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John K. Brown. *The Baldwin Locomotive Works, 1831-1915.* Baltimore, Md.: Johns Hopkins University Press, 1995. xxxii + 328 pp. $35.95 (cloth), ISBN 978-0-8018-5047-9.

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Any company that did not implement the standardization and bureaucratic centralization characteristic of American System manufacturing would appear doomed to failure in the highly competitive Gilded Age business environment, yet the Baldwin Locomotive Works thrived by deliberately avoiding standardized mass-production techniques. In advancing this argument, John Brown asserts that Baldwin's customized building techniques forced the company to develop systematic managerial controls earlier than companies that were able to standardize production. The author organizes his work topically, exploring such issues as innovation, management, labor relations, and production methods.

As a leading producer in the nineteenth-century capital goods industry, Baldwin experienced periodic peaks and troughs in locomotive orders. By the 1850s, furthermore, railroad motive power officials were demanding significant control over the development of locomotive technology. The egotism of many railroad master mechanics, combined with varied railroad operating conditions, resulted in demands for a plethora of locomotive designs. The size, complexity, and, above all, this multiplicity of designs rendered standardized mass production impossible in the steam locomotive industry.

Baldwin not only survived on this diet of customized small-batch production; it positively thrived. Much of this success resulted from the entrepreneurial abilities of the company's founder, Matthias Baldwin, as well as from its lack of a centralized bureaucratic management–for Baldwin, despite its size, remained a partnership until 1909. The Baldwin partners understood that locomotive building was a risky business, and they diluted this risk by relying on outside suppliers for capital, by forming financial allegiances with banking houses and with the railroads themselves, by making extensive use of the inside contracting system, and by relying on collusion and price-fixing.

Baldwin exploited economies of scope, far more than scale economies. Particularly during slack periods, the company solicited foreign business and orders for non-traditional railroad products, ranging from mine locomotives to elevated railway equipment–all of which contributed to its non-standard production. More important, Baldwin sought to use as many common parts as possible on its custom-built locomotives. As a result, despite offering hundreds of locomotive designs, Baldwin drew from a vast reservoir of established designs. By the 1860s, Baldwin employed a system of jigs, fixtures, and gauges to ensure standardized production–methods commonly referred to as Armory Practice, although Brown indicates that Baldwin "seems to have developed its own variant of these techniques without any direct transmission from the Armories or other American System manufactures" (p. 174). Baldwin also improved production efficiency by implementing piecework, which, Brown states, caused little dissent within the ranks of skilled workers. By standardizing and systematizing the production of locomotive components, Baldwin's partners "created new organizational controls ten to thirty years before their American System consumer product cousins took up such concerns" (p. 93).

The "labor question" troubled Baldwin's managers, as it did their counterparts elsewhere in industrial America. Baldwin exhibited a particularly strong sensitivity to this issue, because varying business cycles called for hiring binges followed by massive layoffs; yet the technical complexity of steam locomotives required the company to maintain a cadre of skilled and loyal workers. Baldwin succeeded in maintaining peace in an age of industrial violence through cooperative relations, Brown argues, and not by coercive threats or regimented Taylorism. The company paid consistently high wages and instilled worker loyalty through a system of apprenticeships. Of the highly skilled long-time employees, a select few would become partners, since Baldwin rarely recruited outside managerial talent. Since most of the primary source material that Brown uses in his discussion of labor issues consists of company statistical data and managerial correspondence, it is of course difficult to deter-

mine the true degree of worker loyalty; and it is equally difficult to test the assertion that management saw piece rates as a path to cooperative, rather than coercive, efficiency.

Baldwin's skills in responding to varied customer demands ultimately caused great hardship for the company. Locomotive orders peaked in 1906 and, after this date, Baldwin's producer culture was ill-equipped to respond to a combination of a hostile regulatory climate and an increasing pace of technological innovation. Still, as Brown forcefully argues, for more than half a century Baldwin's production and managerial innovations enabled the company to respond effectively to a market that would not accept mass production.

This book leaves several tantalizing questions unanswered. It is largely beyond the scope of Brown's work, but an exploration of technological diffusion in relation to the locomotive industry seems to offer an important topic for future research. In a footnote (p. 252), Brown notes that several employees in the locomotive industry later assumed leadership roles in the development of other manufacturing industries. Aside from this reference, and the thorough discussion of links between railroad master mechanics and technological innovation at Baldwin, there is little material relating to the impact of emerging manufacturing technologies on the company and, in turn, the relationship of Baldwin's technological innovations to other firms and industries. Such linkages merit additional consideration, since Baldwin seems to illustrate a bridge between the emergence of Armory Practice in the early nineteenth century and the development of bureaucratized managerial controls over manufacturing and distribution in high-volume industries during the 1880s and 1890s. Also, given the limited managerial structure at Baldwin, it would be helpful to have more information regarding the disparate backgrounds and entrepreneurial outlooks of individual Baldwin partners.

These minor omissions in no way detract from the excellence of Brown's work, which adds to the growing number of valuable correctives to well-known studies of bureaucratically managed mass-production and -distribution firms. This study provides a thorough and well-balanced analysis of the contributions of an important, although largely neglected, firm and industry to the development of nineteenth-century technological and managerial systems.

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