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LIVES OF THE ENGINEERS

Henry Petroski

Engineers are of two minds on how important they as individuals are vis-à-vis their projects. Some self-effacing ones see themselves as just part of a team: "No one man designed the bridge," Othmar Ammann said of his signature masterpiece, the influential George Washington, although it would certainly not have been built when, where and how it was had it not been for him. Others are self-promoters who take every opportunity to call attention to themselves: David Steinman, Ammann's archrival in bridge building, so bombarded editors with news releases and pictures that at least one editor noted that "his great accomplishments were sometimes clouded by his personality, which frequently made him the center of controversy."

Both men had great careers. Ammann was responsible for or had a significant role in the design and construction of at least eight of New York City's major bridges, including the crowning achievement of the record-setting Verrazano Narrows across the mouth of the harbor. Steinman, who designed and built bridges all over the world, including the enormous Mackinac Straits Bridge connecting the two peninsulas of Michigan, is also remembered for his role in championing his profession and for having founded and been the first president of the National Society of Professional Engineers. Two careers of similar accomplishment could not have been approached and lived more differently.

There are also two approaches to celebrating engineers and engineering in books. On the one hand, engineers and their works can be the subject of traditional biography, in which the life of the person drives the narrative through a chronological course, resulting in an annotated and illustrated *curriculum vitae* of sorts that documents the individual's involvement with contemporary projects. On the other hand, a single great project or an individual's *oeuvre* can be the book's subject, incorporating personal and interpersonal anecdotes only to the extent that they are relevant to the focus of the story.

Autobiographies of engineers almost invariably fall into the first category, albeit often pub-

lished by vanity, small or professional-society presses, some of which either cannot or do not discriminate among degrees of interesting and effective writing. Most such autobiographies do not reach much beyond the small sector of the engineering community to which the subject belonged. Occasionally, though, an autobiography is written and published well and achieves outstanding success, as did electrical engineer Michael Pupin's *From Immigrant to Inventor*, which won a Pulitzer Prize in 1924.

In the second category are books like David McCullough's celebrated *The Great Bridge* and *The Path Between the Seas*, recounting respectively the heroic stories of the building of the Brooklyn Bridge and the Panama Canal. Although engineers like the father and son Roeblings who bridged the East River and the succession of engineers (John Findley Wallace, John Frank Stevens and George Washington Goethals) who led the effort in Panama are certainly looming presences in such books, it is the engineering achievement itself that is the real focus. Either approach to engineering biography can clearly be effective, but just as engineering is the art of compromise, so too can be the art of writing about engineers and engineering.

The Engineers' Biographer

Among the most successful biographers of engineers was Samuel Smiles, who combined stories of human struggle and self-determination with those of technical achievement and entrepreneurial endeavor. His *Lives of the Engineers, with an Account of their Principal Works; Comprising also a History of Inland Communication in Britain*, to give the full title of the 1861 first edition of the multi-volume work, not only provided a model of the Victorian engineering biography, but also essentially defined the pantheon of significant engineers and the canon of landmark engineering projects in British history. Those whose lives were recounted and held up as paragons of virtue and achievement by Smiles became known throughout the world as the engineers who pioneered the improvement of the infrastructure of the kingdom and who drove the Industrial Revolution, which itself was epitomized by achievement in the United Kingdom.

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Figure 1. Samuel Smiles's *Lives of the Engineers* is the most significant collection of biographies of engineers ever produced. Many editions have been printed, including engineer O. F. Nichols's mid-19th century set (left) and the 1904 edition in Duke's Vesic Engineering Library.

Samuel Smiles was not himself an engineer. Born in 1812 in Haddington in southeastern Scotland, he studied medicine at Edinburgh. While at the university, he became involved in reform movements, and his interest in politics and change continued even after he began working as a physician in his hometown in 1832. In 1838, after about a year of contributing articles on parliamentary reform to the *Leeds Times*, Smiles was invited to become editor of that newspaper. He accepted the challenge and eventually abandoned his medical career to work full-time for political change. He had a strong dislike for the aristocracy and sought to unite reformers from the working and middle classes. In the 1840s, having become disillusioned with reform leaders and believing that "mere political reform will not cure the manifold evils" that afflicted society, Smiles turned to advocating "individual reform" and promoting the idea of "self-help."

In 1845, in the midst of what historians of engineering and technology describe as the "mania" to expand the still-young railroads throughout Britain, Smiles left the *Leeds Times* to take up the position of secretary to the Leeds & Thirsk Railway. Although such a radical career change might seem contradictory for the reformer Smiles, it is understandable in the context of the times. Throughout the 1830s, the railroads in Britain had developed in an unregulated fashion, resulting in a proliferation of small lines running short routes in a generally unintegrated fashion. According to one historian, "The motivation for their proprietors was the pursuit of local interests and short-term returns on investment, without anticipation of wider regional benefits, longer-term returns or economic stimulus." In the light of this, "There was a growing call for the substantial returns on railway investment to be partly redirected towards greater safety, and benefiting poorer citizens through lower fare opportunities."

Such sentiments were echoed by Robert Stephenson, the eminent engineer who would be

involved with as much as a third of the miles of railroad development in Britain. According to a report of a speech he made at a dinner involving the shareholders of the Northern & Eastern Railway, in 1844:

Mr. Stephenson carried thoroughly with him the sympathy of all present when he said that railways had benefited the commercial man and the man of pleasure, but that they had yet fallen short of serving the poor man. The poor man had not yet got what he was entitled to—advance towards this was being made, but the true and full effect of railways would not take place until they were made so cheap in their fares that a poor man could not afford to walk.

The reformer Samuel Smiles must certainly have been attracted by such talk. What better way to help bring such a result about than to work within the railway system. Smiles remained secretary to the Leeds & Thirsk line for nine years, at which time he assumed a similar position with the South-Eastern Railway, where he remained for another decade or so. He thus had the opportunity to become quite familiar with the history, state of affairs and effects of rail travel. But Smiles abandoned his interests in parliamentary reform in the 1850s and turned to a project that greatly influenced the rest of his career.

Among those inseparably involved with the early development of the railroad was George Stephenson, Robert's father, and so the story of the technology could be told through the life of the man. Smiles did this in writing his first book, *The Life of George Stephenson, Railway Engineer*, which was published in 1857 to great success. One reviewer considered it to be "one of the best and most popular biographies" of the times.

Smiles regarded the British railway system as "the most magnificent public enterprise yet accomplished." He must also have felt that it had achieved a great degree of success in realizing

the dreams of reformers, for he wrote in the preface to his life of George Stephenson:

The number of passengers conveyed by railway, in 1856, amounted to not less than 129,347,592; and of these, more than one-half travelled by third-class trains, at an average cost of eight-tenths of a penny per mile, the average fare for all classes of passengers not exceeding one penny farthing per mile. The safety with which this immense traffic was conducted is not the least remarkable feature of the system; for it appears ... that the proportion of accidents to passengers, from causes beyond their own control, was only 1 person killed to 16,168,449 conveyed.

Smiles saw the railroad to be of even greater value in Canada and the United States, where he regarded it as "the pioneer of colonisation, and as instrumental in opening up new and fertile territories of vast extent—the foodgrounds of future nations." He envisioned the railways in Europe to hold the promise "to abate national antipathies and bind together more closely the great families of mankind." The railroads, in short, were "the most magnificent system of public intercommunication that has yet been given to the world," and Smiles wanted to answer some basic questions about their origin:

What manner of men were they by whom this great work was accomplished? How did the conception first dawn upon their minds? By what means did railways grow and quicken into such vigorous life? By what moral and material agencies did the inventors and founders of the system work out the ideas whose results have been so prodigious?

Smiles had chosen as the vehicle by which he would answer such questions his biography of George Stephenson, whose "life may be said to include the history of Railway Locomotion." Not incidentally, Stephenson's life was exemplary of those traits that Smiles wished to promote: "Strongly self-reliant, diligent in self-culture, and of indomitable perseverance, the characters of such men—happily numerous in England—are almost equivalent to institutions."

Self-help?

Samuel Smiles not only wrote about character, he lectured on the subject. In particular, he had delivered to young men in Leeds a series of lectures on self-improvement, which he developed into his second book, *Self-Help; with Illustrations of Character and Conduct*, first published in 1859. Like other books by Smiles, *Self-Help* went through many revisions and editions—often but not always reflected in the subtitle—cumulatively selling on the order of a quarter of a million copies by the end of the 19th century. Smiles him-

self admitted that the main title *Self-Help* had "proved unfortunate," since it had led some "to suppose that it consists of a eulogy of selfishness: the very opposite of what it really is—or at least of what the author intended it to be":

Although its chief object unquestionably is to stimulate youths to apply themselves diligently to right pursuits—sparing neither labor, pains, nor self-denial in prosecuting them—and to rely upon their own efforts in life, rather than depend upon the help or patronage of others, it will also be found, from the examples given of literary and scientific men, artists, inventors, educators, philanthropists, missionaries, and martyrs, that the duty of helping one's self in the highest sense involves the helping of one's neighbors.

Though Smiles did not include them explicitly in his list of exemplars, it was engineers to whom he turned for his most extended expositions of how self-help brought about accomplishments that advanced civilization and the quality of life. In 1861 he published *Lives of the Engineers*. The first volume included biographies of Cornelius Vermuyden, the Dutchman who drained the English Fens and thus recovered land long lost to the sea; Hugh Myddelton, who developed a system of water supply for London; John Metcalf, who, although blind, built roads over bogs; and James Brindley, who laid out canals, first for the Duke of Bridgewater and eventually for all of England.

The second volume of Smiles's *Lives* contained biographies of John Smeaton, whose career coincided with the rise of civil engineering as a profession distinct from military engineering and who as a consulting engineer was responsible for a new Eddystone Lighthouse and for bringing a scientific approach to solving engineering problems generally; John Rennie, who had so much to do with London's bridges and docks and who left a family legacy of engineers; and Thomas Telford, first president of the Institution of Civil Engineers, whose roads and bridges, including those linking London and Holyhead, stand to this day throughout England, Scotland and Wales as monuments to him and his engineering genius.

A third volume of the *Lives* also appeared in 1862, but, rather than being an entirely new work, it was a revision of *The Life of George Stephenson*. According to a contemporary reviewer, writing in *North American Review*, Smiles erred in judgment "by incorporating with the text a short account of the life of Robert Stephenson, instead of appending it to the memoir of the elder Stephenson, as a separate and independent biography." The life of the younger Stephenson, who in so many ways surpassed his father as an engineer and a statesman, was indeed worthy of its own volume, but for whatever reason Smiles chose never to give it to him. (One wonders if Smiles could not bring himself to give the son his full due because, rather than being entirely self-

taught like his father, Robert Stephenson had a rather privileged secondary education.)

In spite of the criticism Smiles received for his Stephensons volume, *Lives of the Engineers* continued to be successful. A fourth volume, *Lives of Boulton and Watt: Comprising also a History of the Invention and Introduction of the Steam-Engine*, appeared in 1866. In his preface, Smiles declared that this volume concluded the *Lives of the Engineers*, but a bibliographically bewildering number of expansions, revisions and editions continued to be published throughout the Victorian era. A five-volume enlarged edition was published in 1874. (*Selections from Lives of the Engineers*, edited with an introduction by the historian of technology Thomas Parke Hughes, was published in 1966.)

Turning Up the Volumes

The Vesic Engineering Library at Duke, my library of first resort, has a five-volume “popular edition” of *Lives* with an imprint date of 1904, which is generally considered the date for the last edition of the work. According to acquisition records, the entire set of books was purchased for \$10 and was added to the collection in 1953. Some of the books have an earlier owner’s name crossed out in pencil, but it is still quite decipherable. The flyleaf of Volume 4 reads, “C. G. Baker / Alwen Reservoir / N. Wales / April 1914.” The Alwen Reservoir is in Clocaenog Forest, just north of the A5, the modern highway that follows the historic route of Thomas Telford’s London to Holyhead Road. I imagine Baker to have been a hydraulic engineer interested in the history of his profession.

The Vesic Library’s red-cloth bound volumes of Smiles were long my reading copies. I did not have to look up their call number (926.2 S641L), for I always knew exactly where they were—near the end of the stacks, among the odd assortment of other biographies in the engineering library’s sparsely populated Dewey Decimal 900s. (Duke’s library system has not converted to Library of Congress cataloging, although the issue does resurface every now and then.) The features of their red bindings had become quite familiar to me, down to that of the front cover of Volume 2 being defaced with the remains of a curious paper label bearing the number “341” in large numerals. Whenever I looked for the Smiles, they were always on the shelf. As often as I had the volumes checked out, they never were recalled. This was convenient for me, of course, but it was also disappointing in that no one else on campus seemed to be reading these classics of engineering biography and history.

I had long thought that my personal library should contain a set of Smiles’s *Lives of the Engineers*, but the convenience of having one so readily available in the Vesic Library removed any urgency to my seeking out a set of my own. I halfheartedly looked for the volumes whenever I visited used bookshops, but I never did find

them. Those sets I came across in rare book catalogs always seemed to be too costly or somehow otherwise not quite right. In recent years, I had even stopped looking for my own Smiles, having become attached to the Vesic set, complete with the mysterious label on Volume 2.

Then out of the blue, earlier this year a letter was forwarded to me from the American Society of Civil Engineers (ASCE). The letter was written by a descendant of the distinguished engineer Othniel Foster Nichols (1845–1908). Nichols received a civil engineering degree from Rensselaer Polytechnic Institute in 1868 and early in his career worked on the development of Prospect Park, where I often played as a child in Brooklyn. Nichols spent most of his career in the New York area, working on the city’s first elevated railway. Perhaps his crowning achievements were as principal assistant engineer in charge of the Williamsburg Bridge, which was the longest in the world when completed in 1903, and as chief engineer of the New York Department of Bridges during a time when the Manhattan Bridge was being designed.

O. F. Nichols’s great-grandson was writing to me in my capacity as chairman of the ASCE’s History and Heritage Committee. He was inquiring if I knew of any institution or scholar who might be interested in his great-grandfather’s set of *Lives of the Engineers*. Perhaps it was destiny. I wrote back immediately expressing my desire to give the books a loving home in my own library. The four-volume set arrived a couple of weeks later, and I began to reread Smiles from volumes with a significant engineering provenance.

It might be considered quaint today to read the *Lives* for the moralistic lessons that Smiles intended, but they are still captivating and invaluable biographies of engineers and histories of engineering. Smiles was a generally conscientious and careful scholar, with a not-unpleasant writing style, given the period in which he was writing. The *Lives* still can reward the reader—layperson and professional alike—seeking to understand the personality of the engineer and the nature of engineering.

In fact, Smiles’s *Lives* had an enormous influence on the enduring image of the heroic engineer, and the engineers that he chose to profile as exemplars became the engineers who to this day stand out among all contemporaneous British engineers, save those who were fortunate also to have been memorialized in biographies and autobiographies. (*James Nasmyth, Engineer: An Autobiography* was edited, if not ghostwritten, by Smiles.) But Smiles’s engineers were far from the only ones to be remembered.

Among the Missing

The Victorian engineer who may remain most widely known today is Isambard Kingdom Brunel, curiously absent from Smiles’s pantheon. It is possible that Brunel’s life did not appeal to

Smiles because the engineer did not come from humble-enough or politically preferred origins. His father, Marc Brunel, was a royalist who fled his native France during the Revolution. After working as an engineer in America, he relocated to England, where his son Isambard was born in 1806. As a teenager, Isambard was sent to France to be educated and returned to have a career of heroic proportions in England. That career would not be profiled by Smiles, however, possibly because of the family background but certainly because the subject was already spoken for: Smiles got wind of the fact that the younger Brunel's son, also named Isambard, was working on a biography of his father. The fact that his *The Life of Isambard Kingdom Brunel, Civil Engineer* was published in 1870 lends credence to this observation. As does Smiles's own admission that he at first shied away from writing a biography of James Watt because "the subject had already been taken in hand by ... the literary executor of the late Mr. Watt." It was only when Smiles gained access through Matthew Boulton to documents including an extensive collection of Watt's correspondence (the so-called "original Soho mss." referred to on the title page of the *Lives of Boulton and Watt*) that he undertook his book-length study of them.

Regardless of the reasons that Smiles made the choices of subjects that he did, his *Lives* remains the most significant collection of biographies of engineers ever produced, and subsequent biographers have often returned to the same Victorian giants that Smiles elevated to familiarity. Among the most prolific 20th-century biographers has been L. T. C. Rolt, author of *Thomas Telford* and *George and Robert Stephenson*. Rolt also wrote a biography of Isambard Kingdom Brunel, as have so many others in recent years. (A quick search indicates there are at least 20 distinct biographies of IKB, as he is so frequently referred to in Britain, including one of him and his father. The most recent is *Brunel: The Life and Times of Isambard Kingdom Brunel* by the historian of technology R. A. Buchanan, published just last year.)

As far as I know, no single American engineer has had so many book-length biographies written about him. Among the most popular American subjects has been Charles Steinmetz, whose surname was at one time virtually synonymous with engineering. Full-length adult books about his life number perhaps as many as a dozen, with a significant number focusing on his socialism at least equally with his engineering. John Roebing is, perhaps among all the American engineers, the one who comes closest to maintaining a recognition factor anywhere near approaching IKB. He and his son, Washington Roebing, with whom he is often confused and who completed the Brooklyn Bridge after his father's tragic death, have been the subjects of fewer biographies than Steinmetz, although a joint one, *The Builders of the Bridge: The Story of John Roebing and His Son*, was written by David Steinman. (Unfor-

tunately, according to David McCullough, Steinman's labor of love "was based on superficial research and contains many inaccuracies.") Steinman's own biographer, William Ratigan, who wrote like the commissioned journalist that he most likely was, produced a hagiography, *Highways Over Broad Waters: Life and Times of David B. Steinman, Bridgebuilder*, which is as awkward and pedestrian as its title.

In 1946, Thomas J. Higgins, an electrical engineer with an interest in the history of his field and more, published a compilation of book-length biographies of engineers listing more than 100 lives of civil engineers and more than 50 of electrical engineers. Since Higgins's bibliographies appeared, many more biographies of engineers have been published, some of which are mentioned above, but it is the rare one that has reached a readership anywhere near that of Samuel Smiles's *Lives of the Engineers*.

There has not yet arisen an American Smiles (or even a Rolt) to write commandingly of the likes of Steinman, Ammann and their fellow engineers, whose legacy includes not only the great bridges of America but also the canals, harbors, railroads, highways and other means of inland communication that have shaped the country and enabled it to become what it has. The infrastructure that so affects our quality of life is the legacy of engineers who largely remain anonymous—whether or not their biographies have been written.

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Bibliography

- Bailey, Michael R. ed. 2003. *Robert Stephenson—The Eminent Engineer*. Aldershot, Hants: Ashgate.
- Griggs, Francis E., Jr., ed. 1991. *A Biographical Dictionary of American Civil Engineers*. Vol. II. New York: American Society of Civil Engineers.
- Higgins, Thomas James. 1946. Book-length biographies of engineers, metallurgists, and industrialists. Part I. *Bulletin of Bibliography* 18:206–210; Part II. *ibid.* 18:235–239; Part III. *ibid.* 19:10–12.
- Skempton, A. W., et al., eds. 2002. *A Biographical Dictionary of Civil Engineers in Great Britain and Ireland*. Vol. 1: 1500–1830. London: Thomas Telford.
- Smiles, Samuel. 1857–1866. *Lives of the Engineers*. Four volumes. London: John Murray.
- Smiles, Samuel. 1883. *Self-Help*. Chicago: Belford, Clarke.
- Smiles, Samuel. 1904. *Lives of the Engineers*. Five volumes. London: John Murray.
- Smiles, Samuel. 1966. *Selections from Lives of the Engineers*. Ed. Thomas Parke Hughes. Cambridge, Mass.: MIT Press.
- Smith, Denis. 1994. *Perceptions of Great Engineers: Fact and Fantasy*. London: Science Museum.