

# Frederick Taylor's Apprenticeship

*The “father of scientific management” always looked back fondly on his days as an apprentice in a small manufacturing firm. It was an experience he believed every engineer should have. Ironically, his system of industrial efficiency helped make that impossible.*

by Robert Kanigel

One day in 1874, early in the apprenticeship of Frederick Winslow Taylor at a small pump-manufacturing firm in Philadelphia, the head of the shop approached him with a question. “Do you,” he asked, “know the rule?”

“What rule?” Fred Taylor replied.

“Do you know the rule?” the older man repeated.

*What was he talking about?* “I don’t know what you mean,” the boy fumbled.

“Do you mean to come here and ask to be an apprentice and do not know this foot rule?”

Oh, he knew a *foot* rule, of course.

So the man laid it down on the table in front of him. It was a foot rule with a difference. No numbers were engraved on it, only lines, the bare rulings themselves. The man laid the point of his knife on one of them. “Tell me quick what that means.”

Taylor couldn’t. With a moment’s trouble, he could have counted the lines and determined that it was, say, five and three-sixteenths inches. But he couldn’t do it instantly; he didn’t “know the rule.” So far as any self-respecting mechanic was concerned, he knew nothing.

Fred Taylor, age 18, had, on travels with his family in Europe, seen Bismarck’s Berlin and Louis Napoleon’s Paris. He could tell a Michelangelo from a Raphael, knew geometry, Latin grammar, and meal-

time manners. Back in Germantown, the leafy neighborhood on the outskirts of Philadelphia where he lived with his wealthy parents, he was almost an adult. But down here at the pump works on Race Street, hard by the storage yards, docks, foundries, brick works, and bolt makers of Philadelphia’s teeming industrial heart, he was a child.

In 1878, Taylor finished his apprenticeship and got a job in a Philadelphia steel mill. Over the next 12 years, he worked his way up—through family connections, hard work, and sheer ability—to chief engineer. Along the way he developed time-and-motion study, pay-incentive schemes, work standards, and other innovations, which together made for what he saw as a new “science,” one promising ever cheaper, more efficient production. Taylor—“father of scientific management,” as his champions called him and as it is inscribed on his tombstone in a Philadelphia cemetery—was the first real efficiency expert, progenitor of all the faceless, clipboard-clutching, stopwatch-clicking engineers who stalk the offices and factories of the industrial world.

At first, he was known only within American engineering and industry. Then, in 1910, in a case heard before the Interstate Commerce Commission, attorney (and future Supreme Court justice)

Louis Brandeis made Taylor a household name. Certain powerful railroads had petitioned the ICC for a rate hike. They didn't need it, argued Brandeis. What they needed instead, he said, was a dose of scientific management, Frederick Winslow Taylor's system of science-bred industrial efficiency. Overnight, Taylor was transformed into a celebrity, the man whose genius would save the railroads "a million dollars a day"—the figure that grabbed the headlines. Now, suddenly, efficiency was all, boundless prosperity its certain consequence. During World War I, Taylor's methods and ideas were embraced by the combatant nations. In the 1920s, they swept through the factories—and offices, kitchens, schools, and hospitals—of half the globe.

Lenin, in exile in Zurich, read Taylor's *Shop Management* (1903) in German translation and later, in a speech carried by *Pravda*, urged introduction of Taylorism to the new Soviet state. Antonio Gramsci, the Italian Communist revolutionary, absorbed Taylor's ideas. Weimar Germany was bewitched by *Taylorismus*, France by *taylorisme*. Twelve years after Taylor's death, Mussolini personally welcomed the international scientific management congress to Rome, met Taylor's widow, and exchanged a picture of himself for one of her sainted husband's.

Taylorism shattered the old ideological categories. More goods, lower prices, higher wages. *Everyone* wanted these. And all came courtesy of the new efficiency, born of beneficent science. Management and labor need no longer quarrel over how hard a man must work or how much he should earn; science, the impartial arbiter, would decide.

These notions were immensely seduc-



Taylor in 1873, the year before he entered his apprenticeship

tive, and by 1924 one observer could grandly declaim that Taylor's thinking had become "part of our moral inheritance." Today, it permeates modern life—alive in every work rule, every standard operating procedure, every fast-food burger cooked for just so many seconds.

Back from three years of travel in Europe with his family, Taylor had in 1872 enrolled at Phillips Exeter Academy in New Hampshire, aiming for Harvard and then law school. But during his last year, plagued by headaches induced by untreated vision problems, he dropped out. A few months later, he passed the Harvard admissions exam, but he did not enroll the following fall. Instead, after a fitful summer hanging around the house in Germantown, he started in as a patternmaker's apprentice.

In their letters to him at Exeter, his

parents had spoken of Rensselaer Polytechnic Institute, the Massachusetts Institute of Technology, or some other engineering school as an alternative to Harvard: no more Latin dictionaries with tiny type to cause eyestrain and headaches. But that possibility went nowhere. In Taylor's time, just seven schools offered mechanical engineering degree programs, and their 1874 graduates numbered only about 30. The formal education of engineers was still a new idea. A much older idea—apprenticeship—was a young man's far more customary path into industry.

This went for well-off young men, too—men confident that, 30 years later, they would be running the company and not a lathe. "We know of a number of cases," observed a Wilmington, Delaware, newspaper in 1871, "where the sons of our most highly respected citizens are either apprentices or journeymen in our machine shops. . . . Such do not, of course, expect to remain journeymen always. [But in the meantime], they daily don their blue overalls and blouses and work amidst the dust and grease, veritable 'greasy mechanics,' without any thought that their employment in any way compromises their honor and dignity, and without any loss of social position."

**A**pprenticeship, then, represented no radical turn for a rich man's son. In Philadelphia especially, Taylor himself would say, it had long "been customary for many young men with parents who are well-to-do to start at the bottom in our machine shops, industrial establishments and mercantile houses, and work absolutely on the same level as the regular employees of the shop." At the city's giant Baldwin Locomotive Works, almost one in five apprentices came from middle-class homes. "Professional and white-collar fathers saw a Baldwin apprenticeship," writes John K. Brown, author of a history

of Baldwin, "as a point of entrance for their sons into the high-technology industry of the generation, precision metalworking. . . . [Such apprenticeship programs as Baldwin's were] the engineering colleges of their era." Parents clamored to get their boys accepted. Several company directors had come up through its program.

It was a time when you could still hope to complete your apprenticeship, take a journeyman's job as a blacksmith, machinist, patternmaker, or molder, save your money, start your own shop, and make your fortune. Some, indeed, did just that. Taking *American Machinist* advertisers as emblematic of successful machinist-entrepreneurs, a legendary shop figure known as "Chordal" (a nom de plume of the magazine's editor) pictured their origins this way: At 18, most of them

were working in shops, drilling set screw holes in pulleys, cutting bolts, chipping new holes in old boilers, contriving ways and means to get old broken studs out of old cylinders, forging square keys out of round iron, butt-welding erroneous connecting rods, gouging out core boxes, gluing up segments, spitting white pine dust . . . and doing everything one man does for another man's money. They were not preparing themselves to take charge of probated fortunes. They were working.

Working, that is, and learning. In principle, every apprenticeship was an exchange—the neophyte's labor for the master's knowledge. But while the apprentice surely worked, the master, boss, or foreman didn't exactly "teach"; you didn't so much learn a craft as absorb it.

Especially at first, you simply *did*. You swept up. When one of the men asked for something, you fetched it. You were an errand boy. In a machine shop—the paradigmatic 19th-century workplace where skilled men shaped castings and forgings with machine-mounted cutters of hardened steel—you oiled the overhead shafting that delivered power to the tools. One

> ROBERT KANIGEL, a Baltimore writer, is the author of *The Man Who Knew Infinity: A Life of the Genius Ramanujan* (1991) and a forthcoming biography of Frederick Winslow Taylor, *The One Best Way*. He is also senior fellow of the Institute for Language, Technology, and Publications Design at the University of Baltimore. Copyright © 1996 by Robert Kanigel.

legendary steel industry figure, John Fritz, recalled of his apprenticeship in a blacksmith shop 35 years earlier that his first days were spent pumping a bellows and wielding a sledgehammer. When an apprentice did get something more substantial to do, an *American Machinist* correspondent observed of the traditional “shop-trained boy,” he was “set to work doing things [he could not] spoil by any chance.”

There was wisdom in this, of course. How better to learn the layout of the shop than to find a tool for someone? How better to learn to take orders? How better to ensure that the new boy didn’t wreck the shop?

**A**t first, the apprentice learned much else, too—to keep his limbs out of gears and the overhead couplings; to keep the oil lamp out of the jaws of the chuck; to button his shirt to keep hot, flying chips out. The price of such knowledge was scars, severed fingers, and burns.

Yes, all this was learning of a sort. But was it really what the apprentice, or his parents, had in mind when they looked ahead to four, or five, or seven years at the side of a master craftsman? What about the exchange? Where was the *real* learning? How was the boy to learn his trade?

Certainly, book learning counted for little. In his day, Taylor would assert, all his reading was confined to a single book on machine shop practice which he finished in a couple of hours and from which he gleaned little.

If books did not supply apprentices with much, neither did formal training programs. Nor could you expect some sage old workman to take you under his wing and confer upon you his store of knowledge. Rather, what the apprentice learned in the small machine shops of his youth, a veteran machinist recalled later, was mostly what he picked up from watching: “Machinists, as a rule, were not very liberal with information of the right kind. Once in a while someone would give you some good advice, but that was the exception.”

One report from around Taylor’s time found that apprentices got scant atten-

tion from anyone; whether or not they became skilled workmen depended largely on their own motivation. And *there* lay the “chief vice” of the apprenticeship system, a Philadelphia civic association heard it argued—that it had “scarcely anything of an educational character, and is exceedingly wasteful of the time of the learner.”

A veteran machinist might show the new boy a special tool, impart to him odd bits of shop knowledge. “To straighten a reamer which has sprung in hardening,” one apprentice recorded in his journal in 1858, “heat it with the hot tongs and suck plunger of straightening machine down very lightly—so Bob Bolton says.” And in time, the tips and teaching *did* add up.

But only with glacial slowness. One machinist with otherwise fond memories of his 1870s-vintage apprenticeship, W. D. Graves, could nonetheless concede in 1910 that “after a few half-days in the manual training department of a good public school,” a boy would learn more than “in a month of shop apprenticeship.” By late in the century, many apprentices felt they were working too hard, earning too little, and learning too slowly.

Moreover, the knowledge they imbibed was too often blind, profoundly conservative, and based on simply doing what you were told or as others in the shop did it. Taylor would tell how as an apprentice he’d fashion a tool bit: “We would heat the metal” in the blacksmith’s forge, “lay it on the edge of the anvil one way and ask a friend to hit it a crack, and then turn it around and repeat the process,” giving it a diamond-shaped point. Why that shape? Why not rounded, or blunted, or something else? Well, “in the primitive shops, such as the one in which I served my apprenticeship,” he explained, the diamond point was what you used, period. Here was tradition at work, the dead weight of the past.

**W**hen he was a boy back in the 1840s, 70-year-old J. F. Holloway said in a lapse into nostalgia at an American Society of Mechanical Engineers meeting in 1895, apprentices typically served in small

machine shops

owned by the man who operated them, or by a small partnership, and the apprentice had the privilege, the inestimable privilege, of living in the family, of getting up in the early morning and making the fire, milking the cow, and taking care of the horse, before he went to work in the shop. There was a certain community of feeling between the boys in the shop and the master.

But by Taylor's day, just 30 years later, that warmly communal era was gone forever. Rare was the boy who lived with his master. And many were those who didn't serve out their terms at all. Apprentices were traditionally "bound" for many years so that the master might ultimately recoup losses he suffered while the boy was still ignorant and useless. But now, impatient to earn \$12 a week or so, instead of the \$3 they might earn as apprentices, boys would leave long before their terms were up. Abuses, of course, went both ways; many employers exploited apprentices as cheap labor. The old skein of mutual responsibility had more and more unraveled.

Then as now, *apprenticeship* was one of those charged words, steeped in myth, romanticized with images of the Middle Ages, of boys in coarse garments absorbing wisdom from a grizzled old master in a tiny shop. But the 19th century was not the 13th. It was a time, writes W. J. Rorabaugh in *The Craft Apprentice*, that "confused many Americans, who accepted uncritically the belief that whatever was called an apprenticeship must in fact be one." During this period—one foot in the preindustrial past and the other on the brink of modernity—it was "not always easy to tell the difference between a true apprenticeship and a false one."

Fred Taylor's own apprenticeship was, if not exactly a throwback to the Middle Ages, something close to a "true" one.

**A**t Enterprise Hydraulic Works (known also as Ferrell & Jones, after its proprietors), Taylor took up the craft of the patternmaker, the highly skilled worker who made the wooden patterns that produced hollows in hard-

pressed sand to mold molten metal, producing iron and brass castings.

Patternmaking demanded great skill and intelligence. As one trade manual from the turn of the century observed, a machinist at least had the rough casting itself to guide his work, something to see and touch; but the patternmaker "must *imagine* the casting before him, and must build something in wood which will produce that casting in metal." Some of what he made corresponded to the final shape, some to the negative of the final shape. And he had always to journey, in his mind's eye, between those abstract realms, to imagine dark recesses that twisted and curled in space and through which white-hot metal would ultimately flow.

If any trade, then, was apt to subvert a rich boy's preconceptions about men who worked with their hands, it was that of the patternmaker. At Ferrell & Jones, a company that occupied two attached buildings about the size of a modern suburban house, Fred Taylor worked with three or four such overall-clad virtuosos every day. "The very best training I had was in the early years of [my] apprenticeship in the pattern shop," Taylor wrote decades later, "when I was under a workman of extraordinary ability, coupled with fine character. I there learned appreciation, respect, and admiration for the everyday working mechanic."

Before his apprenticeship, a family friend, Ernest Wright, later recorded, Taylor had shown scant interest in things mechanical. And others of Taylor's friends noted that he showed real antipathy to working with his hands. But, Wright went on, "the influence and teaching of John Griffith, head patternmaker at Ferrell & Jones, made a permanent impression on Fred and laid the foundation for his life work."

Young Fred ate breakfast each morning at 5:30, and took the train (or, less likely, the horsecar) into work. By 6:30, he was sweeping the floor of the shop. Soon, with the steam engine powered up and the other workmen at their places, he was busy taking orders, doing as he was told. For 10 hours or more, he worked amid patterns, and pieces of patterns, in pine or

mahogany—almost comically light and soft compared with the metal pieces they made; lengths of wood and pots of glue, jack planes and grinding wheels, routers, rabbet planes, chisels and gouges, squares and calipers.

All day long the soft gloom of the shop enveloped him; in that era before the electric light, only areas of the shop near the windows or beneath a skylight enjoyed bright light. Especially during the winter, night work left the men hunched over candles, lanterns, or gaslight—making for, in one contemporary observer’s choice phrasing, “a black immensity with little spots of light in it.”

**D**uring those early months, everything was new for Fred Taylor: working with his hands, doing menial jobs, coming home exhausted at day’s end. So, too, was working beside men who, unlike him and his friends, *had* to earn their livings. Euclid and Cicero were a distant memory now. The gentleman’s son from Germantown had stepped into the rough-hewn world of working-class Philadelphia.

It was doubtless some time early in his apprenticeship that, as Taylor told it later, he’d come home to his parents’ house in Germantown at the end of the day, tired and drained, only to be greeted with a light supper of rhubarb—after a day down on Race Street, rhubarb! And later, in the

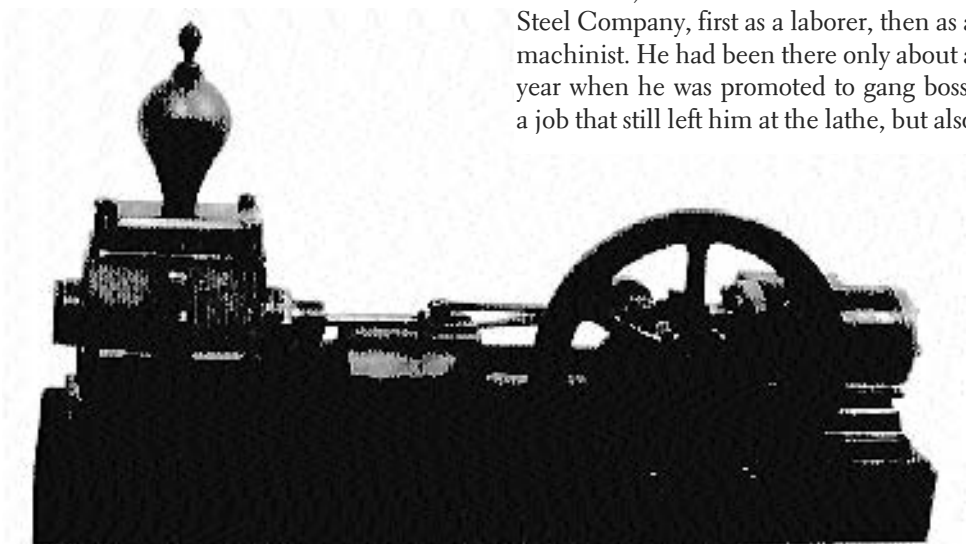
calm of the dining parlor, as a servant cleaned up the dishes, he would listen to his father read, in French, the first volume of Hippolyte Taine’s *Les Origines de la France contemporaine*.

The next morning, often before dawn, he was off to work again, walking down the steep hill flanked by low stone walls. “I look back upon the first six months of my apprenticeship as a patternmaker as, on the whole, the most valuable part of my education,” he once wrote. “Not that I gained much knowledge during that time, nor did I ever become a very good patternmaker; but the awakening as to the reality and seriousness of life was complete, and, I believe, of great value.”

He was strangely happy at his work. As he would later tell his wife, in those early days he would throw “himself entirely into the life of the shop, leaving each morning . . . in overalls, lunch pail under his arm. From then on, he showed such enthusiasm for his new work that his old friends . . . wondered if perhaps they ought to be following his example.”

**I**n 1876, Taylor took six months off and served as a kind of trade show booth sitter for a group of New England machine tool manufacturers at Philadelphia’s Centennial Exposition. After that, he returned to the pump works and served a second apprenticeship, this time as a machinist.

In 1878, he went to work at Midvale Steel Company, first as a laborer, then as a machinist. He had been there only about a year when he was promoted to gang boss, a job that still left him at the lathe, but also



*A miniature steam pump that Taylor made to show what he had mastered in his apprenticeship*



*Two workers at Tabor Manufacturing, in Philadelphia, about 1905, following Taylorist time sheets*

involved overseeing the work of others. “Now, Fred,” said some of the men, coming up to him after he’d been named gang boss, “you are not going to be a damn piece-work hog, are you?”

That, of course, is about what he *did* become: first as gang boss and then as foreman, he set about getting more work out of the men. And over the next two years—through argument, cajolery, threats, and firings—he succeeded. But it was a Pyrrhic victory. “I was a young man in years,” he recalled bitterly, “but I give you my word I was a great deal older than I am now with the worry, meanness, and contemptibleness of the whole damn thing. It is a horrid life . . . not to be able to look any workman in the face all day long without seeing hostility.”

He had lost the friendship and acceptance of the men. And not, in his mind, only those at Midvale. The four years of his apprenticeship, just recently past, haunted him. At the pump works, he had enjoyed a comradely ease among the men, cussing up and down with them, working by their side. If only in retrospect, it must have seemed to him a kind of personal Eden.

How, at Midvale, to restore that lost

Eden? The men said they could push their machines and themselves no harder; he was sure they could. So, stopwatch in hand, he resolved to *study* work, tease apart its elements, establish quantitatively a fair day’s work. He’d rise above petty workplace bickering, let cool, neutral science decide. The result was time-and-motion study, and the rest of the baroque assortment of management tools that came to be known as the Taylor System.

After leaving Midvale in 1890, Taylor took on a succession of industrial clients, bringing to each one some or all of the innovations he had pioneered at Midvale. At Bethlehem Steel, which he joined in 1898, he developed a new, fast-cutting tool steel that revolutionized the machine shops of the world. And—if his famous account, today enshrined in the world’s management textbooks, is to be believed—he got a laborer he called “Schmidt” to load 47 tons of pig iron a day instead of 12.

During this period, too, he wrote the first in a series of influential papers on shop management.

Taylor nominally retired in 1901, but over the next decade he brought legions of industrialists and other acolytes to his estate outside Philadelphia for long, nonstop perorations about his system. Then, in 1910, came Brandeis, the Eastern Rate case, the million-dollars-a-day fuss, and celebrity. The following year’s publication of Taylor’s *Principles of Scientific Management*, which was translated into a dozen languages, projected his ideas onto the world stage.

The better to stir his audience, Taylor would state his views starkly, sometimes brutally. And along the way, his high-handed methods estranged many with whom he had worked, bosses and workers alike. The bosses didn’t like the higher wages he insisted ought to go with higher output; nor that, in turning to science for answers, he took from old-line managers many of their prerogatives, denying them their hunch-ridden ways of old. Meanwhile, in 1912, organized labor had Taylor

hauled before a House Committee to Investigate the Taylor and Other Systems of Shop Management, where he endured a four-day inquisition. This cruel man's system, said his enemies in labor, made for just another brutal speed-up; workers had to toil harder and faster than ever, and any extra pay was apt to be short-lived.

**B**ut labor's hostility went deeper than that. In a Taylorized factory, you worked not just harder and faster but by someone else's lights, not your own. Step-by-step, minute-by-minute instructions—the time the job ought to take, just *how* you were to do it, in what order, with what tools—came from on high. Your duty was to execute them, like a machine; the word *robot* had not yet been coined. In the dark imaginings of Taylor's most hostile critics—and often in practice, too—human work was being stripped of much of what made it rewarding. Taylor's experts and engineers did the thinking, while you were consigned to mindless doing.

Fred Taylor took strands of thought and practice already present in the late 19th century and wound them into a thick, muscled cable—Taylorism. And Taylorism helped seal the fate of the traditional apprentice system, weakening it even as an

ideal. If apprenticeship promised a slow accretion of knowledge through the work itself, Taylorism insisted on a passing down of knowledge, by rule and dictum, from on high. If apprenticeship tended to breach class lines, Taylorism buttressed them. If, for the craft apprentice, thinking and doing blurred, Taylorism sharply partitioned them.

Some critics have argued that through its army of specialists, Taylorism created *more* skilled jobs, not fewer, and threw open the ranks of white-collar functionaries to many more people. Maybe so. But it almost certainly led to less of the kind of skilled work that seamlessly melded thought *and* act, brain *and* hand, in the same 10 hours.

Which, given all that Taylor's own apprenticeship meant to him, represents no inconsiderable irony. All his life, he would look back wistfully to those days at the pump works. Later, when he was an important man, he'd tell anyone who'd listen that no engineering graduate should leave school without a year in a shop like that. And yet his system, the system that made his name known around the world, discouraged just the sort of rich, lingering work experience he had enjoyed as a young man in that small shop on Race Street.