy without rendering it brittle, by heating it almost to the melting point. The resulting "high-speed steel" more than doubled machine productivity and remains in use all over the world.

Despite this and many other successes at Bethlehem, Taylor's sojourn with the company was not uniformly happy. Robert P. Linderman, the president of Bethlehem, had Taylor to the company "to introduce piece work and help us in general to increase our production," in the words of one director, "but what Mr. Taylor did was to go out into the works and start a revolution." Taylor was not an easy colleague. He treated Bethlehem executives with no more ceremony than he did Schmidt. A visitor once heard him tell a company official, "Now look here, I don't want to hear anything more from you. You haven't got any brains, you haven't got any ability—you don't know anything. You owe your position entirely to your family pull, and you know it. Go on and work your pull if you want to, but keep out of my way, that's all."

The old Bethlehem hands gave Taylor the derisory nickname Speedy Taylor. Like Phileas Fogg, he counted the steps from home to office to ascertain the most efficient route. In the end his insistence on getting full control of shop management led to a crisis, and it was resolved by a terse note from Linderman: "I beg to advise you that your services will not be required by this Company after May 1st, 1901."

Though his dismissal came as a shock, Taylor did not let it deter him from what had become a mission, and he decided to spend the rest of his life as an unpaid crusader for scientific management. He and his wife had adopted three children, and he now found time to devote to home and family. His older son remembered him as a firm but affectionate father who had the "habit of converting every difficult or disagreeable task," such as a trip made in bad weather, "into a sporting event." For canoeing he designed life jackets, as yet unknown to sport boating.

Taylor returned to settle in Philadelphia, building a house on an elevenacre estate in Chestnut Hill. When his architect told him he would have to destroy a splendid old box hedge to get the view he wanted, Taylor analyzed the problem, dug a tunnel completely under the hedge to study its root system, designed and built a machine to disinter the plant, and moved the entire hedge, section by section, to a new location.

He found time to take up the new middle-class sport of golf. Despite his slight build, he had always excelled at athletics. As captain of his prep school baseball team, he was believed to be its first pitcher ever to pitch overhand, causing much head scratching among umpires. At twenty-five he shared the U.S. doubles championship in tennis, using an odd-looking racket he had devised with a spoon-curved handle. Predictably, golf also stimulated his inventive genius. He designed a driver ten inches longer than ordinary ones, requiring a radical new swing in which he nearly turned his back to the fairway. Success with it was elusive, as he wrote to a friend: 'The ball still refuses to settle down quietly into the cup, as it ought to, and also in most cases declines to go either in the direction that I wish or the required distance." His two-handed putter, swung between the legs, was ruled illegal by the tradition-bound U.S. Golf Association.

In 1903 Taylor wrote a short treatise titled *Shop Management* setting forth the scientific-management theories he had been developing over the years. One of its readers was Louis D. Brandeis, the future Supreme Court justice and at the moment a prominent Boston lawyer. In 1910 Brandeis was retained to argue a case against a railroad rate increase before the Interstate Commerce Commission and remembered

Taylor's persuasive claims for scientific management. He went to meet Taylor, who gave him his standard two-hour lecture about scientific management. Brandeis later remembered, "I quickly recognized that in Mr. Taylor I had met a great man."

Using Taylor's data, the attorney and several expert witnesses asserted on the stand that the railroads could save at least a million dollars a day through more efficient management. Brandeis ultimately won the case. It gave immense favorable publicity to the tenets of scientific management, and it made Taylor famous overnight.

At the very same time, Taylorism was getting publicity of a quite different color from another source. Army ordnance officers were seeking to implement scientific-management techniques at national arsenals and ran head-on into labor opposition, particularly against Taylorism's despised symbol, the stopwatch. President Taft backed the Army in imposing Taylorism at the arsenals but also backed the Navy Department in its refusal to admit the system in navy yards.

Congress decided to look into the whole question and held a lengthy series of committee hearings early in 1912. Taylor was invited to testify. By this time he had published his *Principles of Scientific Management* in the mass-circulation *American Magazine* . A number of readers had objected to Taylor's cavalier treatment of Schmidt in the pigiron story and his spurning of other men judged unqualified for the job. Taylor hastened to explain that almost all these men had been given other jobs at Bethlehem, but in his testimony before Congress he entertained the congressmen with an account of another experiment at Bethlehem, one that now also gained fame: "The Science of Shoveling."

The title originated with sarcastic critics, but Taylor embraced it with aplomb. Workers who shoveled at Bethlehem, he recalled, had owned their own shovels and would use the same one for any job—lifting light rice coal or heavy iron ore. Taylor asked rhetorically, "Is three and a half pounds the proper load for that shovel or is thirty-eight pounds the proper shovel load?" and asserted that "under scientific management the answer to this question is not a matter of anyone's opinion; it is a question for accurate, careful, scientific investigation." After considerable study he had designed shovels himself to fit the different loads. Shovels for iron ore were given shorter handles (he had identified the optimum length); those for the light rice coal were given broad scoop shapes and longer handles. Ultimately he created about fifteen different shovel designs.

But even with a scientifically designed tool, shoveling had to be done right. Wielding an imaginary shovel, Taylor demonstrated for the congressmen: "There is one right way of forcing the shovel into materials … and many wrong ways. Now, the way to shovel refractory stuff is to press the forearm hard against the upper part of the right leg just below the thigh, like this, take the end of the shovel in your right hand and when you push the shovel into the pile, instead of using the muscular effort of your arms, which is tiresome, throw the weight of your body on the shovel like this; that pushes your shovel in the pile with hardly any exertion. … Nine out of ten workmen who try to push a shovel in a pile of that sort will use the strength of their arms, which involves more than twice the necessary exertion.”

Taylor was heckled by labor leaders and hostile congressmen during the hearing, and they succeeded in provoking his combustible temper. The exchanges between them grew so inflamed they were stricken *in toto* from the record. The net outcome of the hearings was unfavorable for Taylorism, and despite strong support from some senators and representatives, scientific management was effectively barred from the arsenals and shipyards of America by a special proviso henceforth routinely added to appropriations bills. No foreman or other supervisor was to be paid if he used a stopwatch or made a time study.

Congress notwithstanding, time study was far from dead. As a foundation of the Taylor system, it was developed further by Taylor’s most famous disciples, Frank and Lillian Gilbreth, the husband-and-wife engineering team whose carefully ordered family life was chronicled in the best-selling book *Cheaper by the Dozen* . Frank Gilbreth first ventured into time-and-motion study with a Taylor-inspired analysis of bricklaying, and he wrote of it to Taylor with an apostle’s fervor: “My God. … Think of it! Here I am a man weighing over 250 pounds, and every time I stoop down to pick up a brick I lower 250 pounds of weight down two feet… and then raise my 250 pounds of weight up again, and all of this to lift up a brick weighing 4 pounds!”

The Gilbreths invented an adjustable scaffold with which the average bricklayer could speed up his performance from 120 bricks an hour to 350. They coined a new word, *therblig—Gilbreth* backward, almost —to designate an irreducible time-and-motion unit of a work task. Gilbreth and other Taylor disciples founded the Society to Promote the Science of Management, and in 1915, following Taylor’s death, they changed its name to the Taylor Society. By that time Taylor and his system had captured the imagination of much of the media and the public. Enthusiasts included Herbert Croly, the founding editor of *The New Republic* , Walter Lippmann, a young socialist and future pundit; and Melville Dewey, who rationalized the nation’s libraries with his Dewey decimal system and sometimes rationalized his own signature to “Melvil Dui” for efficiency’s sake. Efficiency became a sort of national mania, but enthusiasm was by no means limited to the United States. *The Principles of Scientific Management* was translated into all the major European languages and Japanese and won overseas converts who conspicuously included Lenin and the Bolsheviks.

Up until his death—in 1915, from pneumonia, a common killer at the time—Taylor never lost his zeal for the cause. A warm and friendly man when not fiercely battling for his system, he admitted to being a bit of a fanatic. John Dos Passos selected him for one of the biographical profiles interspersed through the novel *The Big Money* (others included Rudolph Valentino, the Wright brothers, Henry Ford, and Samuel Insull), writing that “production went to his head and thrilled his sleepless nerves like liquor or women on a Saturday night.”

Taylor’s arrogance in dealing with poorly educated manual laborers can be laid partly to class-based elitism, partly to impatience, and partly to ignorance. The men were, of course, far less “stupid,” “phlegmatic,” and “ox-like” than he liked to think, and there’s little wonder that they opposed so bitterly his system and its annihilation of their control over their movements. However, where scientific management, or Taylorism, really got a bad name was in assembly-line production, especially in the auto industry. Henry Ford unveiled the first moving assembly line in Detroit in 1913, to manufacture automobile generators, and soon had whole automobiles coming off a line, one every two minutes. The new technology was a sort of pressurized Taylorism, with a worker’s own skill or judgment replaced by repetitive motions, predetermined procedures, and a work pace totally controlled by mechanical means.

Taylor had told the congressional committee in 1912 that one of the rules of his system was that “a task must never be given to a man that would overwork him in any way,” a principle he reiterated many times. But the moving assembly line—with which Taylor had absolutely no direct connection—irresistibly overrode any such consideration. While carrying production efficiency to a logical extreme, it reduced the worker to a machine component. Henry Ford astounded the world and baffled his competitors when he began to pay his workers an unheard-of five dollars a day, but the workers weren’t happy, and few manufacturers who found the assembly line useful shared Ford’s vision in paying high wages. Protests, absenteeism, strikes, and sabotage were met by coercion, blacklisting, and scabs.

Within a few years of Taylor’s death it was evident that although scientific management could indeed bring about remarkable improvements in production, it failed to fulfill its inventor’s dream of reconciling workers to industrial work. In fact, to the consternation of Taylor’s disciples in industry, the result was frequently not only poor worker morale but poor work—lower quality and less production.

Taylor had made two serious mistakes. First, he had assumed that economic gain was a worker’s sole motivation; second, in the words of the management expert Peter Drucker, usually one of Taylor’s biggest fans, he used the worker “as a poorly designed, one-purpose machine tool [although] repetition and uniformity are two qualities in which human beings are weakest.” Or as the historian Thomas P. Hughes puts it, “Idealistic, even eccentric, in his commitment to the proposition that efficiency would benefit all Americans, Taylor proved naive in his judgments about complex human values and motives.”

Taylor’s very knack for machinery may have inhibited his grasp of the human element in work. His followers continued to think in terms of management and machines until a new point of view was introduced in the 1920s. It came not from industrial engineers but from social scientists. Elton Mayo, who has been called America’s first industrial psychologist, stumbled on a momentous discovery while studying fatigue among workers at a Western Electric plant in Hawthorne, Illinois. He was observing two groups fabricating the same telephone component. In one the shop lighting was improved; in the other it was left alone. Both groups, to

Mayo's surprise, registered modest increases in production. Further experiments deepened the mystery, and Mayo extended his research to women assembling telephone relays. He explained the purpose of his study to them, gave them veto power over changes in their routine, and encouraged them to work in their own individual ways. What he discovered was essentially that the women worked better for being taken into their employers' confidence and having their opinions listened to. The phenomenon of improved work performance resulting from an improved psychological attitude became known to social scientists as the Hawthorne effect.

A whole new school of research into worker attitudes and the work subculture grew out of the Hawthorne study. The new movement was at first perceived as a counterattack against Taylorism, but in time it came to be seen as a complement, a fresh set of dimensions added to Taylor's concern with worker performance. One direction, for example, led to human-factors engineering, the study of man-machine interaction and the design of machinery and equipment to better fit human physiological characteristics, which really amounted to an elaboration of Taylor's "shovel science."

Today it is evident that there is far more to the problem of worker alienation, or "blue-collar blues," than anyone in the 1890s or even the 1920s guessed. Recent years have seen much optimistic experimentation with "flextime," "job enrichment," "job restructuring," and "worker participation." Japanese worker circles have sometimes been hailed as a humane successor to the inhuman assembly line. New Japanese automobile plants in the United States, such as a Mazda-Ford plant at Flat Rock, Michigan, have aroused much anticipatory admiration.

Yet as the social scientist Suzy Fucini, coauthor of a study of that plant's actual operation, says, "Most of these workers went into the plant thinking they could design their jobs and make major production decisions, but the reality was that the jobs were very restricted, even to having the movements set forth in a programmed work sheet." Exactly as were the movements of the factory workers at Frederick Taylor's Midvale plant a hundred years ago.

So Taylor lives. Important progress has been made since his time in understanding worker psychology and improving the industrial work environment, and the fact that the basic problem has proven so intractable does nothing to negate his work. In long retrospect, Taylor seems one of those pioneer geniuses who blaze so new a trail that it inevitably includes major wrong turns along with tremendous discoveries. This driven, obsessive man was the first person to see people as part of technology. As the management authority Robert H. Guest has written, "Despite the subsequent modification … Taylor's work stands as [a] unique contribution to modern industrial technology." His view may have been extreme, but it contained ineluctable truths.

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