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**ROLT, PETROSKI AND LEGGET: ENGINEER-HISTORIANS**

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## **Abstract**

These three engineers have made major contributions to the written history of engineering in Britain, the United States and Canada.....unusually for engineers, and their work in this field has been widely recognized. This paper discusses their differing backgrounds and published contributions, what made them effective as historians, and the importance of their work in relation to the science-engineering dichotomy.

This paper was presented, in part, by the author at the 17<sup>th</sup> biennial conference of the Canadian Science and Technology Historical Association, held in Ottawa, Ontario, on 19 November 2011.

Photographs of the three engineers appear on the last page of this paper.

## **About this Series**

Principally, the Cedargrove Series is intended to preserve some of the research, writings and oral presentations that the author has completed over the past half-century or so but has not yet published. It is, therefore, a modern-day variant of the privately-published books and pamphlets written by his forebears, such as his parental grandfather and grandmother, and his grandfather's brother John.

## **About the Author**

He is a graduate in mechanical engineering and the liberal arts and has held technical, administrative, research and management positions in industry in the United Kingdom and the public service of Canada, from which he retired 25 years ago.

He became actively interested in the history of engineering on his appointment to chair the first history committee of the Canadian Society for Mechanical Engineering in 1975 and served both CSME and the Engineering Institute of Canada in this capacity for varying periods of time until 2003. He has researched, written and edited historical material for both organizations, and is a past president of both.

## Introduction

It is quite unusual for engineers to write about the history of their profession and what it has accomplished in years past. Part of the reason for this is the apparent lack of sustained attention that engineers, generally, give to this history - or to any history, for that matter. But part is also due to the fact that engineering history is either downplayed or largely ignored by 'real' historians or is, wrongly in my view, included as part of the history of *science*.

L.T.C (Tom) Rolt and Robert F. Legget were engineers - as Henry Petroski still is - who have made significant contributions to the *corpus* of published material in this sub-field of history. Rolt, a Briton, wrote principally about British engineers during Queen Victoria's reign. Some - like Telford - worked mostly in civil engineering. Others, like I. K. Brunel and the Stephensons, straddled several disciplines. His working experience had a strong mechanical base. Of the three, it might be said that Rolt was, personality-wise, the most 'colourful' and may well have been the most prolific, although he has strong competition from the other two. He was also the one who gave up the regular practice of engineering once he began writing.

Petroski, an American, has covered engineering in both the 19<sup>th</sup> and 20<sup>th</sup> centuries, as well as in much earlier times, and is still researching, writing and publishing in the present one. He is unique in that he holds university appointments in both civil engineering and history. Of the three, it is possible that Petroski will end up being the best known among both engineers and lay people, and the most influential.

Legget, who was born in Britain but spent most of his working life in Canada, has written principally about the early civil engineering in this country, and especially about canals and railways. His work experience was broadly based. He served in the industry, university and government sectors. Of the three authors, Legget has been perhaps the one most involved in the politics of the profession, which may have influenced the historical writing he did.

## Rolt

Tom Rolt was born in Chester, England, in 1910. His early years were spent further south, at Hay-on-Wye in rural Welsh Border country. At a young age, he developed both a love of the countryside and a fascination with machines. His family had no strong engineering connection, although one relative was a mechanical engineer and an inventor of considerable ability. It was he who advised Rolt's parents to apprentice him in the mechanical field. In 1926, young Rolt left school to serve as a pupil with an agricultural engineering firm. He worked mostly on steam ploughing engines. In June 1928, he began a three year apprenticeship with Kerr, Stuart & Company, locomotive engineers at Stoke-on-Trent, but the firm collapsed before this was finished. However, he managed to finish his 'time' with the R.A. Lister Company of nearby Dursley.

By then, in the early 1930s, he had become enthusiastic about vintage cars and in owning them. So

he took a series of short term jobs until he was able to set up in business with some friends to service these vehicles. He was also involved in the establishment of the Vintage Sports Car Club. At the same time, he developed an interest in the English canals, in the narrow boats that sailed them, and in one of these in particular - the *Cressy* - which belonged to the family responsible for his entry into engineering. An opportunity to acquire the *Cressy* for himself came just as Rolt's literary ambitions were beginning to stir within him. He also began to appreciate the tourist/leisure potential of the canals and their boats, as well as that of the narrow gauge railways.

Late in 1938, Rolt sold his share of the garage and, in 1939, was married. The *Cressy* served as home for him and his new wife. This development also provided the solution to his financial problems, since his new father-in-law - disapproving of Tom - had cut the allowance he had been providing to his daughter. The boat also provided a place for him to work at his new occupation - writing. His first book, *A Painted Ship*, failed to find a publisher until 1944, when it appeared under the title, *Narrow Boat*. This book led to the formation in 1946 of the Inland Waterways Association, of which Tom became the first secretary. It also proved that his writing abilities were substantial.

However, by 1951, things had changed for him. His marriage failed, and the IWA expelled him during a policy dispute. He then turned his attention to a mechanical outlet for his enthusiasm - the Talylyn Railway, a privately-owned narrow-gauge line in central Wales, of no interest to the then nationalized British railway system. He applied his organizational and mechanical skills to its Preservation Society, turning it into a flourishing operation, restored and operated by volunteers. This was only the notable first in a number of such transport system preservations in which he took part.

Around this time, Tom married again. His new wife, Sonia, had been one of the young women trained during World War II to operate canal boats. She had also been associated with the IWA, where she had met Tom. They lived on land, however, in a house in Gloucestershire that had belonged to Tom's father. Here their two sons were born, and here Tom died in 1974, at the early age of 64.

After the *Narrow Boat* in 1944, Tom published regularly. A bibliography of his writings, compiled by Ian Rogerson and Gordon Maxim, with the assistance of Sonia Rolt, was published by M&M Baldwin in 1986. In it, Rolt's publications are listed in several categories - for example: waterways; railways; motoring and other transport; industrial history; biography and autobiography; and even a little fiction.

On waterways, in addition to the *Narrow Boat* he wrote a book on the canals of England, covering the history, construction and working of these waterways since the Middle Ages. He also wrote an account - with photographs by his first wife - of a journey on the waterways of the Republic of Ireland which they took in 1946, and a historical account of France's 17<sup>th</sup> century *Canal du Midi* which, apparently, had inspired the Duke of Bridgewater's canal in England a century later. He also wrote a half-dozen short pieces on inland waterways and contributed articles to such periodicals as *The Field*, *Country Life* and *Motor Boat and Yachting*.

On railways, he published two books and introduced a third that told the story of the Talyllyn Railway and its revival. He also wrote a book on the history of railway accidents, as well as over 30 articles, many of which appeared in the *Talyllyn News*.

On motoring, his book on the evolution of the motor car in England appeared in 1950 and on the history of motoring generally in 1964. A dozen articles on motoring appeared in magazines such as *Motor Sport* and the *Vintage Car Club Bulletin* and another in the *Sunday Times*.

Under the heading of other transport, he wrote about the history of ballooning from 1783 to 1903, the building of Britain's first motorway, the Severn Bridge (built in 1966) and the Tyne and the Mersey Tunnels.

Industrial history is one of the two more important categories of Tom Rolt's writing. This category includes a number of books and longer essays. Among the former is *Victorian Engineering*, in which he discusses, for example, the early days of railway engineering and the building of locomotives, the design and construction of the Crystal Palace, the building of more than a dozen bridges and viaducts and more than two dozen steamships, the application of steam to a variety of machinery, the application of steel in place of wrought iron, the development of machine tools, and arrangements made for the public supply of clean water. Along the way, he touches on the careers of those who made major contributions to engineering during Queen Victoria's reign. Among his longer essays are the histories of a number of industries and companies from the same period. His articles in this category numbered around 30, and the publishers included the *Birmingham Post* newspaper, *Country Life* and *The Engineer* magazines, and the *Newcomen Society Transactions*.

The other more important category includes his lengthy biographies. Beginning with I. K. Brunel in 1957, followed by Thomas Telford in 1958, Richard Trevithick in 1960, George and Robert Stephenson also in 1960, James Watt in 1962, Thomas Newcomen in 1963, and a 'younger reader's' version of the Brunel story in 1965. In this way, he tells the stories of many of the important engineers in English history during the 19<sup>th</sup> century. As a biographer, and given that he was writing about engineers and not political people, Rolt is not immune from criticism, either during or long since the appearance of his books. One such involved the controversy between Brunel and John Scott Russell, whose shipyard built the *Great Eastern*.

He wrote some 20 short historical pieces for a wide variety of publishers, including the *Institutions of Mechanical and Civil Engineers*, and published over 70 book reviews, most of which are connected with engineering. The Rogerson/Maxim list includes 25 items of published correspondence on all subjects, as well as some 20 items of biographical material on Rolt himself by other authors. Lastly, the list of Rolt's fiction includes two collections of short stories, one about engineering, the other not, two horror stories, and one long novel called *Winterstroke*, which describes in a fictional context the development of the early iron industry in England.

Rolt's ability, experience and contributions to engineering history were widely recognized during his lifetime. He became, for example, a vice-president of the Newcomen Society, which is devoted

to the engineering branch of history. He was a member of the Science Museum Advisory Council, and was instrumental in the establishment of the Railway Museum at York. He was elected a Companion of the Institution of Mechanical Engineers, and he received two honorary master's degrees.

### **Petroski**

The youngest of the three, and the one who is still writing, is Henry Petroski. These days, he seems to produce at least a book, plus lectures, refereed journal articles, and conference presentations each year, and at least an article each month in the magazine *American Scientist*. His technical specialties are structural engineering and success-and-failure analysis in engineering design. These subjects - not surprisingly - show up frequently in his written material. He also has concerns about the nature of science, technology and invention in relation to engineering and its history. Among his research sponsors have been the U.S. Corps of Engineers, the NSF, the Sloan Foundation, and the university where he now teaches. Much of his writing is aimed at the general reader and is intended to explain what engineering is and what engineers do.

Petroski is a native New Yorker, born in Brooklyn in 1942. A 1963 bachelor graduate in mechanical engineering from Manhattan College, he obtained master's and doctorate degrees in applied mechanics from the University of Illinois-Urbana in 1964 and 1968. After graduate school, he was on the engineering staff at the Universities of Illinois and Texas until 1974, after which he spent five years at the Argonne National Laboratory where he was a group leader responsible for development work on fracture mechanics.

Since 1980 he has been Aleksander S. Vesic professor of civil engineering and has a secondary appointment as a professor of history at Duke University, North Carolina. He has also served on the U.S. Nuclear Waste Technical Review Board. He is a member of the National Academy of Engineering, the American Academy of Arts and Sciences, and the American Societies of Civil and Mechanical Engineers. For the ASCE, he has chaired its History and Heritage Committee. His honours and awards are, to say the least, numerous. He has also been asked to give many distinguished lectures and keynote addresses.

For Petroski, engineering began a very long time ago, when solutions to everyday problems were sought and found in nature, when rocks became hammers. He began his series of regular contributions to the *American Scientist* about 30 years ago and has written on a wide variety of subjects, ranging from ancient history (for example, on Vitruvius and Machu Picchu), through modern machinery and engineering (for example, tower cranes and controlled demolition) to more philosophical topics, such as scientists as inventors, and the 'anonymous' profession - engineering. Material that has appeared in them has been adapted for his books, of which there are now 16, produced by a variety of publishers. The latest, *An Engineer's Alphabet: The Softer Side of the Profession*, appeared only a few weeks ago.

His first book (1982), *To Engineer Is Human: The Role of Failure in Successful Design*, established one of the main themes of his writing: that the possibility of failure is an essential part of successful engineering. His other books have been:

*Beyond Engineering* (1985) is a series of essays based on earlier articles and was designed to justify the mixing of engineering with writing about it - in other words, both are forms of construction;

in *The Pencil* (1989), Petroski uses 400 pages to explain the origins of the pencil (in Roman times), its manufacture through the ages (by firms headed by the likes of the family of Henry David Thoreau), its many uses, and to justify the thesis that all 'made' objects - even the humble pencil - owe their existence to some kind of engineering;

then came *The Evolution of Useful Things* (1992): how, for example, the fork got its tines; how pins became paperclips; how the zipper evolved; and how some tools make other tools;

in *Design Paradigms: Case Histories of Error and Judgement in Engineering* (1994) he argues for a more pervasive use of case studies in the undergraduate engineering curriculum because of the practical wisdom and experience that they contain;

which was followed by *Engineers of Dreams: Great Bridge Builders and the Spanning of America* (1995), one of Petroski's more impressive books, which provides extensive material and discussion on the careers of a half-dozen eminent American bridge builders and the construction of their bridges;

*Invention by Design: How Engineers Get From Thought to Thing* (1996) expanded on the thought that engineering entails more than knowing the way things work; it is also concerned with economics, aesthetics and ethics, even for things as small as the tab of a beverage can or as large as the cabin design of a turbojet;

*Remaking the World: Adventures in Engineering* (1997) is a series of essays based on earlier columns. They discuss several very large projects, such as the Panama Canal, the Channel Tunnel, the QE2 and Kuala Lumpur's Petronas Towers; profile several eminent engineers, such as machine tool manufacturer James Naysmith, General Electric's Charles Steinmetz, and Karl Terzaghi of soil mechanics fame, as well as discussing the harnessing of steam, the evolution of personal computers, the Nobel Prizes, and the proposition that engineering is driven by economics. He also deals with the I.K. Brunel-John Scott Russell controversy;

*The Book on the Bookshelf* (1999), is rather different, being a history of books, libraries, publishing and bookbinding rather than a conventional piece on the history of engineering;

Petroski's next book (2002) is in the form of a personal memoir of his early years in the Boroughs of Brooklyn and Queens in New York City; it is called *Paperboy*, and discusses the influence his four years delivering evening newspapers had on his later decision to follow engineering as a career;

*Small Things Considered: Why There is No Perfect Design* (2003) provides a perspective on the role of design in everyday life and, in particular, with regard to commonplace items such as the dixie cup, electrical outlets and paper bags, many of which are of contemporary rather than historical interest;

*Pushing the Limits: New Adventures in Engineering* (2004) is another impressive book, dealing with boundaries in the design and construction of longer bridges, taller buildings and unusual structures; it looks to the future as well as to the past and reflects one of Petroski's professional specialties - structural engineering;

in *Success Through Failure: The Paradox of Design* (2006), Petroski returns to his major theme and describes failure in design as "a unifying theme for describing the functional evolution of things"; the book itself was written in parallel with a series of three invited lectures the author gave at Princeton University in 2004;

then comes *The Toothpick: Technology and Culture* (2007), which resembles the earlier book on the pencil in that it discusses the manufacture and uses of toothpicks; it was originally intended to be a chapter in an earlier book, but grew to be a self-contained one on its own account;

in *The Essential Engineer: Why Science Alone Will Not Solve Our Global Problems* (2010), Petroski explores the ways in which engineering differs from science and the ways in which they must work together to address the world's pressing issues; more on this subject in a moment;

finally, with regard to *An Engineer's Alphabet* (2011), I can say nothing about it as yet; I have not yet bought a copy, but hopefully Santa Claus may put one in my stocking next month!

### **Legget**

Robert Legget's standing among engineer-historians is illustrated by his inclusion in the list of winners of the Heritage and History Award of the American Society of Civil Engineers, to which he was added in 1987. Other winners of this award include known names in the field, such as James Kip Finch, Samuel C. Florman and Henry Petroski.

Robert Ferguson Legget was born in Liverpool, England, of Scottish parents in 1904. He was



