

John Rennie and the Bell Rock Lighthouse

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Scotland's Bell Rock Lighthouse ranks as one of the greatest civil engineering maritime achievements. The lighthouse, erected from 1807-11 in the North Sea, about 12 miles off Arbroath, was built of stone quarried at Aberdeen, Mylnefield [near Dundee] and Craigleith [Edinburgh] and shipped to Arbroath [Fig.1]. Exceptional difficulties in building the lighthouse arose from the rock being inundated with up to 14ft [5m] of water every high tide [Fig.2], at times subject to excessive force from the sea. This situation severely restricted working time at the rock before the temporary barrack for the workers adjoining the tower became operational. But with ingenuity, determination, and outstanding courage, this seemingly impossible challenge was met, to achieve an elegant lighthouse, 115ft [35m] tall with a 42ft [13m] diameter base, costing £61,331.9s.2d. [Stevenson 1824, 483]. During the next half-century the project significantly influenced lighthouse, harbour and bridge construction techniques. Its success also enabled Robert Stevenson, in 1811, to set up a family engineering firm practicing through four generations for 151 years and achieving international reputation.

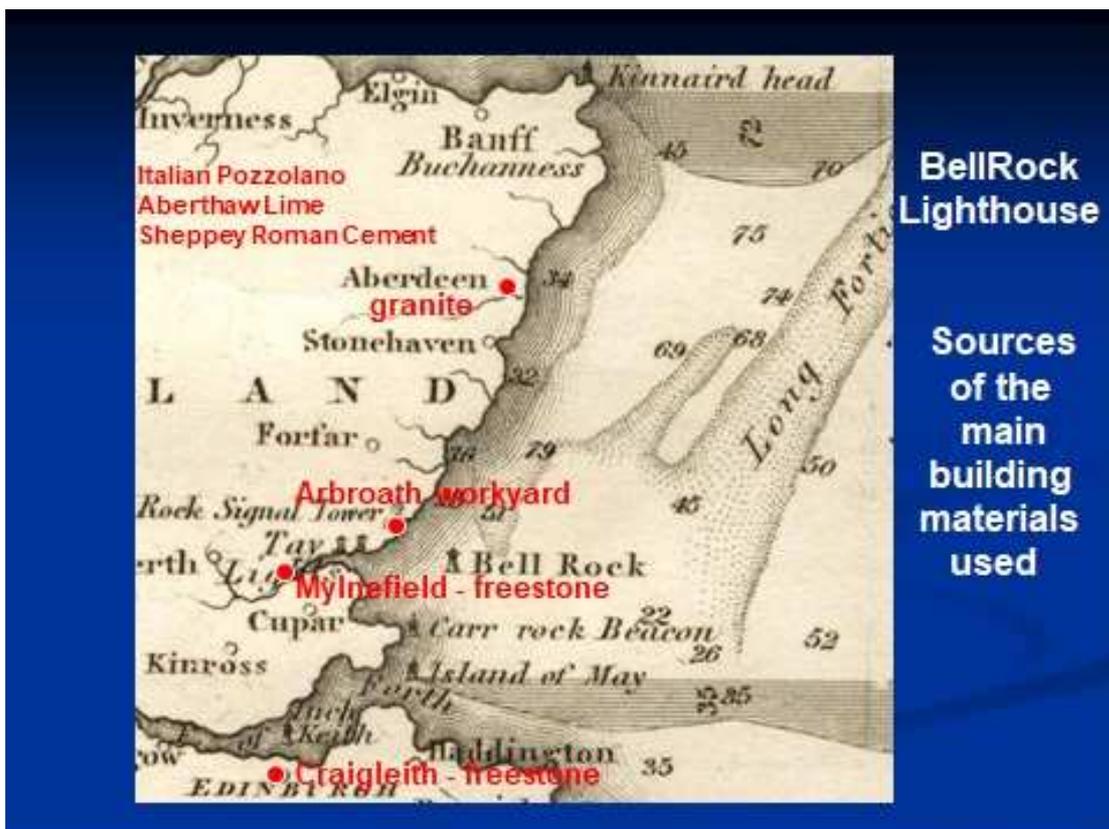


Fig.1 <https://ice-museum-scotland.hw.ac.uk/> Lecture 10, 4

In 1799, 70 vessels were stranded or lost within 30 miles or so of the rock, many of which might have been saved by a lighthouse. Stevenson, then apprenticed to and in charge of the lighthouse work of Edinburgh lamp manufacturer Thomas Smith, Engineer to the Northern

Lighthouse Board, proposed and modelled a stone lighthouse. From 1800-06 this proposal formed the basis of application for the Act of Parliament needed for its execution that was obtained on 21st July 1806 with the support of John Rennie. He had more experience of marine construction than Stevenson and had just reported on the provision of Plymouth breakwater, pier, and two lighthouses, estimated to cost £1.17m, for which he later became the Engineer.

On 3rd December, the Northern Lighthouse Board resolved that the lighthouse be erected 'under Rennie's direction' and appointed him 'Chief Engineer' and Stevenson as his 'Assistant'. Although very busy on other work, by February 1807 Rennie had drawn up his basic design of the lighthouse and furnished Stevenson with an elevation and details for setting out the cycloidal form of curved face he considered essential for its stability [Paxton 2011 *Dynasty*, 82]. Rennie's elevation with details was first published in the *Scots Magazine* for June 1807 [Fig. 3 - Note the sea being deflected upwards at the curved face].



Bell Rock reef at low tide from 'Cunningham's Ledge' in 1986 – submerged up to 5 m at high tide. The railway, also an extraordinary achievement designed against sea effects , was an essential element in the project's completion by 1810.

Fig.2 <https://ice-museum-scotland.hw.ac.uk/> Lecture 9, 5. The railway is high-lighted in purple



Fig.3 Rennie's Lighthouse elevation, February 1807
R.Scott sculpt for A. Constable, Edinburgh

Under Rennie's able superintendence, the as built design of the lighthouse soon developed significantly from Stevenson's 1800-06 proposal [see Fig.4]. The competent Clerk-of-Works, David Logan, who later became Engineer to the Clyde River Trust, wrote: *'that if Stevenson's design had been built not one stone would have been left standing. It was not dovetailed ... there was no lateral connection and the profile had not the curvature for breaking up the waves'* [Dynasty 2011, 77]. We shall never know if this fate would have materialised but, in 1817, Stevenson's 36ft [11m] tall Carr Rock tower beacon, with a similar face curvature to his Bell Rock design, was destroyed in a storm. In a simulation undertaken at Heriot-Watt University, the tower was swept away by 5m waves [Paxton 2011 *A grand design* – Lecture 10, 39].

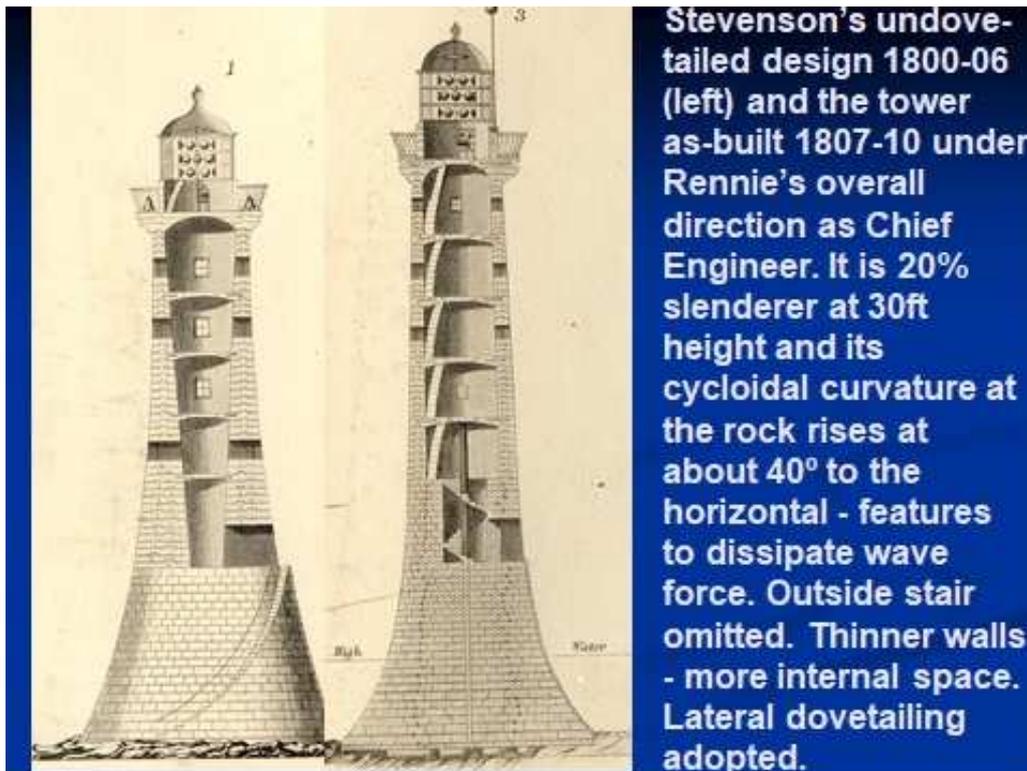


Fig.4 <https://ice-museum-scotland.hw.ac.uk/> Lecture 10, 10

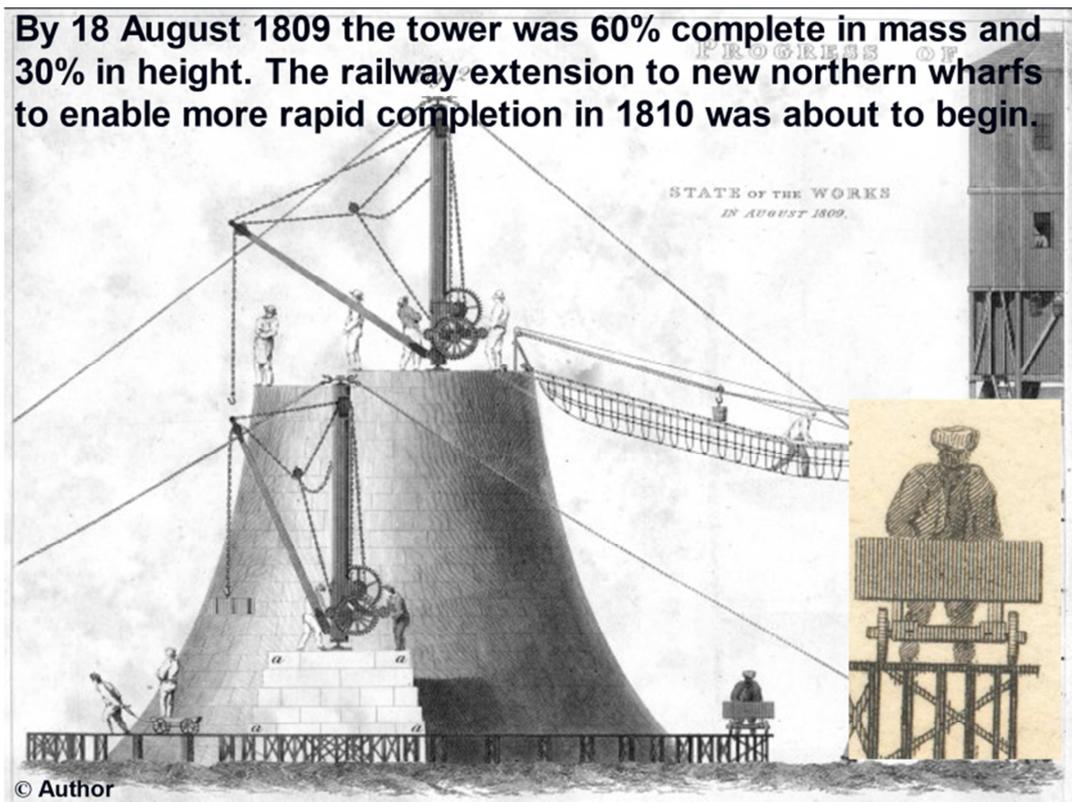
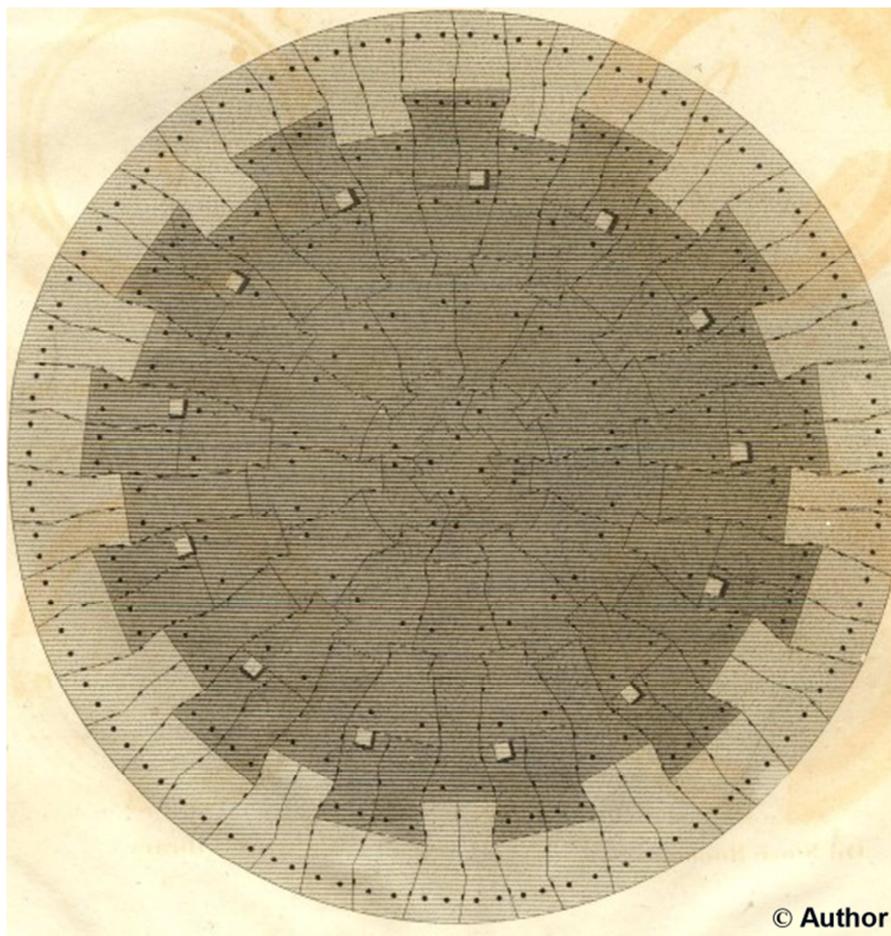


Fig.5 <https://ice-museum-scotland.hw.ac.uk/> Lecture 9, 19

On 24 September 1809 Rennie inspected the tower [Fig.5] and reported that *'the curve of the outside of the tower answers fully to every expectation I had formed of it, the sea plays round it and I trust it will be found when finished the compleatest work of its kind.'* [2011 *Dynasty*,73]. Rennie also saw the essential temporary works innovations invented and implemented by the ingenious Francis Watt under Stevenson's direction with his [Rennie's] approval. These included the powerfully efficient swivel cranes, the cast iron railway for transporting materials over the rugged rock surface from wharfs at the rock edge, and the beacon barrack for the workforce that obviated time-consuming travel to and from ships anchored some distance from the rock. These features, and the chronology of the lighthouse's erection, can be seen in Figs 5, 7, 8, & 9.

Rennie insisted on dovetailing [Fig. 6] and furnished several sketches of alterations to David Logan, including *'the courses undovetailed at the centre which were adopted by Mr Stevenson but afterwards rejected (by Rennie)'* [2011 *Dynasty*, 77].



First entire course [of 90] [1 ft x 42 ft dia. 104 tons] 123 stones from 11 patterns. Outer stones Aberdeen granite, inner - Mylnefield sandstone – Average stone weight 17 cwt, some >1 ton . 28,530 cu. ft. of stone in all. Total weight 2076 tons.

Fig 6 <https://ice-museum-scotland.hw.ac.uk/> Lecture

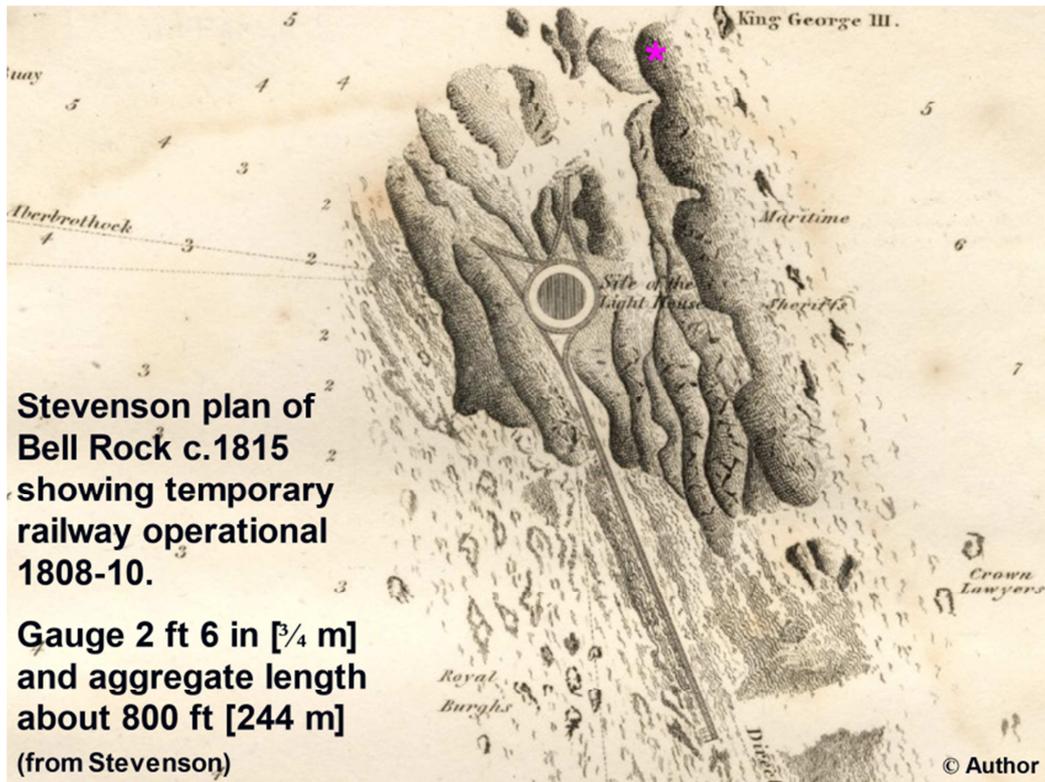


Fig. 7 <https://ice-museum-scotland.hw.ac.uk/> Lecture 9, 10

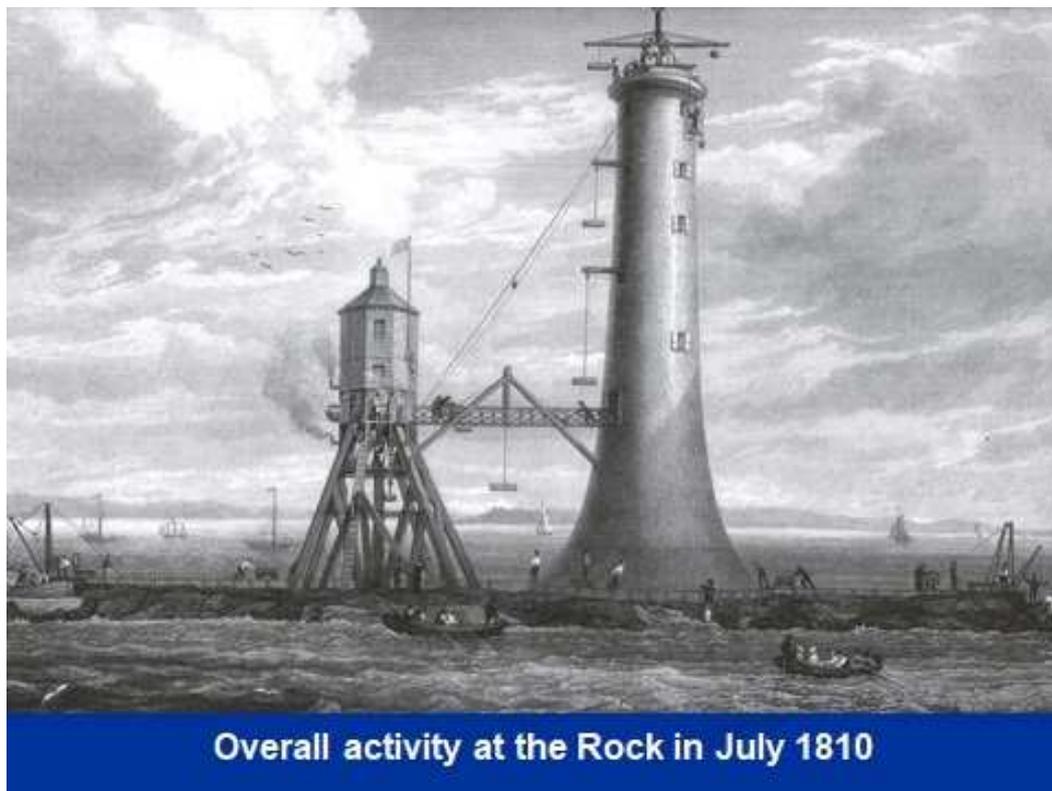
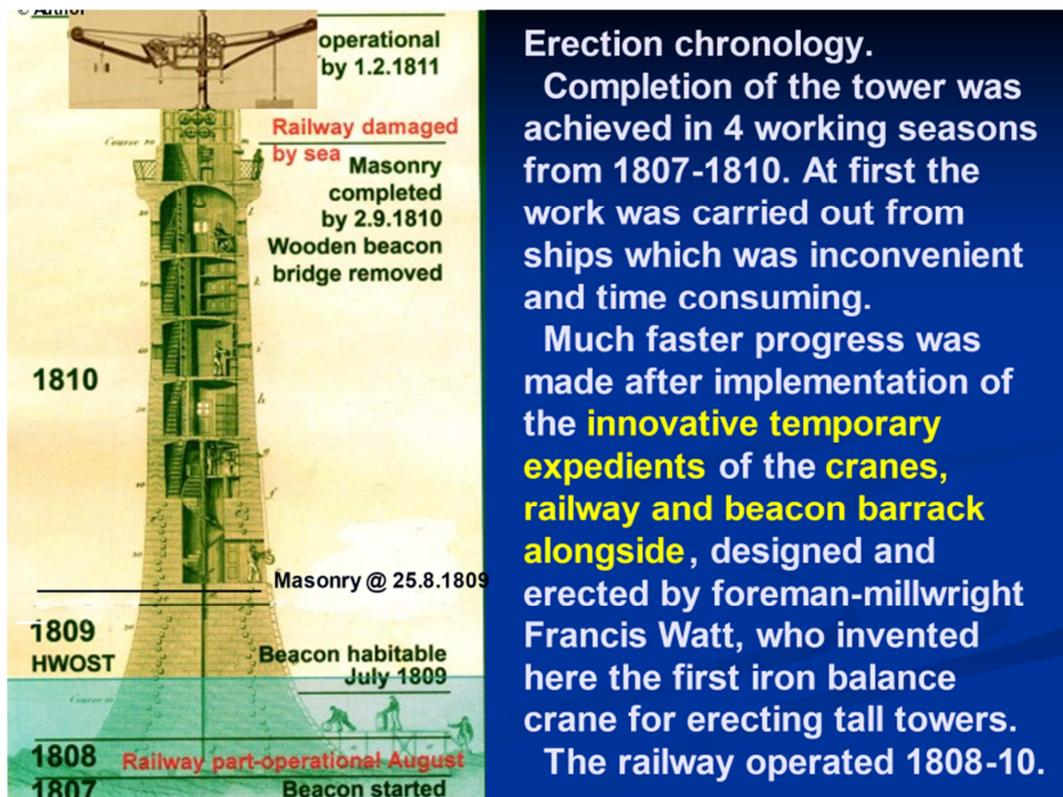


Fig.8 <https://ice-museum-scotland.hw.ac.uk/> Lecture 10, 35



Erection chronology.
 Completion of the tower was achieved in 4 working seasons from 1807-1810. At first the work was carried out from ships which was inconvenient and time consuming.
 Much faster progress was made after implementation of the **innovative temporary expedients** of the **cranes, railway and beacon barrack alongside**, designed and erected by foreman-millwright Francis Watt, who invented here the first iron balance crane for erecting tall towers.
 The railway operated 1808-10.

Fig.9 <https://ice-museum-scotland.hw.ac.uk/> Lecture 9, 6

On 1st February 1811 the light came into service and nature tested the tower with a gale. Spray rose to about 70ft [21m] and 'the sea was covered with foam as far as the eye could reach' [Stevenson 1824, 407]. It is a wonderful tribute to all concerned that the lighthouse, with its nominal range of 28 miles, automated in 1988, is still in service. In 2003 a BBC 2 documentary fittingly dubbed it as one of *Seven Wonders of the Industrial World* along with Brooklyn Bridge, the Panama Canal and Hoover Dam.

The credit for the lighthouse's **design and erection** has been generally attributed to Stevenson, not Rennie. Their letters indicate they had a good working relationship, so it is of interest to note how their merit deservance difference developed. Until 1848, the sons of each believed their father was due this merit, a matter that their families disputed for the next 1½ centuries.

The publication of my research findings shedding light on this issue [Dynasty 2011], was only possible after comparison of the contemporary records of both engineers now in the National Library of Scotland. This led to the surprising discovery that some key letters indicating Rennie acting with the authority of a chief engineer had been cut out of the Stevenson letter books, possibly in the mid-19th century, also, that Rennie's authoritative report of October 1809, after inspecting his design features as built, and directing other work, had been, almost certainly, deliberately omitted from Stevenson's definitive account of the project [Stevenson 1824] which Rennie never saw as he died in 1821, nor was he consulted on its content although work on it began in 1814. It does not acknowledge Rennie's key contribution to the project's success.

The above factors support Rennie's contention in March 1814, that Stevenson was about 'to assume the whole merit for the Bell Rock Lighthouse'. David Logan agreed [2011 *Dynasty*, 79, 50]. These factors contributed to many later writers being unaware of and misled about Rennie's role. Ironically, even Robert Louis Stevenson in *Records of a family of engineers*, and D. Alan Stevenson in *The world's lighthouses before 1820* [2011 *Dynasty* 78].

My *Dynasty of Engineers* attracted a full-page review by Mark Macaskill in *The Sunday Times* on 6th Feb. 2011 headed, 'Forgotten lighthouse hero hailed at last' correctly promoting that **both** engineers 'played their part in creating a wonder of the modern world'. It was pleasing to read that James Will, the great, great, great, grandson of Robert Stevenson, welcomed my research and commented that the 'contribution through this new book is very valuable'. My friend, the late James Rennie, would have been delighted at this recognition of the key role of his forebear. But less so when on a visit to the Bell Rock that I had arranged for him the boatman referred to the lighthouse as 'Stevison's'! Hopefully this matter now rests.

From my review of contemporary obituary notices on it seems apposite on this occasion of this bicentenary to let the eminent French engineer, Charles Dupin, have the last words, which although in retrospect are not those I would have used are not far off the mark. They are of interest in probably reflecting the popular view until Stevenson's book [Stevenson1824] was published, after which he was mistakenly credited increasingly with the lighthouse's design and erection, particularly in Scotland. In 1821 Dupin wrote: that on the Bell Rock reef 'Mr Rennie has built the most beautiful lighthouse which closely compares with Eddystone, being of similar shape and competing with its audacity and greatness. Mr Stevenson was the able engineer who executed the lighthouse under Mr Rennie's direction'[Paxton 2011 John Rennie 7,10 -11].

References and further reading

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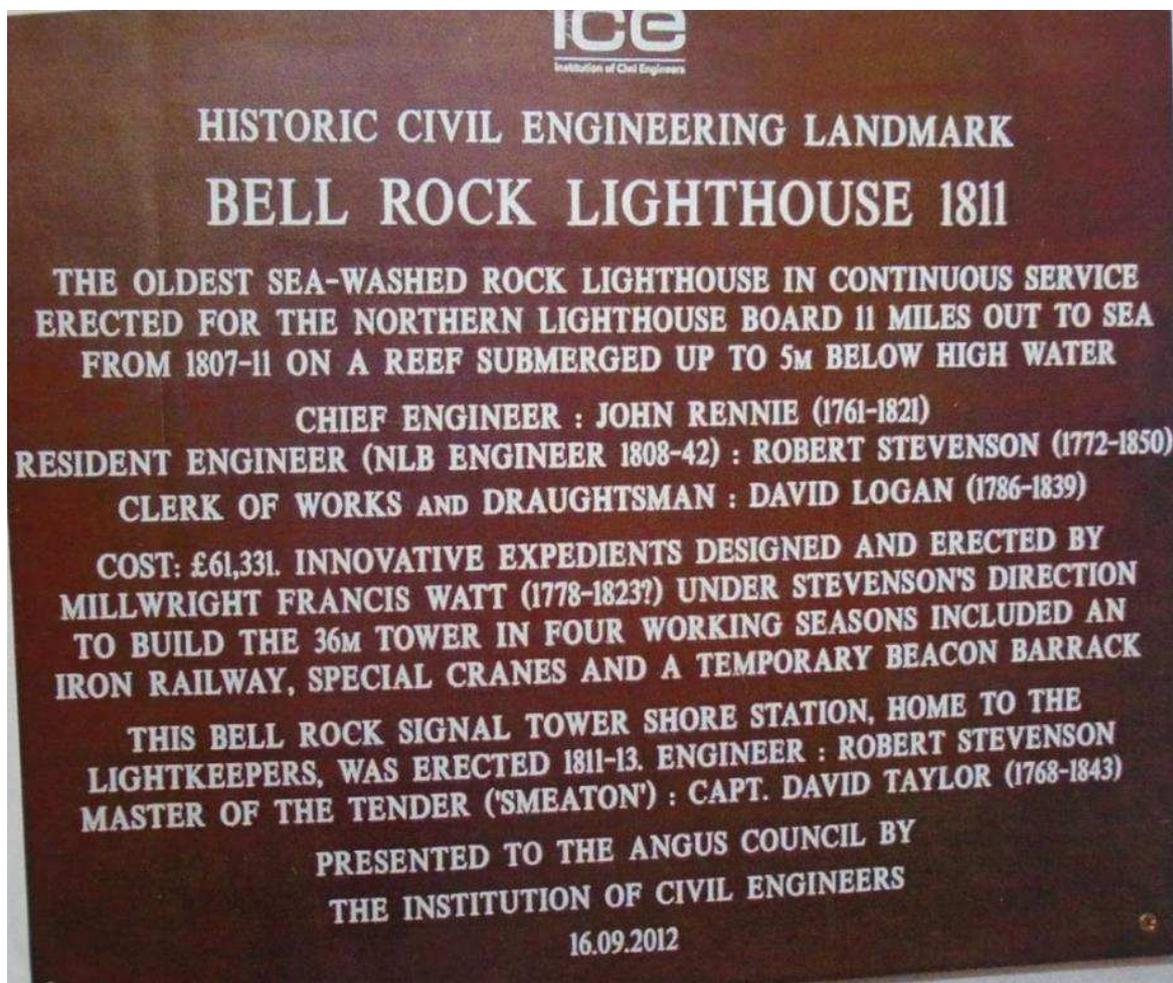
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Postscript:

In 2012, Professor Paxton, then vice chairman of the Institution of Civil Engineers' Panel for Historical Engineering Works, dubbed by the late HRH Prince Phillip '*The plaque man*', initiated and organised the following plaque to better inform the public about the Bell Rock Lighthouse and of its distinction in having been designated an *Historic Civil Engineering Landmark* by the Institution. In addition to crediting Stevenson for his role in erecting the lighthouse, the plaque records, for the first time in this way, other key contributors and their roles. They are, David Logan, Francis Watt and Captain David Taylor, headed by John Rennie. The plaque was presented to the Angus Council at the iconic Bell Rock Signal Tower Museum, Arbroath in 2012, where it has been on display for nearly a decade.



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