Applying Scientific Management Principles to Railroad Repair Shops — the Santa Fe Experience, 1904-18

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In the early 20th century many American firms reorganized their men and machines according to the principles of scientific management as set forth by such efficiency experts as Taylor, Towne, Emerson, and Gantt. Students of labor and business history have studied scientific management in such metal factories as the Watertown Arsenal, but no one has analyzed closely this work reorganization in the railroad industry. Two major lines, the Santa Fe and the Canadian Pacific, introduced major principles of scientific management in their construction and repair shops between 1904 and World War I. In this paper I shall examine how Taylorism was applied on the Santa Fe between 1904 and 1918. I shall try to answer six questions. What was the nature of shop work on the Santa Fe in the early 20th century? Why was scientific management installed? What did the work reorganization look like? What were the results? Why was it ended, never revised, or widely copies by other railroads? Finally, what are some of the broader implications of the experiment?

WHAT WAS THE NATURE OF RAILROAD SHOP WORK ON THE SANTA FE?

Railroad shops specialized in the construction and repair of locomotives and freight and passenger cars. Although some lines built part of their locomotives and cars, most of this work was performed by such outside firms as the Baldwin Locomotive Works. Therefore, most railroad shop work was the repair of rolling stock and engines. The task was done by railroad mechanics -- machinists, boilermakers, blacksmiths, carmen, their helpers and apprentices, as well as common laborers. In the first two decades of the 20th century, railroad shopmen were more numerous than the train and enginemen and just as essential to their companies' operations. These shopmen toiled in roundhouses and in small and large shops located at various points along the line. While the men in roundhouses and small shops did minor

repairs, the mechanics in larger facilities performed such time-consuming tasks as locomotive rebuilding, as well as some new construction.

The Santa Fe Railway's chief repair and construction facilities were located in Topeka, Kansas. These shops employed 1,600 men in 1900, and by 1918 the total was approximately 3,000. In addition, medium-sized shops (employing between 250 and 750 men) were located in such places as San Bernardino, California; Ft. Madison, Iowa; and Cleburne, Texas. Smaller contingents of shopmen were found in roundhouses and adjacent shop facilities at nearly every division point along the system. Except for the Topeka car shop employees (who performed piecework), all Santa Fe shopmen were paid on an hourly basis.

Shop work on the Santa Fe was varied, although at times it approached the repetitive nature of mass production. Railway mechanics disassembled and rebuilt locomotives and repaired or built freight and passenger cars. In the larger shops this work was done by an increasingly specialized labor force. Occupational titles reflected this specialization: there were (in Topeka) blacksmiths, hammersmiths, and springmakers; there were inside and outside coach carpenters, car painters, air brake repairers, and car repairers; there were erection and machine machinists, as well as various types of helpers and laborers. Sometimes the work resembled mass production. For example, when the Topeka car shops built 200 furniture cars in 1901, many of the tasks were repetitive because each car had the same size and style doors, axles, supports, and so on. But most shop work was repairing existing rolling stock. There were many types of locomotives, freight, and passenger cars. Although they had many common parts, there were countless variations in their structure, which meant that the work was more varied and required more skill than repetitive assembly-line mass production. (During the age of steam, the Santa Fe had 280 different classes of locomotives.)

WHY WAS SCIENTIFIC MANAGEMENT INSTALLED?

By introducing scientific management, the Santa Fe hoped to check rising repair costs, increasing union influence over shop work, and general deterioration in worker-management relations.

The company's concern for efficiency and cost reduction was shared by other corporations in this period, but the Santa Fe's interest was especially strong because of its recent recovery from bankruptcy and its new leadership. A depression had forced the already troubled Santa Fe into receivership in December 1893. Two years later the railroad emerged from receivership with a different board of directors, reduced mileage and debt, and a new president -- Edward Payson Ripley. The new chief executive and his staff achieved dramatic improvements by trimming unprofitable

trackage, instituting such cost-reduction programs as conversion of coal-fired locomotives to less costly oil, ordering new construction only after careful study, and reinvesting all profits into the company. From 1898 to 1900, the company's surplus rose, the board resumed payment of dividends, and rising profits generated by Ripley's prudent management and rising national prosperity allowed the Santa Fe to embark on a modest expansion program.

Rising repair expenses, however, worried corporate executives. Maintenance costs, especially for locomotives, were rising alarmingly on the Santa Fe and other roads. The cost of repair per locomotive on this line increased from $2,032 in 1897 to $3,772 in 1904. The culprits were rising wages and material costs, as well as declining labor efficiency. Ripley became convinced that trade unions were detrimental to his quest for high productivity and employee loyalty. The Santa Fe had earlier signed agreements with such shop unions as the machinists, blacksmiths, boilermakers, and carmen in 1892, due mainly to the firm's weak condition. Although the 1893 depression and disastrous Pullman strike of 1894 had undermined union influence on the road, by the turn of the century returning prosperity helped give shopcraft organizations a new sense of power. In Topeka these shop unions exercised considerable influence over foremen and working conditions in the period 1899-1903, despite the absence of written contracts for three of the four groups. At such company shops as San Bernardino, Cleburne, and Needles, California, labor organizations called strikes over such matters as hours, pay, and the discharge of union members, much to the disgust of company officers.

Demands of the machinists' union brought the simmering union-management conflict to a crisis in 1904. This labor organization had stepped up its activity on the Santa Fe in late 1903 with the goal of organizing enough men to force the company to grant a written contract and improved wages for the entire system. At that point the only written contract for machinists was on the Gulf Lines (in Texas). President Ripley and Vice-President J. W. Kendrick decided, however, that the rising union influence had to be halted. The machinists' union taught the men "that their employer is their natural enemy," said Kendrick, and counseled workers to do as little as possible. The vice-president condemned the proposed machinists' union agreement because it would reduce efficiency and output. For example, one part of the proposed agreement specified that such tasks as running lathes and stripping engines be done only by machinists. Kendrick argued that such tasks could often be performed by lower-paid helpers or handymen. The company knew that its flat rejection of the machinist proposals would probably trigger a strike. But the cost of such a conflict, Ripley wrote, would be less than the additional expense of one year under the proposed union rules.

The strike came in May 1904 and lasted four years. The machinists and the boilermakers and blacksmiths who joined the strike went down to defeat, and the company maintained nonunion repair shops until 1918.

In early January 1904 nearly four months before the shopmen's strike, the Santa Fe had hired efficiency expert Harrington Emerson to improve repair shop operations. After his arrival in Topeka, he sent telegrams to Kendrick to outline the consultant's purposes. They were to cut shop costs below those of other American railroads, to find the best obtainable equipment for certain kinds of work, utilize to the fullest existing company equipment, and to keep constantly in mind the labor problem. The company hired Emerson not to provoke a strike but to reduce costs and solve labor problems. If a conflict occurred, however, he felt that his system could help thwart the effect of the strike. In Emerson's words, "If peace comes, let us introduce these methods while they can be done quietly. If 'war' occurs, let us introduce them as one means of defense."

A more detailed version of his objectives appeared in business periodicals in 1906. These goals were (1) restoring harmonious relations between employer and employee, (2) freeing workers from the tyranny of petty officials, on the one hand, and the "individuality-destroying union domination," on the other, (3) giving the line more reliable and efficient workers, (4) raising automatically the pay of competent employees without interference from foremen, (5) increasing shop capacity without adding new equipment, (6) improving the reliability and efficiency of the work performed, and (7) accomplishing all this while reducing company repair costs.

Thus, this cost-conscious railroad management wanted to lower repair costs and make the output more efficient. An integral part of these tasks was the elimination of union influence in the shops. Emerson promised that his system would meet those goals.

WHAT DID THE SYSTEM LOOK LIKE?

Emerson's scheme had three major parts -- betterment of methods and equipment, centralized manufacture of material and tools, and the individual effort reward system (that is, the bonus system of pay). Before I explain these components, I shall provide a little information on the man who installed them. Harrington Emerson was a self-confident, colorful efficiency expert. Although an admirer of Frederick W. Taylor, the father of scientific management, Emerson later became an antagonist and competitor. Emerson's concentration on ambiguous "principles of efficiency," and emphasis on the labor features of Taylor's system (especially time study and incentive wages) drew Taylor's

wrath for being dangerous "short cuts." Nevertheless, at the time of his appointment to the Santa Fe, Emerson considered himself one of Taylor's disciples. In major respects, Emerson's changes on the Santa Fe (his most important corporate assignment) reflected Taylor's influence, as will be documented later. (Among Emerson's pre-1904 ventures were "systematizing a large new western university," attempting to organize US postal routes in The Yukon, and managing a factory of 100 employees.)

The first of Emerson's three main reforms was betterment of methods and equipment. His goal was to ensure that shop conditions, methods, and equipment in Topeka would promote the highest efficiency. For example, he studied the belting which transmitted power to machinery. Improvements in belting material and maintenance lowered failures from 300 to 55 per month and reduced monthly belt maintenance from $1,000 to $275. He redesigned many machine tools so they could use high-speed steel, which allowed workers to perform tasks quicker. In addition, he designed dispatching boards. The shop machinery board had separate spaces for each machine, along with a peg for requisition slips. By examining the board, the general foreman could know which jobs were to be rushed (high-priority work had a special color tag) and could assign future jobs for each machine. Hence the foreman could prevent tie-ups and idle machines and men. Finally Emerson greatly improved blacksmith shop furnaces so that men spent less idle time waiting for the fires to reach operating temperature.

The second element of Emerson's innovations was centralizing in Topeka the manufacture of tools and materials for the entire Santa Fe system. For example, the Topeka blacksmith shop began making over 200 standardized forgings (of bolts, wrenches, and so on) for the entire system. Previously the company had done this work at several points along the line and occasionally had given the work to outside contractors. Concentrating their manufacture allowed the railroad to produce them more cheaply.

Probably the most important of Emerson's three innovations was the individual effort reward system, also called the bonus system of pay. The basis for this wage incentive scheme was time study. Using stop watches, Emerson and his assistants studied thousands of individual operations in the Topeka shops. The staff then decided the appropriate time (called "standard time") for the tasks and composed corresponding bonus schedules of pay. Every worker assigned to perform an operation received his base hourly pay regardless of how slowly he toiled. But if the employee performed his assigned task in the "standard time," he was said to be "100 percent efficient" and received extra money. If he performed at 66 percent efficiency or less, he received no bonus; 80 percent efficiency led to a 3.25 percent bonus, 90 percent efficiency drew a 10 percent bonus, 100 percent efficiency merited a 20 percent bonus, and so on. Many tasks were

done by individuals, but when there was group work, each worker was given a bonus based on the output of his group or gang. In addition, foremen and high-level shop supervisors received bonuses based on the performance of the men under them.

The record keeping required for such a system was formidable. Bonus inspectors examined the repair work performed by each employee, noted on special forms the time the task required as well as the standard time, and then recorded the base wage and bonus that the employee received. Emerson introduced Hollerith tabulating machines to the Topeka shop offices so that all these records could be processed by coding, punching, and tabulating cards. He used mechanical tabulation of records to calculate the wages and bonus for each worker, work gang, department, and shop, as well as the cost of each repair operation. This accounting system could, therefore, show management the people or shops in need of improvement. To coordinate all of Emerson's changes, he set up a Betterment Department in Topeka. As his innovations were extended to other company shops in the years 1905 and 1906, Betterment Department personnel conducted time studies of work operations and bonus inspectors recorded output in other shops. The tasks were formidable, for Emerson had to make changes in 20 repair shops, large and small, employing 12,000 people scattered over 9,000 miles of railroad. Eventually the Betterment Department merged into the line's regular Mechanical Department organization. Emerson left the Santa Fe in 1907 for a consulting job with American Locomotive, but he left behind a group of experts headed by Assistant Superintendent of Motive Power H. W. Jacobs, himself a railroad man and long-time Emerson assistant.

In most respects Emerson's changes incorporated the major features of Taylor's scientific management. According to Daniel Nelson, the major elements of Taylorism were preliminary technical and organizational improvement, a planning department, functional foremanship, time study, and incentive wages. Preliminary improvement on the Santa Fe included changes in belting and blacksmith furnaces. Planning was performed by the Betterment Department. Functional foremanship was present to a limited degree: that is, there were separate gang bosses, inspectors, and time and cost clerks. Finally, time study and incentive wages were integral to the bonus pay system.

WHAT WERE THE RESULTS?

As Emerson's scheme spread from Topeka to all other shops on the Santa Fe system, outside observers and company officials both noted that machines and men moved more quickly and more efficiently, generating a substantial monetary savings. The work reorganization was not, however, without its problems. There was

some resistance from workers even after unions were thrown out, and even some supervisory personnel were opposed to the innovations.

Among those noting the faster work pace was Topeka shops general foreman D. E. Barton, who said this about the bonus system: "It changes the men from half-hearted, listless... workmen to striving, alert... workers who... are willing to do whatsoever their hand finds to do with all their might." There were several reasons for the faster pace. First, workers could, and often did, earn substantial bonuses for doing tasks quickly. For example, 54 percent of the Topeka machinists earned bonuses of 10 percent or more during September 1906. Second, foremen and higher level supervisors had extra cause to push their men hard because the former received bonuses based on their subordinates' performances. Third, workers knew that their output was recorded by the elaborate cost accounting system. The company used these records to promote, warn, or occasionally fire workers. Finally, Emerson eliminated many production bottlenecks. For example, by improving belting and blacksmith furnaces, he ensured that the idle time of men and machines was minimized.

These improvements were reflected in higher output and decreased unit costs. After two years of work in Topeka, Emerson's system increased shop output 57 percent, decreased unit cost of production 36 percent, even while the average pay of the men rose 14.5 percent. Per-unit cost of maintenance for shop machinery and tools fell from $10.31 (in the period 1903-04) to $4.89 (in the period 1906-07) on the Santa Fe, while per-unit cost on another Western line -- the Southern Pacific -- actually rose slightly during the same time. In 1906 railroad journals reported that the Santa Fe's new system had restored employer-employee harmony, improved worker efficiency and reliability, and that for every dollar of supervisory and bonus pay, the company had saved 10.

Work reorganization, however, was not without its problems. The company asserted that workers liked the new system, and that the only grumbles came if some were not given the opportunity to work for a bonus. But while some liked it, others did not -- especially union members. In May 1904 the machinists' union struck the entire system, and soon after the Coast Lines boilermakers and blacksmiths joined the walkout. Although scientific management was not the cause of their protest (since they did not realize that it was being installed), its introduction stiffened their resolve; they vowed to stay out until the Emersonian bonus plan was removed. In April 1905 boilermakers in Eastern Lines shops including Topeka struck to protest installation of the bonus system in their departments. The shop unions eventually called off their protests in 1908, but only after they had disrupted repair operations for several years, especially on the

Coast Lines. Protests extended beyond the ranks of the union men. For example, one-fourth of those who quit the Topeka boiler shop in April 1905, were nonunion employees. A year later non-union machinists at LaJunta and Raton struck to protest installation of the bonus system there. In 1907 a Cleburne carman reported that the bonus system had driven out most of the older, experienced workers in his shop.

Employees complained that the bonus forced workers to toil at a killing pace, that the rate schedules were sometimes slashed, and that employees had no collective input into rate setting. Union men also charged that the company increased the number of apprentices and semiskilled handymen at the expense of skilled journeymen, and that the system fostered sloppy work and boss favoritism. The degree of truth in some charges is hard to measure, but payrolls and other records indicate that the ratio of apprentices and handymen to journeymen did rise, that the company did set rates unilaterally, and in some shop departments did cut rates. Rewarding hard work by premiums did not solve all their labor supply problems. A shortage of skilled railway mechanics in 1907 prompted the company to institute an elaborate apprentice-training program in its shops. The Brotherhood of Locomotive Engineers evidently believed that shopmen's complaints were legitimate, for when the company attempted to extend the bonus system to enginemen, the Santa Fe engineer's union forced management to end the experiment in 1909.

Resistance to the innovations also sprang from foremen and higher-level supervisors. Although publicly praising the "hearty cooperation" of several Topeka department heads in 1906, Emerson later revealed that during the first year of his Santa Fe work, mechanical department officials were "almost without exception hostile." Perhaps the most powerful company opponent of Emerson's schemes was Superintendent of Motive Power A. A. Lovell. Lower-level supervisors also showed opposition. On the Topeka machine shop erection floor, one of Emerson's assistants found that "most of the sub-foremen were opposed and inclined to thwart our efforts." Emerson and his staff also encountered some resistance when they brought their work changes to such company shop as Albuquerque. Fortunately he had the total support of President Ripley and Vice-President Kendrick, but by the time of his departure in 1907, Emerson had generated considerable ill-feeling.

Another problem with the work reorganization was "paper efficiency." A writer for *American Machinist* in 1912 pointed out that because the Santa Fe used reports based on bonus earnings to compare shop performances, the system had a "great tendency to make different points 'give them [top level management] any old efficiency they want'." For example, 'since it was impossible to estimate in advance the amount of repair work necessary for a

given engine, the foreman might overestimate the amount needed. Similarly, workers might discover less work was required than anticipated, but try to convince the bonus inspectors that they had performed more than they actually had done. "As every increase in efficiency of the men also increases the 'efficiency' and the bonus of the inspector, the foreman, and all above, everyone has benefited financially by this move." It is probably no coincidence that after several complaints of this activity in 1911 and 1912, the Santa Fe abolished bonuses for foremen and most higher level supervisors by 1913. Nevertheless even *American Machinist* believed that Emerson's system had reduced locomotive and car maintenance costs on that line.

WHY WAS IT ENDED, NOT REVIVED, OR WIDELY COPIED?

World War I, a labor shortage, inflation, government takeover of the railroads, trade union power, and worker grievances combined to end the bonus pay portion of Emerson's innovations in 1918.

The company's carrot-and-stick approach to shop labor relations worked for some years. The Santa fe rewarded hard-working employees with large monthly bonuses and increased the base hourly pay rates when unions threatened to make a comeback among the railway mechanics. At the same time the company refused to recognize unions in the shops and fired or refused to employ known union members. After the strikes and high turnover of the early years of Emersonian change, the Santa Fe quit rates settled down. Incentive pay and the apprentice program provided an ample supply of skilled, loyal workers. Shopcraft union journals contained complaints of arbitrary company practices, especially those related to the bonus system. However, these very journals also carried evidence that the lure of the bonus hindered union organization attempts.

With the passage of time, however, signs of trouble appeared. The base hourly pay rate of many Santa Fe shopmen began to slip below those of unionized lines, forcing mechanics to rely more on their bonus. Schedule cutting in some Topeka shop departments reduced the number receiving bonus pay. World War I brought a rapid inflation which outstripped company pay hikes; the war also caused a labor shortage and government intervention in labor-management disputes to keep the flow of war goods going. Government takeover of the Santa Fe and other lines in late 1917, along with United States Railroad Administration (USRA) support of labor unions, helped foster a wave of railroad shop organization across the nation. In February 1918, several thousand Santa Fe shopmen in Topeka rushed to join shopcraft unions and applauded their leaders' promises to end the bonus. Soon all

company shops were organized and workers demanded wage raises and the scrapping of bonus pay. The Santa Fe ended the bonus in September 1918, several months before the USRA ordered an end to all incentive wage schemes on railroads whose shop employees voted to end them. The work pace slowed and worker influence in the shops remained strong throughout the period 1918-22. Thus the bonus, a key element in scientific management, disappeared because of worker pressure, not management dissatisfaction.

When management later gained the upper hand, the bonus system was not revived. Shopcraft unions remained strong in Santa Fe shops until their demise during the 1922 nationwide shopmen's strike. In an effort to stiffen striker resolve, union leaders asserted that the bonus system would return if the strike was lost, but incentive pay did not come back. Remaining evidence sheds little light on why this was the case. One factor was probably the passing of Emerson's most powerful corporate advocates. Santa Fe President E. P. Ripley had retired in 1918 shortly after USRA takeover, and J. W. Kendrick had departed earlier. The antagonism generated among supervisors as well as workers probably also was a reason why the incentive wage was not revived. Other elements of scientific management presumably remained. These included improved belting, better blacksmith furnaces, dispatching boards, and Hollerith tabulating machines. The company continued the centralized manufacture of materials and maintained a standardized supply system. In 1921 the company reported an experiment with maintenance-of-way crews, an experiment that resembled parts of Emersonian ideas. To spot inefficient track gangs, the company standardized its track maintenance time charges on one segment of the Gulf Lines. Officials issued dictionaries with exact definitions of 70 classes of work (such as "putting in ties"), and required track foremen to make daily reports indicating how many man-hours were spent on each category; but there was no mention of incentive pay.

Emerson's work on the Santa Fe was not widely copied. To my knowledge, he introduced his form of scientific management to no other railroad. In 1902 he did install a premium pay scheme in Union Pacific shops (unions forced the company to stop the change in 1903), and one of his Santa Fe assistants later left the line and established a bonus pay system on the Chicago & Eastern Illinois Railroad. While a consultant for the American Locomotive Company, Emerson introduced incentive pay, but this triggered a strike and the firm later dropped the scheme. Taylor disciple Carl Barth installed scientific management in the Pullman Palace Car shops, 1913-19 but, like American Locomotive, the installation was primarily for construction and not repair. The only other railroad whose shops were Taylorized was the Canadian Pacific, but this was engineered by H. L. Gantt.

On the other hand, many railroads installed what might be considered a watered-down version of scientific management -- piecework. Although a few lines such as the Norfolk & Western and the Burlington paid railway mechanics by the piece before 1900, most railroads introduced the measure in the early 20th century. By 1911, some 65 percent of blacksmith shop work was paid by the piece, and by 1917, 60 percent of car shop work was done by the same method. Major lines using piecework in their shops included the Pennsylvania, the Erie, and the Union Pacific.

Many railroads preferred piecework to Emerson's bonus because they felt that they could get most of the advantages with few of the drawbacks. Both were incentive-pay systems designed to stimulate worker production. Both were based on examination of various shop jobs, which included calculation of the standard time and compensation for each task. Most piecework plans required additional clerical and supervisory people (such as piecework clerks, inspectors, and "experts"), but its advocates asserted that it had less supervision costs in proportion to output and was cheaper to install and supervise than Emerson's bonus. Of course, Emerson's innovations produced a more systematic rationalization of the workflow (no piecework plans mentioned dispatching boards, for instance), but its price tag was higher.

The very railroad and technical journals which had carried articles favorable to the Santa Fe's scientific management program also contained many critical letters. Skeptics charged that a good portion of Emerson's improvements came because the shops had been in such sad shape at the start due to the strikes. When in 1910 Louis Brandeis used Emerson to bolster his contention that railroads could save millions (and thus not need a requested rate hike) by being more efficient, skeptics charged that Emerson's claims for an annual savings of $5 million were not verifiable by annual company reports. The *American Machinist* charge of "paper efficiency" probably had an impact in railroad circles. A source of difficulty for anyone attempting to standardize railroad shops was that their repair work was largely of an uncertain nature and, therefore, "much more difficult proposition to standardize than manufacturing work." In addition, only the largest and most wealthy railroads stood to gain substantially from scientific management, because only they had the resources to eliminate union resistance and pay the overhead involved in installing work reorganization.

BROADER IMPLICATIONS?

My research suggests that scientific management faced two obstacles in railroad shops, one from the workers and one from the managements. Were it not for stiff worker resistance, the

system might have spread farther. Perhaps equally as important, railroad managements were often skeptical of major reorganization of their shop operations, for understandable and not-so-understandable reasons.

The bonus system ended on the Santa Fe in 1918, not because the company decided that it was no longer useful but because it was under intense pressure from shopmen, their unions, and (indirectly) the USRA. Several months later worker pressure, abetted by USRA officials eager to keep the railroads running, led to the demise of piecework on other rail lines. Similarly an earlier Santa Fe attempt to expand the bonus system to enginemen was halted by the unbending resistance of the Brotherhood of Locomotive engineers. The Santa Fe's long and costly struggle to defeat the shopcraft unions during the early stages of scientific management was one reason that smaller lines such as the Ann Arbor Railroad decided against the introduction of incentive pay. In the absence of such employee resistance, the Santa Fe might have expanded Emerson's innovations and retained them much longer. More lines might have followed suit. In this respect, my results conflict with the findings of Daniel Nelson, who has argued that scientific management experts encountered stiffer opposition from managers than workers.

On the other hand, the Santa Fe experience shows that management opposition was formidable, within the company and the rest of the railroad industry. The varied, uncertain nature of railroad repair work made scientific management's application less appropriate than for mass production. In certain cases it was simply easier to use a shortcut version -- piecework. The source of some management opposition, however, was of less laudible origin. Many railroads had "self satisfied attitudes" and were not open to change. Often railroads were jealous of each other and, therefore, did not wish to adopt a method employed by another. Considerable skepticism to change was generated by resistance to outside experts. Emerson was indeed an outsider. His chances for advising other lines was probably reduced by his testimony during the 1910 rate hearings. These hearings generated considerable debate within the railroad industry about efficiency, much of it defensive in nature. A common response to the inefficiency argument is found in a 1912 *Railway Age Gazette* editorial.

> There is no question that there is room for increased efficiency in almost any department of most of the railroads of this country, but if real results are to be obtained is it not far better to accomplish them through the regular organizations and under the direction of men of long and wide experience in the department which they concern?

It is significant that the most widely implemented innovation, piecework, was installed mainly by men from within the railroad industry.

The decline of the American railroad industry can be traced to such factors as increased competition from more efficient modes of transportation, and the lopsided policies of a federal government which heaped subsidies on alternate modes while it denied railroads needed rate hikes in the pre-World War I era and later (during the Kennedy Administration) denied them the opportunity to lower rates. The evidence of this paper might lead one to add another factor for railroad woes -- managements' stubborn refusal to recognize the potential of Taylorism. I believe, however, that criticism of railroad corporate management must be tempered by recognition of two other factors -- the recalcitrance of railroad labor toward such innovations, and the legitimate doubts which companies had about the applicability of scientific management toward their repair establishments.

NOTE

*Most of the material in this paper comes from Carl Graves, "Scientific Management and the Santa Fe Shopmen of Topeka, Kansas, 1900-1915," Ph.D diss., Harvard University, 1980.

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