Corporate Response to Technological Change: Dieselization and the American Railway Locomotive Industry During the Twentieth Century

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During the 1930s and, even more so in the 1940s and 1950s, diesel locomotives replaced steam engines on railroads throughout the United States. My work examines the effects of this technological change, not on the railroad industry, but rather on the companies that produced steam and diesel locomotives.

Although nearly a century has elapsed since Rudolf Diesel began the development of the engine that bears his name, diesel engines were not applied successfully to railroad service until the 1920s [17]. During that decade, a number of cities, most notably New York, passed a series of safety-related noise and smoke-abatement ordinances that sharply restricted the use of steam locomotives within city limits. As a result, railroads such as the Pennsylvania and the New York Central demanded diesel locomotives that, although technologically primitive, were the only suitable replacement for steam locomotives in many applications. By the mid-1930s, diesel locomotives were reliable and powerful enough to replace steam engines in yard switching service. By the 1940s, diesels had made inroads into mainline freight and passenger traffic and, by the end of the 1950s, had replaced virtually all steam locomotives in the United States.

Typically, The American Locomotive Company (ALCo) and the Baldwin Locomotive Works each maintained a 40 percent share of the steam locomotive market, with the Lima Locomotive Works controlling the remainder, although these figures could vary substantially from year to year. While ALCo and Baldwin produced experimental diesel locomotives as early as the 1920s, their peak years of diesel locomotive production encompassed the period from the late 1930s until the late 1950s. Baldwin suspended diesel locomotive production in 1956, while ALCo built its last diesel in 1969. Lima produced diesels only between 1949 and 1951 [2, 3, 6]. While all three of these companies made the transition from steam to diesel locomotive production, all three failed to survive in that industry and were replaced by two large, diversified, companies that had never produced so much as a single steam locomotive – Electro-Motive, initially an independent company, after 1930 a wholly owned subsidiary of General Motors, and by 1941 a GM division; and General Electric. GM built its first large diesel locomotives in the mid-1930s, while GE did not commence production of large freight diesels until 1960.

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My initial interest in this topic arose from an understanding that a total replacement of firms had occurred in the American locomotive industry during the middle years of the twentieth century – a situation that is comparatively rare in American business history [18, 22]. Given the ultimate inability of any of the three steam locomotive builders to successfully make the transition to diesel locomotive production, it might be tempting to assume that inadequate capitalization, inept management, or antiquated technology doomed the steam locomotive producers to failure. For ALCo and Baldwin, at least, nothing could be further from the truth. By the 1920s, these companies had acquired a widespread reputation as successful, well-financed, technologically progressive, and well-managed companies. Paradoxically, however, the very strengths that allowed ALCo and Baldwin to succeed in the steam locomotive industry simultaneously prevented them from attaining success in the diesel locomotive industry. Their advantages became disadvantages, their skills became hindrances.

ALCo, Lima, and Baldwin could not adapt traditional (and well-understood) steam-locomotive manufacturing techniques to the different requirements of diesel locomotive production. The steam locomotive producers made extensive use of iron and steel castings in their locomotives. Baldwin, for example, maintained a controlling ownership in the General Steel Castings Corporation, a company that supplied its parent with high-quality castings, and also sold its products to other sectors of the railroad industry, thus providing a cushion against periodic declines in locomotive demand [9, 10]. Baldwin erred, however, when it applied casting technology to diesels. The weight and vibration of diesel engines caused cast steel frames to crack, necessitating costly repairs and producing much ill-will among customers [13].

The steam locomotive producers also found it difficult to adapt their corporate culture to suit the demands of the diesel locomotive industry. While the phrase "corporate culture" often tends toward the vague and nebulous, I use it here to indicate the sum total of the training, attitudes, beliefs, customs, and loyalties of senior executives – those with the greatest control over corporate strategy [19, 20, 27]. Executives at ALCo, Baldwin, and Lima possessed extensive training in the techniques of steam locomotive production and marketing, and considerable loyalty to steam locomotive technology. That, in itself, is hardly surprising. Problems occurred, however, because industry executives, particularly during the crucial, formative years of the late 1920s and early 1930s, universally regarded the diesel as adjunct technology, suitable only for those few narrowly specialized niche applications where steam locomotives absolutely could not be used [7, 9, 13]. As a result, these managers continued to devote the lion's share of their firms' resources to continued incremental improvements in familiar steam locomotive technology. Not until the 1940s, when Electro-Motive had already established substantial first-mover advantages, did managers at ALCo, Baldwin and Lima begin to perceive that the diesel locomotive actually constituted replacement technology, and, indeed, was replacing steam locomotives far faster than they had ever anticipated [23, 24].

Customer loyalty also proved more of a burden than a blessing. Executives at ALCo, Baldwin, and Lima developed and maintained valuable contacts with railroad motive power officials. In fact, top managers frequently spent more time managing customers than they did managing the companies under their jurisdiction [16]. Customer relations were so intimate that railroad motive power officials frequently helped to design the steam locomotives that they later purchased. During

the period covered by this study, however, motive power officials increasingly lost corporate power – and thus control over major purchasing decisions – to railroad finance officials. Electro-Motive executives, in particular, understood that they could employ this transition to their advantage by targeting their marketing efforts toward a different group of customers *within* the railroad industry [26].

It is entirely possible that ALCo and Baldwin, at least, could have gradually (and successfully) redirected their manufacturing techniques, corporate culture, and marketing efforts to meet the new and different challenges of steam locomotive production. ALCo's relative longevity in the diesel locomotive industry indicates that the company was at least partly successful in managing this transformation. What mattered in the end, however, was that Electro-Motive was more successful in developing and adapting its corporate culture and its manufacturing and marketing techniques to suit the rapidly changing demands of the diesel locomotive industry.

Harold Hamilton, a former auto industry executive, founded Electro-Motive in 1922 for the purpose of producing and selling self-propelled, single-unit railcars. "Producing" is actually something of a misnomer, since Electro-Motive had no factory and thus, strictly speaking, did not manufacture anything. The company instead contracted the production of major components to various outside suppliers, including the Winton Company, producers of gasoline and diesel engines [13]. During the 1920s and into the 1930s, Electro-Motive's real strengths lay in its highly developed marketing program, which provided financial incentives, performance guarantees, product warranties, rapid spare-parts service, and on-board operational and maintenance training. By stressing the cost savings associated with railcars, Electro-Motive targeted its marketing efforts toward railroad financial, rather than operating, officials. As Hamilton expressed Electro-Motive's marketing philosophy, "we were going to sell these cars to the top management and work downward, as far as necessary, rather than up through the organization as was conventional. We were selling a product entirely on 'economy and performance,' which likewise was new and different"[22, p. 14-15].

In 1930 General Motors purchased Winton in order to obtain small diesel engine production capabilities which, they hoped, could be transferred to the automobile industry [30]. Since Electro-Motive was Winton's largest customer, GM also acquired the railcar producer in 1930. By doing so, GM combined its technical expertise and engineering talent with Electro-Motive's marketing skills. Despite its status as the world's largest industrial corporation, GM's financial resources had little impact during the 1930s, primarily because GM had no interest in the diesel locomotive industry during the early years of that decade. It was not until a few railroad industry executives, most notably Ralph Budd, president of the Burlington, lobbied for the successful installation of diesel submarine engines in locomotives that top GM executives began to take an interest in their tiny subsidiary [5]. In 1935, Electro-Motive opened a new diesel locomotive manufacturing facility at La Grange, Illinois, near Chicago; and, by 1938, had achieved integrated locomotive production – a manufacturing capability that ALCo, Baldwin, and Lima were never able to duplicate.

The Second World War transformed Electro-Motive. While War Production Board mandates had little long-term effect on the structure of the locomotive industry, wartime military demand for diesel engines of all types ensured Electro-Motive's profitability [1, 15]. In 1940, Electro-Motive first contributed to GM's corporate coffers, and, on January 1, 1941, GM transferred Electro-Motive from a

subsidiary to divisional status. Intense wartime demand induced a sustained plant expansion program and, more importantly, forced Electro-Motive to add production standardization to its earlier successful efforts at design standardization. In order to cope with unprecedented volume, Electro-Motive vastly increased its use of jigs, fixtures, and gauges, previously considered unsuitable for use with the massive parts and sub-assemblies employed in diesel locomotive construction [5]. GM, recognizing Electro-Motive's profitability, made significant managerial changes that effectively transformed the focus of the division's corporate culture from experimentation to predictability, stability, and bureaucratic control. These wartime changes enabled Electro-Motive to exploit successfully the postwar market for diesel locomotives, particularly between 1945 and 1955. In its most profitable year, 1951, the division garnered a 269 percent return on its investment on plant and equipment, and, by 1957, had an 89 percent share of the domestic diesel locomotive market. This success, to reiterate, resulted from the marriage of marketing expertise and engineering talent during the 1930s, as well as from the implementation of production controls and managerial reforms during the World War II years [5, 21].

Electro-Motive executives, and, later, their counterparts at General Electric [4], understood that diesel locomotive technology demanded considerably different manufacturing, managerial, and, above all, marketing techniques. It is hardly surprising that Electro-Motive based many of these techniques on those developed in the auto industry, given Hamilton's early career, and given his company's ties to GM. Executives at ALCo, Baldwin, and Lima, however, discovered that their impressive production, marketing, and managerial skills could not be transferred from the steam locomotive industry to the diesel locomotive industry. Ultimately, they did not understand that their long heritage of success lay in their ability to custom manufacture small batches of unique products [25, 28, 29]. Steam locomotives fit that category. Diesel locomotives did not.

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