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Albert Churella

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Article abstract

Beginning in the 1930s, North American railroads began replacing their steam locomotives with diesels at an ever-accelerating rate. Established steam locomotive producers, most notably the American Locomotive Company and the Baldwin Locomotive Works, proved incapable of dealing with this radical technological discontinuity. As successful steam locomotive manufacturers, these firms developed a corporate managerial culture that was not only linked closely to steam locomotive technology; it also embodied the fundamentals of small-batch custom manufacturing. More successful competitors, such as Electro-Motive (later a division of General Motors), developed a corporate culture amenable to both diesel locomotive technology and the standardized near-mass-production techniques that made diesel production efficient and profitable. Electro-Motive executives understood that railroad customers increasingly valued performance characteristics (flexibility, lower operating costs) best fulfilled by diesels, while steam locomotive producers continued to concentrate on the outdated characteristics (horsepower, low initial cost) of steam locomotive technology.

Organizational Culture and Radical Technological Change: The Railway Locomotive Industry During the Twentieth Century

ALBERT CHURELLA

By the end of the 1920s, the American Locomotive Company (ALCo) and the Baldwin Locomotive Works dominated the steam locomotive industry. These two companies were large, successful, well-managed, and highly respected firms that funnelled substantial profits to their shareholders, yet neither firm survived the introduction of a radically new technology, the diesel locomotive. Beginning in the 1920s, and culminating in a "dieselisation revolution" during the 1950s, diesels replaced steam locomotives on most North American railroads.[1] ALCo and Baldwin both responded to the dieselisation revolution by manufacturing diesel locomotives; yet, that response proved inadequate and unsuccessful. Even though the Electro-Motive Company (later the Electro-Motive Division (EMD) of General Motors) never produced steam locomotives, it quickly displaced established producers and dominated the American diesel-locomotive industry.

ALCo and Baldwin failed in the diesel-locomotive industry primarily because both companies possessed a maladaptive corporate culture and organisational routines finely tuned to the competence-enhancing innovations of

During my research on this topic, I have benefitted greatly from the advice and insights of Mansel Blackford, David Hounshell, and Steven Usselman, among others. Of course, any inaccuracies in this work are solely my own responsibility.

1 The only recent scholarship concerning the diesel-locomotive industry has come from Thomas G. Marx, in "Technological Change and the Theory of the Firm: The American Locomotive Industry, 1920-1955," *Business History Review* 50 (Spring 1976): 1-24 and "The Diesel-Electric Locomotive Industry: A Study in Market Failures," PhD thesis, University of Pennsylvania, 1973. Marx, an economic historian, studies issues that are considerably different from those addressed here. In addition, Marx did not have access to the vast wealth of company records relating to individual firms now available to historians. Three of the most useful popular, or "railfan" books on the diesel-locomotive industry have been written by John F. Kirkland: *The Diesel Builders, Vol 1: Fairbanks-Morse and Lima-Hamilton* (Glendale, California, 1985); *The Diesel Builders, Vol. 2: American Locomotive Company and Montreal Locomotive Works* (Glendale, California, 1989); and Kirkland, *Dawn of the Diesel Age* (Glendale, California, 1983).

steam-locomotive technology. However, that corporate culture proved ill-suited to the radically different managerial, production, and marketing requirements of the diesel-locomotive industry.

The definition of corporate culture used here refers to the beliefs, attitudes, and values of company management, the way in which these beliefs were shaped by education and work experience, and the impact of the resulting values on corporate decision-making processes. It also encompasses the ways in which corporate executives were rewarded (or punished) for their conformity (or lack thereof) to these norms and standards.[2] Although business executives have often emphasised the virtues of teamwork, consensus, and organisational culture, a maladaptive corporate culture can frequently do more harm than good. For example, Dorothy Leonard-Barton shows that four key characteristics influence organisational core capabilities: employee knowledge and skills, technical systems, managerial systems, and values and norms. Leonard-Barton emphasises that "All four dimensions of core capabilities reflect accumulated behaviors and beliefs based on early corporate success." The steam-locomotive producers developed considerable skills in all four of these dimensions, yet all were inappropriate for the diesel-locomotive industry. The last of these, in particular, proved quite difficult to modify. In the case of the locomotive industry, "values and norms," in the form of management's corporate culture, constrained the ability of these companies to adapt to radical technological change.[3]

Executives at ALCo and Baldwin, through lifelong training and experience, developed a corporate culture that was virtually inseparable from the custom craft production of steam locomotives. This corporate culture allowed ALCo and Baldwin to manage incremental changes in steam-locomotive technology and thus dominate the steam-locomotive industry and gain respect

2 In his 1995 Newcomen Prize Essay, "Culture and the Practice of Business History," *Business and Economic History* 24: No.2 (Winter 1995): 1-41, Kenneth Lipartito points out the need for a cultural approach to business history: "Reducing business behavior to the pursuit of profit, growth, and stability cannot account for the divergence of competitors located in the same market, sharing the same technological constraints, facing the same government mandates. It seems at least possible that culture supplies one of the missing pieces to this puzzle" (p. 2). Other useful works linking culture, technological change, and business performance include: Charles Dellheim, "Business in Time: The Historian and Corporate Culture," *Public Historian* 8 (Spring 1986): 9-22; Dellheim, "The Creation of a Company Culture: *Cadburys*, 1861-1931," *American Historical Review* 92 (February 1987): 13-44; Michael Rowlinson and John Hassard, "The Invention of a Corporate Culture: A History of the Histories of Cadbury," *Human Relations* 46 (March 1993): 299-326; and William R. Childs, "The Transformation of the Railroad Commission of Texas, 1917-1940: Business-Government Relations and the Importance of Personality, Agency Culture, and Regional Differences," *Business History Review* 65 (Summer 1991): 285-344.

3 Dorothy Leonard-Barton, "Core Capabilities and Core Rigidities: A Paradox in Managing New Product Development," in *Managing Strategic Innovation and Change: A Collection of Readings*. Michael L. Tushman and Philip Anderson, eds. (New York, 1997), 255-70.

throughout corporate America as successful, reliable, and well-managed firms. Paradoxically, the corporate culture that contributed to this success had become ossified by the 1920s, with managers slow to respond to growing evidence that the steam locomotive industry was headed for extinction.

Managers at ALCo and Baldwin failed to appreciate what historian of technology Edward Constant would later call a "presumptive anomaly" – that functioning technological systems would eventually reach the outer limits of their capabilities and would thus be replaced by radically different technology. Nor were they successful at "technical forecasting" (the term is Christopher Freeman's) and they therefore could not integrate accurate technical forecasts into normal operating routines.[4]

The very success of their corporate culture blinded executives at ALCo and Baldwin to the opportunities, and requirements, of radical technological change.[5] ALCo and Baldwin mastered the art of making incremental technological changes to their established product lines. These changes tended to be competence enhancing; in other words, they encouraged the established producers to reinforce their existing organisational routines (their core capabilities) and create higher barriers to entry, while many less successful competitors fell by the wayside, particularly during the nineteenth century.

Diesels represented a radical technological discontinuity, since they did not share any significant technology or components with steam locomotives and since their manufacture demanded vastly different organisational routines. Radical discontinuities tend to destroy competency, and this was certainly the case in the locomotive industry. The technological capabilities and organisational routines that had worked so well for so long in the steam-locomotive industry were ill-suited to the vastly different requirements of diesel-locomotive production.

Executives at ALCo and Baldwin committed two crucial errors as they attempted to make the transition from steam to diesel-locomotive production. First, they incorrectly identified the optimal performance characteristics of their products – what Richard Rosenbloom and Clayton Christensen define as a "value network."[6] This misdefinition caused ALCo and Baldwin to manufacture

4 Benjamin Constant, *The Origins of the Turbojet Revolution* (Baltimore, 1980); Christopher Freeman, *The Economics of Industrial Innovation*, 2nd ed. (London, 1982),165-67.

5 For an analysis of the relationship between the diesel locomotive (as replacement technology) and social change, with particular reference to railroad labour, see: Maury Klein, "Replacement Technology: The Diesel as a Case Study," *Railroad History* 162 (Spring 1990): 109-20.

6 Clayton M. Christensen, "The Rigid Disk Drive Industry: A History of Commercial and Technological Turbulence," *Business History Review* 67 (Winter 1993): 531-88; Richard S. Rosenbloom and Clayton M. Christensen, "Technological Discontinuities, Organizational Capabilities, and Strategic Commitments," *Industrial and Corporate Change* 3 (1994): 655-85; Christensen and Rosenbloom, "Explaining the Attacker's Advantage: Technological Paradigms, Organizational Dynamics, and the Value Network," *Research Policy* 24 (1995): 233-57.

The Lima Locomotive Works. Employees pose with the last of only 174 diesels completed by Lima.

locomotives that were increasingly technologically sophisticated, yet also increasingly less suited to customer requirements.

Second, diesel-locomotive technology not only forced managers at ALCo and Baldwin to change their product lines, it also required them to alter their entire manufacturing philosophy. Small-batch customised production, coupled with a high degree of customer input over the design process, characterised the steam-locomotive industry, and ALCo and Baldwin excelled at this type of manufacturing. Standardized near-mass-production techniques were more suitable for diesel-locomotive production, however, and neither company had much familiarity with this methodology.

Electro-Motive had a corporate culture that, while not inherently "better" than that of ALCo and Baldwin, nonetheless recognised the applicability of the diesel locomotive and fostered its development. In particular, executives at Electro-Motive, unlike their counterparts at ALCo and Baldwin, realised that diesel-locomotive technology, while unable to match traditionally valued steam-locomotive performance characteristics, nevertheless offered a vastly different set of attributes that were ultimately of greater value to railroad customers.[7]

7 Richard R. Nelson and Sidney Winter use clusters of organisational routines to explain firm behaviour in *An Evolutionary Theory of Economic Change* (Cambridge, 1982). Also see: Nelson and Winter, "In Search of a Useful Theory of Innovation," Research Policy 6 (1977): 36-76.

When historians look back at the dismal fate of ALCo and Baldwin in the locomotive industry, it is not difficult to uncover evidence that managers at those two companies retained their loyalty to steam locomotives and at the same time harboured a deep suspicion of diesels. Long-time Baldwin executive, Samuel Vauclain, who was ultimately responsible for the construction of some 60,000 steam locomotives, typified this public show of devotion to an increasingly outdated technology.[8] In 1926, Vauclain conceded "the established efficiency of modern internal combustion engines," but concluded that "it will be many years before the steam locomotive, owing to its simplicity, its serviceability, and its low production cost, will be relegated to the era of the past."[9] A transcript of Vauclain's June 1930 address to the annual convention of the American Railway Association shows that he devoted three pages to steam-locomotive development and only one paragraph to diesels. He called the steam locomotive "the greatest of all human devices" and concluded that "we are just beginning to realize what actually can be done with the steam engine . . . that will continue it in service, so that it can be more ably discussed in the year 1980 than at this convention in 1930."[10]

ALCo executives also predicted the continued survival of the steam locomotive. In 1938, William C. Dickerman, ALCo's president, thought that "the technical potentialities of the Diesel-electric locomotive are about the same as they were at the beginnings," and that "the possibilities of the Diesel-electric locomotive are already fixed and known . . . [but they are] not so with the steam locomotive."[11] In an April 1938 address, delivered at a meeting of railroad operating and mechanical officials, ALCo's president explained, "for a century . . . steam has been the principal railroad motive power. It still is and, in my view, will continue to be."[12] In 1944, ALCo president, Duncan W. Fraser, predicted that "Progress in steam locomotives has gone hand in hand with Diesel developments . . . [and] it is unlikely that there will be any one dominant type of locomotive, at least in the foreseeable future." ALCo produced its last steam locomotive four years later.[13]

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8 John K. Brown, *The Baldwin Locomotive Works, 1831-1915* (Baltimore, 1995), 172-83; *Baldwin Locomotives* 8, No.1 (July 1929): 3; *Railway Age* 86 No.14 (6 April 1929): 791-92; Railway Age 108, No.6 (10 February 1940): 282-83; Marvin W. Smith, *Samuel Vauclain: Courageous Pioneer, Believer in America!* (New York, 1952); Samuel M. Vauclain, *Mass Production Within One Lifetime* (Princeton, 1937).

9 *Baldwin Locomotives* 5,No.1 (July 1926): 43-49.

10 *Railway Age* 88, No.25D (25 June 1930): 1548D140-44.

11 *Railway Age* 104, No.19 (7 May 1938): 796-801.

12 William C. Dickerman, address to the Western Railway Club, 25 April 25 1938, quoted in US Congress, Senate, Hearings of the Committee on the Judiciary, Subcommittee on Antitrust and Monopoly, 84th Cong., 1st sess. (1955), 9 December 1955, 3955.

13 *Railway Age* 116, No.7 (12 February 1944): 369.

In August 1945, a memorandum issued to ALCo shareholders predicted "that great advances will be made in the development of coal-burning steam locomotives during the next decade."[14] Four months later, ALCo senior vice-president, Joseph B. Ennis, asserted "that the future holds an expanding role for both the steam locomotive and the Diesel."[15] W. A. Callison, an ALCo vice-president, stated, in 1947, "We do not, by any means, believe that the steam locomotive is dead."[16] In 1948, as ALCo turned out its last steam locomotive, Perry T. Egbert, then vice-president in charge of the locomotive division and later president of the company, announced that "American Locomotive is not intentionally going out of the steam locomotive business. It is simply a matter of [insufficient] demand."[17]

Given the benefit of hindsight, one could easily excoriate these managers for their presumed ignorance, incompetence, or even outright stupidity. Such an accusation does not square well with the productive and successful careers of these talented individuals, nor is it accurate.

On a basic level, since the careers of these executives were inextricably linked to steam-locomotive production, it is hardly surprising that they would continue publicly to defend steam-locomotive technology to their shareholders, customers, and the general public. Beyond this, these managers realised the potential, and the dangers, of diesel-locomotive technology. For that reason they devoted a portion of their scarce resources to diesel-locomotive research and development programmes. Managers at ALCo and Baldwin also accelerated the pace of incremental technological improvements to their steam-locomotive product lines – a pattern commonly seen in established industries that are under assault from radically new technologies.[18] ALCo and Baldwin experimented with poppet valves, roller bearings, streamlining, and light-weight steel alloys for valve gear and other critical parts, innovations that boosted the power and efficiency of steam locomotives to unprecedented levels.

But they missed the point. Steam-locomotive industry executives radically, and fatally, underestimated the performance characteristics demanded by railroads. Traditionally, ALCo and Baldwin had developed a value network based on cost and horsepower considerations, and ALCo and Baldwin were supremely successful in providing products that fulfilled these requirements. No one could deny that the manufacturing costs of a steam locomotive, per

14 *Railway Age* 119, No.9 (1 September 1945): 388.

15 *Railway Age* 119, No.24 (15 December 1945): 970-72.

16 *Railway Mechanical Engineer* 121 (October 1947), 541-42.

17 *Railway Age* 124, No.25 (19 June 1948): 1225.

18 James M. Utterback, *Mastering the Dynamics of Innovation: How Companies Can Seize Opportunities in the Face of Technological Change* (Boston, 1994), xxvii, 151, 155-56, 158-63, 176-77, 194-95, 204-11.

horsepower, were a third of those of a diesel. And, even as late as 1990, few single-unit diesels matched the brute horsepower of a state-of-the-art steam-locomotive of the 1940s.

The problem was that railroads increasingly came to value a radically different set of performance characteristics that were best fulfilled by diesel locomotives. Railroads sought reduced operating and maintenance costs, regardless of initial purchase price. They found that multiple-unit diesel locomotive combinations were as powerful, and more flexible, than single-unit steam locomotives. And, in many other ways, diesels offered a range of performance attributes that steam locomotive technology could never provide.

Whenever locomotive builders advertised their products, they illustrated their differing interpretations of the value network. ALCo and Baldwin advertisements in *Railway Age* and other trade journals stressed the importance of speed and horsepower – attributes that diesels could not match. Electro-Motive advertisements instead stressed efficiency and cost savings. As the dieselisation revolution went on, railroads paid increasing attention to the latter set of performance attributes, and increasingly ignored the former.

Managerial misunderstanding of the relevant value network created problems even within the context of diesel locomotive production at ALCo and Baldwin, since both companies sought to apply traditional steam-locomotive design, production, and marketing techniques to their diesel-locomotive product lines. Both builders continued to rely on their voluminous experience in small-batch customised production. This was appropriate to the steam-locomotive industry, since these locomotives were built in small lots, usually no more than about 20 units, to suit the highly specialised operating requirements of individual railroads. Diesel locomotives had much higher research and development costs, however, and these costs could only be amortised through long, standardised production runs; not 20 locomotives for one railroad, but a thousand locomotives for dozens of railroads. Thus, ALCo and Baldwin not only had to adapt to the radical technological discontinuity embodied in diesel locomotives, they also found it necessary to alter their entire manufacturing philosophy from small-batch custom production to standardised near mass production.[19]

Railroad customers added another layer of difficulty to this adaptability problem. Traditionally, railroad motive-power officials had exerted a substantial degree of control over steam locomotive design. This customer influence

19 For studies of flexible small-batch custom production, see Philip Scranton, *Figured Tapestry: Production, Marketing, and Power in Philadelphia Textiles, 1885-1941* (Cambridge, 1989); Scranton, *Endless Novelty: Specialty Production and American Industrialization, 1865-1925* (Princeton,1997); and Michael J. Piore and Charles F. Sabel, *The Second Industrial Divide: Possibilities for Prosperity* (New York, 1984).

was appropriate to the customised nature of steam-locomotive production, yet was totally inappropriate for the requirements of standardised diesel-locomotive technology. Managers at ALCo and Baldwin realised the danger inherent in customer control over the design process, yet were nonetheless more willing than their counterparts at Electro-Motive to offer custom-design locomotives to suit the tastes of particular railroads.[20]

Railroads had a corporate culture too, and this culture often reinforced the tendency of ALCo and Baldwin to place continued reliance on traditional performance criteria. Well into the 1940s, many, if not most, railroad-motive power officials remained loyal to steam-locomotive technology; after all, diesels would devalue their own skills and training. Electro-Motive's success lay partly in its ability to bypass those motive-power officials and instead to market diesels to higher-level railroad finance officials, who were more attuned to the performance characteristics that only diesels could provide. These finance officials, having no vested personal interest in the retention of steam-locomotive technology, were willing to accept standard-design diesels. Electro-Motive was thus in a stronger position to refuse customer requests for custom-built diesels than were either ALCo or Baldwin. As Electro-Motive president, Harold Hamilton, said, "We were going to sell [our products] 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."[21]

On the shop floor, ALCo and Baldwin also suffered because they attempted to apply traditional steam-locomotive design and production methods to diesel-locomotive technology. Baldwin, for example, applied steel-casting technology, used in steam locomotives, to the manufacture of diesel-locomotive underframes. These cast underframes tended to crack, however, and were generally less satisfactory that the welded underframes typically used by Electro-Motive.[22] Baldwin designers also attempted to transfer their principal design goal, that of packing as much horsepower as possible in a single locomotive, from steam to diesel-locomotive production. One result was a particularly massive and unwieldy prototype, designed to accommodate eight diesel engines in a single locomotive shell. Such designs, while powerful, were no match for the smaller and more flexible multiple-unit diesel locomotives offered by Electro-

20 For a solid overall account of production and marketing practices at Baldwin, see Brown, *The Baldwin Locomotive Works*.

21 General Motors Institute Alumni Foundation's Collection of Industrial History, Flint, Michigan, Harold Hamilton, "Historical Background and Notes on the Development of Electro-Motive," 11.

22 Louisville and Nashville Railroad Collection at the University Archives and Record Center, University of Louisville, Louisville, Kentucky, Box 56, Folder 1870-B, J.B. Hill to F.B. Adams, 25 July 1945.

Motive. One railroad locomotive engineer summarised his own appraisal of this situation by saying "The Baldwin [diesels] pulled like steam engines – and rode like 'em too!"[23]

Electro-Motive embodied a very different, and highly experimental, corporate culture. Auto-industry executive Harold L. Hamilton founded Electro-Motive in 1924, and he understood that a wide variety of marketing initiatives, including training programmes, financing, and other support services, were as important, if not more important, than the technology itself.[24]

In 1930, Electro-Motive became a wholly-owned subsidiary of General Motors, yet it remained small, financially insignificant, and largely insulated from GM's organisational routines. As such, Electro-Motive's corporate culture placed a premium on innovation and experimentation, and this allowed Hamilton to find a ready ally in GM's research director, Charles Kettering. Hamilton, his associates at Electro-Motive, certain technical experts at GM, and a few forward-looking railroad executives not only appreciated the performance characteristics of diesel locomotives, they also had so much confidence in the inevitability of dieselisation that they acted as "boosters" for the new technology. They had as much confidence in diesels as executives at ALCo and Baldwin had in the long-term survival of the steam locomotive, if not more. This enthusiasm, set within the larger realm of Electro-Motive's corporate culture, enabled Hamilton and his allies to manipulate subtly the GM corporate hierarchy and pursue policies that were often based more on personal devotion than on corporate strategy.[25]

Electro-Motive's corporate culture, and that of its parent, General Motors, may have embodied a degree of ruthlessness not present at ALCo or Baldwin.

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23 Bob Simonson (Northwestern Pacific fireman), *Trains* 58, No.3 (March 1998): 60.

24 *Railway Age* 132, No.11 (17 March 1952), 90-1; *Railway Age* 132, No.15 (14 April 1952): 57-58; *Railway Progress* 12, No.2 (April 1958): 32-43; General Motors Institute, Hamilton, "Historical Background and Notes on the Development of Electro-Motive"; Franklin M. Reck, *On Time: The History of the Electro-Motive Division of General Motors* (Detroit(?), 1948), 14, 22; Reck, *The Dilworth Story* (New York, 1954), 32; General Motors Institute, The Kettering Archives, 1965 Oral History Project, Clyde W. Truxell interview, 10 March 1961, pp. 3-5; General Motors Institute, Folder 76-16.1, "History of the Winton Engine Company," ca. 1930; General Motors Institute, Donald Borland, "Research Report TI-8," p.37; General Motors Institute, Folder 83-12.101, EMD *Streamliner* 12, No.2 (18 June 1948); *Diesel Times* 5, No.5 (May 1948): 1-8.

25 It is important to keep in mind, of course, that, while diesels represented a radical technological discontinuity for ALCo and Baldwin, such was not the case at Electro-Motive. The principal goal of Hamilton, Kettering, and others was merely to make repeated incremental, competence-enhancing improvements to comfortably familiar technology.
"Statement of Harold L. Hamilton," Senate Hearings, 10 November 1955, 2421-422; Hamilton, "Historical Background and Notes on the Development of Electro-Motive"; Hamilton, interview by members of GM Research Laboratories, 14 Oct. 1957, in Borland, "Research Report TI-8," p.90; Alfred P. Sloan, Jr., *My Years with General Motors* (New York, 1964), 17-26.

It is possible that senior GM officials, secure in the knowledge that GM was not only the largest industrial corporation in the world, but also the largest shipper of freight in the United States, pressured railroads to purchase Electro-Motive diesels. Executives at ALCo, in particular, certainly alleged that GM engaged in "reciprocity" – promising to direct freight shipments toward railroads that bought Electro-Motive diesels, and away from those that did not. And, the US Justice Department did charge GM with reciprocity in both civil and criminal antitrust suits during the 1960s. While both antitrust suits were dropped for lack of evidence, some Electro-Motive officials hinted that they considered reciprocity to be an acceptable business practice.[26]

Despite the overall rigidity of organisational routines and corporate cultures, Electro-Motive adapted to changing market conditions. As World War II began, military demand for diesel engines far exceeded railroad demand for locomotives and ensured Electro-Motive's profitability. In this context, GM officials understood that an experimental corporate culture was not amenable to stability and predictable profitability. As a result, GM not only expanded Electro-Motive's manufacturing facilities; it also assigned enough GM organisation men to Electro-Motive to change fundamentally Electro-Motive's corporate culture. GM realised that its once-neglected subsidiary had enormous potential and sought to protect and enhance that potential by replacing the manager-engineers at EMD with employees who were schooled not only in the practicalities of internal combustion technology but who also understood that EMD was subservient to the larger goals of GM corporate policy. Electro-Motive did not, and quite possibly could not, have initiated this necessary change in its corporate culture. Instead, the impetus for change came from a larger entity that was not affected by Electro-Motive's organisational routines.[27]

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26 For example, in 1939, the president of the Louisville and Nashville wrote that an Electro-Motive sales representative indicated "that all of their sales were brought to the attention of the General Motors Corporation. ..." and hoped that the railroad could "use this [diesel locomotive] purchase advantageously in the matter of securing traffic [from GM]." Louisville and Nashville Collection, Box 1, Folder A-15113, J.B. Hill to E.A. deFuniak, 6 September 1939; see also, The Honorable Sidney Sugarman, Opinion, United States of America against General Motors Corporation, US District Court, Southern District of New York, 25 May 1961; US National Archives, Northeast Region, Stenographer's Minutes, *United States of America vs. General Motors Corporation*, 22 May 1961.

27 *Railway Age* 101, No.19 (7 November 1936): 696; *Railway Age* 102, No.23 (5 June 1937): 960; *Railway Age* 105, No.19 (5 November 1938): 680; General Motors Institute, Folder 18/3, T. A. Boyd, "Advances in Engines and Fuels: A History of Vital Pioneering in the Field," 1958, 85; General Motors Institute, Folder 83-12.101, GM-EMD, *The Diesel Locomotive: Preface of a New Era*, ca. 1951, p.16; Reck, *On Time*, 90-94, 120-21; Reck, *The Dilworth Story*, 49.

Electro-Motives's better-adapted corporate culture did not guarantee its success throughout North America. In Canada, ALCo was the dominant producer during the initial stages of dieselisation, indicating that customer loyalty and proper product positioning could temporarily offset some of the deficiencies imposed by ALCo's corporate culture.

In order to comply with Canadian domestic content laws, EMD established a subsidiary, GM Diesel, Ltd., to assemble and market diesel locomotives. In June 1950, GM Diesel completed a facility in London, Ontario, that would employ one thousand workers and have a capacity of one locomotive per day. EMD manufactured such major locomotive components as diesel engines, generators, and traction motors at its main Chicago plant, while GM Diesel fabricated locomotive bodies, underframes, trucks, and ancillary electrical equipment and then assembled the final product. By January 1952, GM Diesel had built more than two hundred locomotives in Canada.[28]

However, GM Diesel's success in Canada never approached the level achieved by EMD in the United States and ALCo-designed locomotives continued to offer stiff competition to EMD designs long after ALCo itself had ceased diesel-locomotive production. Two major Canadian railroads, the Canadian National and the Canadian Pacific, often preferred the enhanced cold-weather performance of ALCo diesels. In addition, ALCo's subsidiary in Canada, the Montreal Locomotive Works (MLW), had a long tradition of Canadian operations (its predecessor, the Locomotive and Machine Company of Montreal, Ltd., had opened in 1902), and seemed to many Canadian customers to be a more "Canadian" company than GM Diesel and less obviously a subsidiary of a US corporate colossus.

ALCo, in cooperation with MLW, in 1948 completed the first diesel locomotive manufactured in Canada. At first, MLW merely assembled diesel locomotives, using ALCo diesel engines imported from the United States and electrical equipment supplied by the Canadian General Electric Company plant in Peterborough, Ontario. Later, ALCo licensed the Dominion Engineering Works to produce ALCo engines in Canada for use in MLW diesel locomotives. MLW prospered during the 1950s and 1960s, even as ALCo's fortunes declined. When ALCo ended US locomotive production in 1969, the company transferred its diesel engine and locomotive designs to MLW. Bombardier, a struggling producer of snowmobiles, acquired MLW in 1975; and, although

28 *Business Week*, (19 August 1950): 98; *Railway Age* 127, No.6 (6 August 1949): 267-68; *Railway Age* 129, No.8 (19 August 1950): 51-52; *Railway Age* 132, No.6 (18 February 1952): 54; *Railway Age* 133, No.1 (7 July 1952): 148-50; *Railway Age* 133, No.11 (15 September 1952): 15.

diesel-locomotive production has since ceased, the company still sells mass-transit equipment and other railroad-related products.[29]

ALCo's Canadian experience was the exception, not the rule, and along with Baldwin, it succumbed completely to Electro-Motive. ALCo survived in the diesel-locomotive industry until 1969, largely because it was the second-best producer in a market dominated by EMD. Baldwin, plagued by quality-control problems, was even less successful, exiting the locomotive industry in 1956.

Corporate culture lay at the heart of the adaptability problem at both ALCo and Baldwin. Based on decades of training and experience, executives at those two companies had considerable familiarity with steam-locomotive technology. Industry executives logically saw less immediate risk in maintaining their existing product lines and operational routines than in testing uncharted waters. The failure of early diesels to meet traditionally valued steam-locomotive performance criteria served to reinforce this managerial aversion to diesels.

Beyond the risks inherent in new technology, executives at ALCo and Baldwin faced an agonising decision: should the company remain true to its *production* heritage and emphasise the small-batch customised fabrication of items other than diesel locomotives even as the capital goods sector of the economy declined, or should the company continue its *product* heritage by abandoning custom manufacturing in favour of the near mass production of diesel locomotives? In the final analysis, managerial indecisiveness ensured that those companies did neither.

29 *Commercial and Financial Chronicle* 169 (20 January 1949), 312; *Railway Age* 133, No.1 (7 July 1952): 148-50; Association of American Railroads library, Washington, DC, MLW-CGE press release, 10 May 1948; AAR library, MLW press release, 21 December 1949; ALCo 1946 and 1952 annual reports; *Wall Street Journal*, 22 January 1975, 12; 27 January 1975, p.4; *Business Week* (10 March 1975): 81; Chris DeBresson and J. Lampel, "Bombardier's Mass Production of the Snowmobile: The Canadian Exception?" *Scientia Canadensis*.