The Lure of Technology and the Appeal of Order: Railroad Safety Regulation in Nineteenth Century America

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In the year ending June 30, 1894, 1,823 workers died on American railroads. Another 23,422 were seriously injured. All told, 1 employee out of every 428 had been killed, and 1 out of 33 had been injured. Most of the victims were trainmen, the class of employee who routinely scampered over, under, and between cars, often with the train in motion, uncoupling cars and setting hand brakes. One out of every 156 trainmen had died in service; 1 out of 12 had received serious injury [19].

These statistics were staggering, even by the standards of the day. But in 1894 one could reasonably assume that they would mark a low point. During the previous year Congress had passed the Safety Appliance Act, which called for railroads over the next five years to place automatic couplers on all freight cars. In addition, all trains were to have automatic brakes in sufficient numbers to enable engineers to stop without assistance from trainmen. Congress would later slip the original deadline to 1900, but it also upped the requirement for brakes, so that by 1903 all freight cars were required to have self-couplers and half in every train were to be equipped with automatic brakes [21].

When the House Committee on Interstate and Foreign Commerce examined the Interstate Commerce Commission's casualty statistics for 1904, then, it expected to see significant improvement. Instead, it found a deterioration. Now 3,632 workers (1 out of 357) had died and 67,067 (1 out of 19) had been injured in a single year. For trainmen, the ratios stood at 1 out of 120 dead and 1 out of 9 injured. The Committee put on a brave face and sought refuge in the murky waters of international comparison. American workers might at first glance appear to face much greater peril than their British counterparts, the Committee noted, but when adjusted on a per mile basis the Americans were killed and injured with only slightly greater frequency. (The Committee did not offer comparisons of casualties per volume of business, which would have placed Americans in a worse light.) All of the rationalization in the world, however, could not mask the fundamental disappointment regulators felt. The act had been put forward as a remedy for casualties, and compliance had not in fact reduced them [19].

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What had gone wrong? How do we explain what appears to be yet another example of a failed effort at reform? Without detailed accounts of large numbers of accidents from before and after the period of regulation, we cannot reach a definitive answer. The Safety Appliance Act may in fact have prevented many accidents and averted what otherwise would have been a catastrophic increase in casualties. This explanation, however, carries with it the burden of identifying new sources of danger that arose during the period of regulation. ICC commissioners contemplated this possibility and found no obvious candidates, which is not to say that they did not exist.

Rather than persist with that line of inquiry, I propose here to approach the matter by posing another question: Why did the desire to protect railroad workers from death and injury come to focus almost exclusively on regulation requiring the adoption of safety appliances? This is, frankly, a loaded question. I am asking it in order to make a point. My belief is that by focusing on appliances, safety advocates actually worked against their own cause. They diverted the energies of reform down a path that had far less potential for providing safety than they imagined, and in so doing they reduced the possibilities of achieving more meaningful reforms.

The railroad safety movement succumbed to what I refer to as the lure of technology--the faith that mechanical devices would solve problems of extraordinary complexity. In following this lure, the movement placed itself directly at odds with the vision of safety held by most railroads, which emphasized the importance of regularity, routine, and accountability. The image of perfectly ordered operations had a powerful appeal among those responsible for running the railroads, and at times they seemed to pursue it with something like a religious conviction.

As the accident figures indicate, operations in reality fell far short of this vision. Railroads managed to handle a greater diversity of products and carry them in much larger volumes without corresponding increases in accidents, but the degree of carnage remained alarming. Nothing in the record suggests that railroads if left to their own accord would soon have attained their idealized vision and reduced their casualties to levels reformers would have found acceptable. Reform was necessary. But the railroads' approach to safety and the vision that inspired it pointed to a very different type of reform than that embraced by the Safety Appliance Act.

These two conceptions--the lure of technology and the appeal of order--shaped the contours of discussions about railroad safety and its regulation throughout the Gilded Age and Progressive Era. They appeared distinctly in the aftermath of the notorious disaster at Revere in 1871, which prompted Charles Francis Adams, Jr., and the Massachusetts Railroad Commission to issue their influential report on railroad accidents, and they persisted at least through the initial investigations of signalling methods conducted by the ICC between 1906 and 1912. Congressional hearings in connection with the Safety Appliance Act betray their importance, as do subsequent reports by the ICC regarding compliance. Perhaps most tellingly of all, we can detect their influence in the private expressions and deeds of numerous executives who were responsible for operating railroads. In the brief space available here, I will draw selectively from these sources to present a skeletal account of how

the lure of technology and the appeal of order influenced the course of safety regulation over the period.

Charles Francis Adams, Jr.'s response to the Revere disaster has often served as overture to discussions of railroad safety regulation, with good reason [4, 5, 7]. When America's most famous family of patricians turned one of its minds to something, it generally shed a great deal of light, especially on the ambiguities. Indeed, Adams' reflections on safety and its regulation anticipated the full range of issues that would occupy discussions of the matter for the next half century. These reflections, moreover, were not mere ruminations by an informed observer. They appeared as an official response to a tragedy that had attracted national attention and unleashed broadly felt sentiments for reform, and they were accompanied by some of the first concrete actions by government regarding safety. Adams' ideas and proposals gave definition to the safety issue. Virtually all subsequent public discussions of railroad safety owed something to them.

Adams entered the safety debate with two reports issued shortly after the accident at Revere, where a train had run into the rear of another packed with tourists making a holiday excursion to the beach. In one report, intended primarily for the railroads, Adams attributed the accident to sloppy procedures and improper clarification of responsibilities. He stressed the need for rule books that would anticipate all operational conditions and advised that they be kept on file with the state commission. In other words, he made an appeal for greater order. Adams directed the second report to the public, which he feared had reached a state of panic in the wake of the disaster. Adams sought to restore confidence. He cited statistics showing that travel in Massachusetts was still safer than in most other states. Then Adams noted that several new appliances offerred the potential for dramatically improved safety, and he promised that the commission would sponsor trials of a few, including air brakes, tight-fitting couplers, and automatic electric signals. To the public, Adams had held out the lure of technology [7].

In his subsequent reports on accidents, which appeared periodically during the 1870s and eventually were gathered together in an influential book, Adams revealed clearly that his personal sentiments regarding safety rested firmly with the appeal to order. His analyses of accidents repeatedly focused on administrative neglect and the failures of management to establish routines and insure they were followed. Adams thought that by relentlessly drawing attention to these issues and by publishing statistics on actual performance, railroads would bring a more concerted effort to the task of running trains safely [1, 7].

Among the public, however, Adams had sparked widespread interest in safety appliances and in legislation mandating their use. Adams raised this possibility himself in his annual report of January 1872, but in keeping with his "sunshine" approach to regulation concluded that compulsory legislation "would be of very doubtful expediency" [5, 6, 7]. Numerous other state commissions entertained the idea, however, and in 1873 Representative Andrew King introduced a bill to Congress calling for all passenger trains to have continuous brakes by 1875 [9, 21]. These proposals prompted a vigorous exchange of editorial opinion in the general press and the railroad trade

literature. Spokesmen for the railroads generally sympathized with the drive for safety but argued that legislation should "make safety the requirement without troubling ourselves with the means." (One proposed alternative called for laws that would make railroads responsible for all damages.) Editors denied that lawmakers could "judge the value and necessity of inventions" and warned that "legislators should not be too positive that they can at once solve problems that have taxed professional railway men for years" [9, 16, 17]. The trade press also raised questions about the wisdom of compelling railroads to adopt patented devices, a concern shared by Adams, who worried that such laws would reward monopolists and freeze further development [7, 16, 17].

As it turned out, these issues would not be resolved in the context of the passenger business of the 1870s. Aside from an Illinois statute requiring automatic couplers, the agitation produced no legislation, because none proved necessary [21]. Railroads voluntarily applied Westinghouse brakes and Miller platforms to their passenger trains. Correspondence suggests that in taking this step railroads were responding more to advertisments boasting that a competitor used the safety devices than to the threat of legislation or censure by a commission [2, 10, 15]. Customer demand prompted the change, though Adams' sunshine approach could certainly take some of the credit for helping build public enthusiasm. But whatever its ultimate source, the pressure to place safety appliances on passenger trains clearly had come from outside, rather than from a deep conviction on the part of railroad managers that these devices would indeed improve safety. Robert Harris, President of the Burlington, conveyed the prevailing sentiment when encouraging the manager of a subsidiary to adopt the air brake. "I have no doubt that it will be made a subject of reference in advertisements," Harris wrote, "and that whether the travelling public would really be more safe or not, they would *think* so" [3].

The conflicts in outlook glimpsed in the debate over regulation of passenger safety were magnified greatly as discussions of safety appliances shifted to consider the freight side of railroad operations. Though the challenges posed by running fast passenger trains captured more attention from the public, then and now, railroads understood that the freight business presented them with problems of much greater complexity. Freight operations took place on a grander scale and involved a much greater diversity of products and tasks. Passenger trains might travel rapidly and meet tight schedules, but they generally stayed together as coherent units for long stretches of time, travelling the same route over and over again, with regular crews and routine inspections. Most freight trains, in contrast, were continually reshuffled as crews picked up cars from various sidings and dropped them off at others. Demand for services varied widely, making routine elusive. Railroads faced a daunting task in trying to impose order in this vast, diverse, fluid realm. But the very difficulty of the task made its achievement seem all the more urgent and appealing [27].

While the challenges of freight operations prompted railroads to pursue order with still greater conviction, the comparative insulation of the freight business from public view permitted them to carry out the pursuit with a deeper sense of control. Here railroads could more readily harbor illusions about idealized modes of operation. To be sure, railroads were periodically

jolted back into reality by meat packers, express companies, and others who taught them that consumer taste could indeed place demands on freight operations that did not readily conform with the goal of slow, ordered movements [27, 28]. But railroads consistently balked at such demands and met them only grudgingly. Charles Perkins, President of the Burlington, was reluctant even to accept a lucrative contract to carry mails because he thought the emphasis on speed in mail delivery would foster bad habits and recklessness in other parts of the service. The Burlington and other midwestern roads struggled throughout the late nineteenth century to band together and resist pressures to run fast stock trains into Chicago [2, 27]. When division managers at the Pennsylvania learned of the competition among Chicago firms to run such trains, they uniformly expressed relief that they were not required to provide similar services. In the eyes of these executives--the most respected in the industry--prudence called for railroads to move freight slowly and methodically at their own discretion [13].

In attempting to follow the prudent course, the Pennsylvania and other railroads had an extraordinary range of options, many of which had nothing to do with technology (especially technologies whose primary appeal were speed and comfort). I have discussed these choices in detail elsewhere, and here will suggest simply that the amount of energy expended on "software"--rules, schedules, traffic management, pension programs designed to instill loyalty, cooperative arrangements to minimize transshipment delays--probably dwarfed that devoted to hardware [27]. The desire and inclination to bring order stimulated continual organizational innovation. These organizational responses, moreover, sometimes further complicated the process of innovation in the freight industry. Years ago, when I first broached the subject of railroad innovation through a study of the air brake, I emphasized the importance of one organizational response--the interchange of equipment among railroads--to limiting the diffusion of the device [24]. But in contemplating the broad sweep of railroad technology and the issue of safety, the interchange issue strikes me as merely one element of an extraordinary gulf in attitude that existed between railroads and the public.

We can gain some further appreciation of that gulf by considering the question of patent control, which Adams and the railroads had raised when faced with the prospect of mandatory requirements for passenger equipment. Once again, the nature of the freight industry compounded the earlier concerns. Railroads never liked paying what they viewed as a premium to a monopolist, but in the passenger trade they could console themselves that by featuring the device in advertisements they could attract additional business and reclaim at least part of the patent fee. Freight operations presented no such opportunities, except in the specialized services railroads worked so hard to avoid. The scale of freight operations, moreover, made patent monopolies extraordinarily more costly, especially since railroads wanted to maintain uniformity across the entire industry. Under these circumstances railroads had come to see patented devices as virtually incompatible with freight operations, and they had taken a variety of cooperative measures to insure that technology remained free from patent control [26].

Documents from the Burlington Archives and from the recently opened records of the Pennsylvania Railroad indicate clearly that patent control caused railroads to shy away from using air brakes and automatic couplers. Both lines negotiated extensively with Westinghouse throughout the 1880s to buy air brakes for freight trains, but neither did, because they believed the inventor was using his monopoly to set an exorbitant price. Railroads collectively attempted to have key Westinghouse patents overturned and scheduled public demonstrations of competitive systems immediately upon their expiration [25]. As early as 1880, a committee of top management at the Pennsylvania Railroad expressed its intent to obtain automatic couplers for freight cars, if it could find a "modified Janney coupler." But it abandoned the effort after "a party was sent to the Patent Office...to secure data necessary to make a report in regard to the different inventions" and returned to inform the committee that "there is such a mass of invention and so mixed that it would take six months to get the desired information, and we much doubt whether when secured it would be of any real value" [11].

The attitude of safety advocates toward patents could hardly have been more different than that of the railroads. Air brakes and automatic couplers attracted so much attention from the public in large measure because they were patented. In an age that revered inventors, patents gave brakes and couplers an identity and an aura that most railroad technologies did not carry. People spoke constantly of "patent" brakes and "patent" couplers and referred to specific devices by name, as in Westinghouse brakes and Janney couplers. We can detect little public interest or enthusiasm for countless other technologies--shock-absorbing springs, bearings made from alloys that did not so easily deform, wheels and rails that did not crack or split so readily, hand grips and running boards--that made enormous contributions to improved safety but were not controlled by patents. Congress did not mandate the use of such simple, generic technologies as sill steps, running boards, and ladders on freight cars until 1910 [21].

These diametrically opposed responses of railroads and the public to patented technologies reflected a profound difference in attitudes about novelty. Air brakes and automatic couplers, as well as certain types of signals, were alluring devices. They were marvels that seemed to hold forth the promise of absolute, fail-safe protection, without dependence on human beings. In the cases of brakes and signals, they accomplished this by utilizing the mysterious new forces of compressed air and electricity. Yet these very features that made the technologies so tantalizing to the public were those that made them so troubling to the railroads. For those in charge of running the system, automatic devices that relied on many complex parts and utilized technologies that fell well outside the established expertise of their employees hardly seemed to offer the most immediate path to greater safety. Skeptical managers worried that such devices would not be maintained properly across their vast freight operations, and that the appliances might actually work against safety by malfunctioning or providing a false sense of security [25].

A remarkable series of reports collected by the Pennsylvania Railroad in 1894 suggest that these doubts had considerable justification. Immediately after passage of the Safety Appliance Act, the Pennsylvania surveyed its own

division managers and those of many other lines in an attempt to ascertain how air brakes were actually used in freight service. The survey included the Burlington and the New York Central, companies that had more experience using the brakes in freight operations than virtually any others. The vast majority of respondents reported that crews seldom relied on automatic brakes, even after they had gone to the trouble of shifting numerous cars equipped with the appliance to the head of the train and attached them to the locomotive. Crews did not trust that the equipment had been properly maintained and inspected, and they lacked the knowledge necessary to evaluate it on their own [13, 14]. A decade later, a similar investigation of automatic electric signals by the Pennsylvania produced much the same result. Engineers, conductors, and trainmen did not trust the devices and continued to rely on older, manual techniques [12].

One could argue that compulsory legislation would remedy this predicament by making safety appliances so universal that railroaders would rapidly gain confidence in them. But if we look at the legislation passed in 1893, this does not appear to have been the prevalent way of thinking at the time, at least with regard to brakes. The Act merely stipulated that railroads place automatic brakes in sufficient numbers at the head of freight trains to allow engineers to stop without assistance if necessary. In effect, this requirement simply embraced prevalent practice at the best firms, which the Pennsylvania soon discovered to be something less than first apparent. Significantly, the Act contained no provisions for inspection. Government had no means to conduct an investigation of the sort performed by the Pennsylvania.

The failure to provide for inspection gets to the nub of the matter. When railroad officials discussed safety, time and again they fell back on the notion of discipline, by which they meant that safety above all required diligence and vigilance, and a clear sense of what could not be tolerated. Their attitude and actual experience pointed to the need for methodical, relentless attention to routine procedure, free from gimmicks and illusions, with strong measures of accountability. The railroad safety movement sought to tell the railroads what could no longer be tolerated, to change the acceptable standards of human carnage. But the movement produced legislation that expressed those standards not in terms of lives (or, more realistically, in terms of dollars, had railroads been made liable for deaths and injuries), but in terms of appliances. With their fail-safe features those appliances carried an implicit standard of zero tolerance--no lives lost--and with their automatic qualities they appeared to provide constant vigilance, without need of inspection. This was illusory.

Perhaps nothing better illustrates the tendency of regulation to pursue perfection through sophisticated technologies than the case of signals. Though brakes and couplers have attracted more attention from historians, railroads in fact devoted far more attention to signals, a technology that better fit their conception of safety and their approach to innovation [27]. Whereas brakes and couplers attracted attention primarily for the comfort and emergency response they offerred even at higher speeds, signals provided greater separation between trains in congested areas. Railroads used them to create

what they referred to as "space intervals" or "blocks." Block systems came into use gradually, in the ordinary course of affairs, as traffic grew dense in particular stretches of track. If operating in ideal fashion, passengers would not even notice them. The goal was to improve flow, not increase speed.

Railroads could create block systems in a variety of ways by using the telegraph and simple, hand-operated semaphores. In one of the simplest arrangements, a train exited one block and entered the next each time it passed a signal. A signalman set his own semaphore to the stop position, indicating his block was occupied, then sent word back up the line to return the previous signal to the go position. In Great Britain, where problems of congestion were much more widespread, such manual arrangements became so common that government regulations began stipulating their use in 1889. Government inspectors regularly examined practices on all roads to assure that railroads indeed enforced the procedures necessary to sustain block movements [20].

Regulatory action regarding signals did not occur in the United States until 1906, when Congress directed the ICC to form a board to investigate block signalling systems. Rather than merely ask this board to assess American practices in a manner similar to that done routinely by its British forerunner, which itself would have been a daunting task given the sporadic development of signaling over many years, Congress also requested that the ICC study "appliances for the automatic control of trains" [20, 21]. Congress apparently had in mind a variety of mechanisms that used electric circuits and motors to adjust signals directly in response to the movement of trains, without intervention from signalmen. Once again, American regulatory politics had proposed a remedy for safety that emphasized novel, automatic technology rather than close monitoring of routine practice.

As in earlier examples, it is difficult to see how this course of action advanced the cause of safety. Investigations of automatic control devices swamped all other responsibilities of the signal board during the intial years of its existence, to the obvious frustration of its members. Within a year the board had received nearly 500 techniques for consideration, and hundreds more followed. Three years later, the board reported that "only 12 plans, devices, or processes have been found...to be of sufficient merit to warrant...giving them any encouragement" [20, 23]. (This result could hardly have come as a surprise to railroads, who years before had come to rely on two suppliers for such devices.) The board seemed anxious to extricate itself from this charade and move toward a broader consideration of signalling practice. It noted that automatic signals did not provide the fail-safe protection many imagined, since engineers could still run through them, and it discouraged those who argued in response that locomotives should be outfitted with "automatic stops" to protect against that possibility. After several years, the board recommended that Congress require block systems but not stipulate that they operate automatically. As the board pointed out, enforcement would require regular government inspection of train-handling methods, since manual block systems were only as effective as the rules and procedures that defined and governed them [22].

With these recommendations, the ICC signal board shifted the terms that had so long dominated discussions of safety regulation. Now regulators embraced the appeal of order, as Adams had decades before. Unlike Adams, however, they also employed the powers of mandatory requirements and established the administrative capabilities necessary to enforce them. The board had found a legislative remedy without falling for the lure of technology, but had moved beyond the sunshine approach.

In following this trajectory, railroad safety regulation traced a path much like that of the more famous and extensive efforts to regulate rates. As in the case of rate regulation, railroads would certainly have preferred that no movement for safety had ever developed. They did not launch the campaign for legislation or become its most powerful advocate. When the movement first emerged, railroads steered debate toward a court-based approach and away from a legislative one. Later, when some sort of legislation appeared inevitable, with the help of their old friend Senator Cullom they helped fix attention on an act that narrowly specified the use of safety appliances and did not open the door for more general action. Regulation of safety appliances offerred a convenient means to address a problem without establishing government administrative capacity. The act basically embraced current practice by the best firms and helped railroads insure standardization and a level playing field. Regulation of signalling repeated this scenario at first, but eventually it produced a solution requiring administration--at virtually the same moment the rate question reached a similar outcome. Throughout it all, the lure of technology had exerted an influence not unlike that of the public outcry against pools in the case of rate regulation. Driven by the best of sentiments, it offerred simplistic solutions that gave vent to frustrations but did not take very seriously the conditions railroads saw themselves facing, and as a result it may well have worked against more meaningful reform [7, 8, 18].

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