

revenues. As the authors point out, new and better technologies often accompany capital investments. The acquisition of capital in turn requires the ability to generate adequate revenues, which had been a difficult feat in an era of regulated rail rates and relentless competition from truck, pipeline and barge operations. An enhanced ability to acquire advanced technologies embedded in new investments made the railroads much more competitive with other modes of transportation and has been one of the main reasons for deregulation's successful outcome.

If there is one subject in *American Railroads* that does not receive sufficient coverage, it is how deregulation and technological advance affected labour. The authors note that 100,000 operating jobs were lost as a result of the replacement of steam locomotives by diesel-electric engines (p. 352), but much more could have been said about the forces, not all of them technological, that significantly altered labour requirements. Much less consequential but nonetheless amusing are the places where it appears that some sort of automatic gender neutraliser converted 'firemen' into 'firefighters'; locomotive firemen were charged with keeping the fire going, not putting it out.

Criticisms aside, *American Railroads* is a detailed and comprehensive guide to the near-death of the American railroad system and the technological and political changes that stimulated its rebirth. It will be of interest to scholars who specialise in transportation issues, along with anyone interested in the interaction of public policy and technological change.

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Tony Hadland and Hans-Erhard Lessing. *Bicycle Design: An Illustrated History*. Cambridge, MA: The MIT Press, 2014. Pp. 576. \$34.95/£24.95.

'I'm more interested in a world that works than what sells.' These words by Paul MacCready, pioneer of human-powered flight, begin *Bicycle Design* and set the tone for what is to follow. In sixteen chapters and four appendices, Tony Hadland and Hans-Erhard Lessing present the development of the bicycle in exhaustive detail.

In Chapter one (Velocipedes and Their Forerunners), Hadland and Lessing present fascinating examples of personal mobility from the eighteenth and early nineteenth centuries, including ice skating, roller skating and a human-powered vehicle from Japan; all these illustrate a powerful, emerging human wish for mobility. In Europe, personal transport still relied heavily on horses and therefore was expensive. However, critical events such as shortage of food resulting from bad harvests and army raids during the Napoleonic wars necessitated horseless transport. Gradually, the idea of a two-wheeled human-powered machine spread through the Western world.

Forerunners of contemporary bicycles, self-propelled vehicles like draisines and velocipedes were developed in different countries and in many variations. This was not an easy task, which Hadland and Lessing reveal in Chapters Two to Four by distilling wealth of primary and secondary information so as to discuss numerous successful and unsuccessful attempts to develop these mechanisms.

The safety bicycle, which surpassed technological deadlocks of earlier bicycle types and substantially contributed towards safe bicycling is the subject of Chapter Five, whereas Chapters Six to Eleven focus on specific user needs and particularly on ride comfort, reduced resistance and energy dissipation, improved holding and traction, increased practicality and, above all, safety. Chapters Twelve to Sixteen are dedicated to special types of bicycles: racing, military, mountain, small-wheeled and recumbent. The text is complemented by appendices that provide additional material. One, for example, debunks the myth that Leonardo da Vinci invented the bicycle, as well as other priority hoaxes that were used as propaganda tools in the economic wars among Western countries.

As *Bicycle Design* convincingly demonstrates, the evolution of the bicycle has been a long and complex process. Within this process, endless technical innovations were created, many of which soon became extinct, pneumatic brakes being one notable case. This did not necessarily happen because failed solutions to specific problems were technically inferior, but because of the interplay of a multitude of technical, social, commercial, economic and other parameters. The evidence provided in the book indicates the highly contingent character of the bicycle's evolution. Furthermore, the theme of imitation runs through the text: bicycle evolution manifests mutual influences with other human-powered devices. For example, bicycle development was inspired by balancing on roller skates, but also from hand-cranked and treadle-driven sewing machines. At the same time, early bicycles stimulated the later invention of the scooter and the automobile.

Hadland and Lessing, throughout their work, extensively use patents as historical sources. This, like their highlighting of the legal complications of technological development, is particularly noteworthy. The authors also observe that cycle sport is governed by various national and international bodies which lay down rules affecting the design of bicycles. They are especially critical of the Union Cycliste Internationale, an organisation setting rules described as very arbitrary and thus substantially impeding the development of human-powered transport, principally the bicycle. On the other hand, they suggest that the concise and flexible nature of rules set by the International Human Powered Vehicle Association is more conducive to innovation.

Although *Bicycle Design* is richly illustrated, it is practically impossible to present visually all the bicycle parts and mechanisms discussed. Thus, elaborate descriptions lacking relevant illustrations are a bit difficult to follow. Additionally, more careful editing could have improved the cohesion and readability of the text. The extensive index is very welcome, although several useful terms are missing from it, such as the titles of national or international exhibitions (the Britain Can Make It Exhibition of 1946 and the Great Exhibition of 1851), and of various museums mentioned (the Victoria and Albert Museum, the Compiègne Museum, etc.); this is, indeed, a measure of the density and richness of the text.

Altogether, *Bicycle Design* is rich in technical descriptions and offers a wealth of insights into bicycle development. The book may be regarded as bridging the area between two related publications, namely David Gordon Wilson's science-focused *Bicycling Science* and David V. Herlihy's comprehensive historical account, *Bicycle: The History*. As Hadland and Lessing note in their Preface, they concentrate on the technological rather than the sociological aspects of the bicycle. Much of their research material originates from the International Cycling History Conferences; hence, the perspective is limited to that of the developed countries of the West. Aesthetic issues are also neglected, but as they state in Appendix C, this was deliberate since, in their opinion, most of bicycle's aesthetic characteristics derive primarily from engineering. They also acknowledge that the history of technology, which was established as an academic discipline after the appearance of the bicycle, later paid little attention to this invention. *Bicycle Design* thus aims to fill a significant gap. The book is successful in this respect; its omissions point to the need for further research and scholarship into unexplored aspects of the subject matter. *Bicycle Design* is a laudable contribution to the historiography of bicycles and its content provides ample evidence of the continuing popularity and allure of the 'freedom machine'.

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Alexandra Hui. *The Psychophysical Ear: Musical Experiments, Experimental Sounds, 1840–1910*. Cambridge, MA: The MIT Press, 2013. Pp. 233. \$34.00.

In this well-researched and important contribution to the cultural history of science, Alexandra Hui deals with the interaction between psychophysical studies of sound and musical aesthetics from the middle of the nineteenth to the early twentieth century. Although there are books on some aspects of this subject, such as Myles Jackson's splendid *Harmonic Triads: Physicists, Musicians and Instrument Makers in Nineteenth Century Germany* (2006), Hui