Topic Page: Brunel, Isambard Kingdom, 1806-1859

Image from: **I K Brunel standing by the checking chains at an...** in *The Cambridge Dictionary of Scientists*

Summary Article: **Brunel, Isambard Kingdom (1806-1859)**
From *The Hutchinson Dictionary of Scientific Biography*

Place: United Kingdom, England

Subject: biography, technology and manufacturing

English engineer and inventor. The only son of Marc Isambard Brunel, he pursued a similar career, marked by hugely ambitious projects unparalleled in engineering history, becoming ever more ambitious as the years progressed.

Born in Portsmouth in 1806, he was sent to France at the age of 14 to the College of Caen in Normandy and later to the Henri Quatre school in Paris. Brunel was appointed resident engineer on his father's Thames Tunnel enterprise when only 19. This promising start was abruptly ended when he was seriously injured by a sudden flood of water into the tunnel. While recuperating from this accident at Bristol, he entered a design competition, submitting four designs for a suspension bridge over the River Avon. The judge, Thomas Telford, rejected all of them in favour of his own. After many battles and a second contest, one of Brunel's designs was accepted. Work on the bridge began in 1833, but owing to lack of funds it was not completed until after its designer's death.

In 1833 Brunel was appointed to carry out improvements on the Bristol docks to enable heavily loaded merchant ships to berth more easily. It was while working on this project that Brunel's interest in the potential of railways was fired. The famous Rainhill trials, at which George Stephenson's *Rocket* had triumphed, had been held four years previously.

Brunel completed a survey for constructing a railway from London to Bristol, which was to be known (with a grandiloquence typical of Brunel) as the Great Western Railway. This characteristic love of the outsize was again evident in Brunel's decision to adopt a broad gauge of 2.1 m/7 ft for his locomotives, a choice that had the advantage of offering greater stability at high speeds. This size was in contrast to Stephenson's 'standard' of 1.44 m/4 ft 8 in.

In all, Brunel was responsible for building more than 2,600 km/1,600 mi of the permanent railway of the west of England, the Midlands, and South Wales. He also constructed two railway lines in Italy and acted as advisor on the construction of the Victoria line in Australia and on the East Bengal railway in India.

The bridges that Brunel designed for his railways are also worthy of note. Maidenhead railway bridge had the flattest archheads of any bridge in the world when it was opened, and Brunel's use of a compressed-air caisson to install the pier foundations for the bridge helped considerably to win acceptance of the compressed-air technique in underwater and underground constructions. However, many of Brunel's viaducts were workaday timber structures that used cheap, readily available materials and were designed so that renewal of members was quick and simple. They were only replaced when timber for repair rose to an uneconomic price. Of all the railway bridges Brunel produced, the last and the greatest was to be the Royal Albert, crossing the River Tamar at Saltash. It has two spans of 139 m/455 ft and a central pier built on the rock, 24 m/80 ft above the high-water mark. The bridge was opened in 1859, the year of Brunel's death.

No sooner, it was said, had Brunel provided a new land link between Bristol and London through his Great Western Railway than he decided to extend the link to New York. The means of achieving his aim came in the shape of ships: the *Great Western*, launched in 1837, the *Great Britain* of 1843, and the *Great Eastern* of 1858. Each was the largest steamer in the world at the time of its launch.

Brunel's predilection for large vessels was not simply the outcome of his love for the outsize - there was sound engineering reasoning behind his designs. At the time, there was a strong body of scientific opinion that held that ships could never cross the Atlantic under steam alone because they could not carry enough coal for the journey. And building a larger ship was no remedy, it was argued, because doubling the size of the vessel doubled the drag forces it had to overcome, thus doubling the power needed and therefore the amount of coal required. Brunel was probably the only one of his time who could see the fallacy of this argument. This lay in the fact that the coal-carrying capacity of a ship is roughly proportional to the cube of the vessel's leading dimension, while the water resistance increases only as the square of this dimension. The voyage of the *Great Western* proved Brunel right - when it docked after its first transatlantic voyage it had 200 tonnes of coal left in its bunkers.

The *Great Western*, with 2,340 tonnes displacement, was a timber vessel driven by paddles. Its crossing of the Atlantic in the unprecedented time of 15 days brought, after initial wariness, the most enthusiastic acclaim and established a regular steamship between the UK and the USA.

Brunel's next ship, the *Great Britain* of 3,676 tonnes displacement, represented a great advance in the design of the steamship. It had an iron hull and was the first ship to cross the Atlantic powered by a propellor. The value of its revolutionary hull was made clear on its first voyage, when it was beached in Dundrum Bay on the Southern Coast of Ireland. It remained there for the best part of a year without suffering serious structural damage. As a passenger ship, the *Great Britain* was an unprecedented success, remaining in service for 30 years, sailing to San Francisco, journeying regularly to Australia, and even serving as a troopship.

Then, in what was thought to be the final chapter of its life, the ship was badly damaged off Cape Horn in 1866, managing to struggle to the Falkland Islands only to be condemned. It lay, a hulk that refused to rot, in Sparrow cove until it was salvaged by the *Great Britain* project, set up in 1968. Through the efforts of the enthusiasts, who towed it to Montevideo and from there to Bristol, the *Great Britain* entered the dock where it was made on 19 July 1970, exactly 127 years from the day it was floated out.

On 31 January 1858 Brunel witnessed the spectacular sideways launching of his last ship, the *Great Eastern*, which was to remain the largest ship in service until the end of the 19th century. Well over ten times the tonnage of his first ship, it was 211 m/692 ft in length, had a displacement of 32,513 tonnes, and was the first ship to be built with a double iron hull. It was driven by both paddles and a screw propellor.

Initially the *Great Eastern* was beset with problems. There was constant engine trouble and the day after the ship set out on a new commissioning trial, Brunel - who was too ill to be on board - was struck down with paralysis. Unable to delegate responsibility, the work and worry of his many other enterprises had finally broken his health. He died at his home in London on 15 September 1859, having heard that an explosion aboard *Great Eastern* had apparently brought this most ambitious enterprise to nothing. Despite the damage this was not the end of his great ship. It was used successfully as a troop ship, and its greatest moment came in 1866 when, under the supervision of the great physicist Lord

Kelvin, it was used to lay down the first successful transatlantic cable.

Brunel was elected to the Royal Society in 1830, at the age of 24, and was made a member of most of the leading scientific societies in the UK and abroad. These honours, however, seem scant reward for such a giant in an age that bred such engineering giants. He was the last, and the greatest, of them all.

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