

Henry Marc Brunel: Civil Engineer

Derek Portman

The Brunel Family

In the euphoria surrounding Isambard Kingdom Brunel, it is often forgotten that the Brunels were an Anglo-French family. Isambard Marc (Marc) was born in Normandy in 1769. As the second son of the family he was intended for the priesthood of the Roman Catholic Church, but he resisted this and eventually, with the support of his family, he received a scientific and mathematical education. He joined the Royal French Navy as an officer cadet. After an extended period at sea, he returned to France to find the French Revolution in progress. Marc was a Royalist so he fled France and eventually found his way to England after a period in the United States where he honed his skills as a civil engineer. Some six months after his arrival in England, Marc married Sophia Kingdom, whom he had met in France before going to America, at St. Andrew's Church, Holborn, London on the 1st April 1799.¹

There were three children of the marriage who survived into adulthood, Sophia, Emma and a boy, Isambard Kingdom (Brunel), born on the 9th April 1806 at Southsea, Hampshire. Although he had settled in England, Marc retained his loyalty to all things French, and this was made easier by the restoration of the French monarchy at the end of the Napoleonic Wars. Brunel was a fluent French speaker so when he decided to follow his father's profession, he was sent to the College of Caen in Normandy and then to the *Lycée Henri Quatre* in Paris, a school noted for its mathematical teaching. This academic training was followed by a period of apprenticeship to Louis Breguet, maker of chronometers, watches and scientific instruments. This academic and practical education had a breadth and quality not available in Britain at the time. Brunel's training continued in Marc's office after his return to England.²

The integration of the Brunels into British society was by now well underway. Brunel married Mary Elizabeth Horsley on the 5th July 1836; he was thirty years of age and she was about twenty-two. He had first met her in 1831, about the time of the Clifton Suspension Bridge design competition. By the time the marriage took place, Brunel had progressed significantly: he was Engineer to the Great Western Railway. His career was not only progressing: it was burgeoning, and perhaps he felt that to advance still further, he needed a "trophy" wife. If so, in Mary Horsley he had won just such a prize. She was a classic beauty, socially accomplished with much musical talent: an ideal hostess. There were three children of the marriage, Isambard (Isambard) born in 1837, Henry Marc (Henry) born 27th June 1842, followed by a daughter, Florence Mary. The father was 36 years of age and the mother 28 at the time of Henry's birth. All the children were born at 18 Duke Street, Westminster, which doubled as Brunel's office and the family home. The house was well located for his professional needs, overlooking St. James' Park, just around the corner from the offices of many of his engineering colleagues and rivals in Great George Street; it was also a fashionable address for Mary's busy social life. So Henry was born into a seductive meld of upper middle class society and cutting edge technology. These two threads co-existed and competed for Henry's attention throughout his life.

Henry Brunel: early days

Henry had just left Harrow School when his father died on the 15th September 1859. He was only 17 years and 2 months old (Fig1). On the threshold of manhood, he had lost the father he idolised. He was to spend much time, for the rest of his life, guarding his father's image and reputation. While still at

school, he had spent his holidays, and sometimes part of term time as well, with his father on various engineering occasions, such as the lifting of the first span of the Royal Albert Bridge across the Tamar into position, particularly in the West of England and South Wales. The loss of his father seems to have reinforced Henry's determination to become an engineer. In January 1860, he entered King's College, London as an occasional student attending classes on mathematics, manufacturing art and machinery, and practical and analytical chemistry. He left King's in June 1861, with no formal qualifications. This was the extent of his academic education although, conscious of his weakness in mathematics, he did, on occasion, study the subject more rigorously afterwards. Both his father and grandfather were bilingual but he lacked fluency in French, so he spent time studying the language in Switzerland.³



Fig1. The young Henry M. Brunel (reproduced with permission of the Director of Information Services, University of Bristol).

During most of his career Brunel had a team of engineers assisting him. Of these, particularly in his later years, three were of greater importance than the others. Brunel was essentially a civil engineer and his ventures into mechanical engineering were, on occasion, disastrous. His choice of engines for the Great Western Railway could have led to grave difficulties, but the appointment of Daniel Gooch as Locomotive Superintendent of the GWR helped him to resolve the problems. Robert Brereton was Brunel's principal assistant civil engineer. He played a major part in the design of the railway bridge across the River Wye at Chepstow and also contributed to the engineering of the Royal Albert Railway Bridge at Saltash. After Brunel's death he set up his consultancy offices at 18 Duke Street and remained there for many years. The third member of the triumvirate, closest to Brunel in his later years, was William Froude. Froude had been an assistant engineer on the South Devon Railway, but, more importantly, he conducted rolling tests on a model of the Great Eastern steamship's hull. Further, he lived in Paignton just a few miles away from the Brunel estate at St. Marychurch east of Torquay.⁴

William Froude took a great interest in Henry, particularly after Brunel's death. He became effectively in loco parentis and Henry's informal professional tutor. Insofar as it was possible, he replaced Brunel in every aspect of Henry's life. It was an inspired relationship which continued until Froude's death in Simonstown, South Africa in May 1879. While Henry was still at King's he and Froude visited a succession of sites of engineering interest. In November 1860 they went to William G. Armstrong's gun factory at Woolwich Arsenal. This was a centre of innovation and excellence for military ordinance. In February 1861 they visited Waltham Abbey gunpowder mill, one of the principal centres for the manufacture of explosives.

The political situation in North America was particularly tense in the early months of 1861. The United States of America was on the brink of civil war. The British Government thought that Canada might be vulnerable should unrest spread, so it decided to reinforce the garrison in Quebec, amongst other locations, in British North America. Brunel's Great Eastern was viewed as an ideal troopship. Not only was she the largest ship afloat, she was well appointed, which enabled large numbers to be embarked including families as well as the soldiers and their officers. Henry and Froude secured an invitation to travel in the vessel from Liverpool to Quebec. From Henry's point of view this was an opportunity not to be missed. He saw the Great Ship as his father's masterpiece. For Froude it was a chance to study the performance of a vessel which he had in part designed. During the voyage they

monitored the ship's speed, coal consumption and her rolling and pitching characteristics. These latter were of particular interest to Froude as they were the characteristics of the vessel in model form which he had studied on Brunel's behalf. This venture in the Great Eastern, which began mainly as a pleasure trip as far as Henry was concerned, was the start of what was to be a long term working relationship with Froude, studying the performance of ships at sea and, later, of model testing in tanks followed by ships' trials, relating the results obtained on the models to the performance of the completed vessels at sea (Fig2). This was to be Froude's area of expertise as the years passed. He became, in the eyes of some, the outstanding naval architect of the nineteenth century, but in 1861 the full flowering of his genius lay in the future.

Sir William Armstrong

On his return from North America Henry joined Sir William Armstrong's firm at Elswick, Newcastle-upon-Tyne in September 1861 as a premium apprentice. His training took the well-established route of following the manufacturing processes in the factory which produced, amongst other products, hydraulic machinery and armaments. Henry started in the foundry, followed by the pattern shop, machine shops, and erection shops, with a period in the drawing office and then on to outside erection.⁵

Armstrong was an old friend and colleague of Brunel. He did not draw a clear line between Henry's training and his own longstanding connection with the Brunel family. He indulged Henry, inviting him to his home for meals and the occasional weekend. Further, should Henry wish to have leave of absence, no obstacles were placed in his way. The Great Eastern was a source of fascination to Henry and he liked to visit her when she docked in England or elsewhere in the British Isles. Henry's posting on outside erection was to Birkenhead to install hydraulic equipment, made at Elswick, in the docks there. He was, therefore, ideally placed to see the Great Eastern when she returned to Liverpool. The chequered history of the Great Ship with her engineering problems and accident proneness secured Henry's continuous attention. He maintained a relentless correspondence with the Captain and the Chief Engineer demanding details of her condition and performance in good times and in bad. He also followed the newspapers on both sides of the Atlantic avidly and wrote to anyone whom he thought could help him in building up a comprehensive picture of the vessel and her performance.⁶

Henry found his time in Newcastle difficult. He was used to the polite gentility of Westminster and the social amenities of the metropolis. Living in lodgings was a new experience and the rough and tumble of factory life was alien to him. In particular, he found the coarse language of his fellow apprentices objectionable. He did, however, accommodate to the pattern of behaviour common to most factory workers then and since. He knew how to use the time clocks to the best advantage, checking out "on the dot". How he struck his fellows is difficult to assess but his diary suggests that a number of them may have thought him to be a "stuck up" prig. Further, they must have been envious of his long periods of absence to pursue his interest in the Great Eastern, and the extended holidays he took in Duke Street and Paignton, particularly over the Christmas and New Year period. The way in which this pattern of behaviour was overlooked by Armstrong cannot have gone unnoticed. Probably, as well, the name Brunel did not help Henry one little bit.

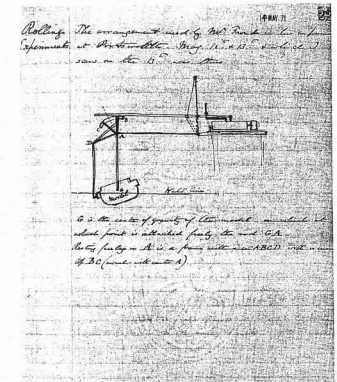


Fig 2. A page from Henry M. Brunel's Engineering Notebooks showing an experiment organised by William Froude (reproduced with permission of the Director of Information Services, University of Bristol).

John Hawkshaw

In September 1863 Henry left Armstrongs to join John Hawkshaw's consultancy firm as a pupil engineer. Hawkshaw's office was at 33 Great George Street, Westminster, less than a five-minute walk from Henry's home in Duke Street. Hawkshaw was 53 years of age and at the apogee of his career when Henry joined him. The previous year, 1861-1862, he had been President of the Institution of Civil Engineers. Hawkshaw knew the family well, having been a personal friend and professional colleague of Brunel. Henry could not have chosen a better firm to join. Before settling on Hawkshaw as a professional tutor, he had assessed the relative merits of other eminent engineers based in London. A point in Hawkshaw's favour was probably that he had been largely instrumental in reviving the Clifton Suspension Bridge project which had stalled in the 1840s as a result of inadequate funding. As Engineer to the London Bridge and Charing Cross Railway, he played a major part in selling on the chains of Brunel's Hungerford suspension footbridge to the newly formed Clifton Suspension Bridge Company which had been set up to complete the works at Clifton. Work on the London Bridge and Charing Cross Railway and the Clifton Suspension Bridge were ongoing when Henry joined the firm in Great George Street.⁷

Henry had felt isolated in Newcastle: his social life, which was very important to him, was severely constrained while he was with Armstrongs. On his return to London he visited the theatre increasingly frequently, dined out more often and spent much time at the clubs of which he was a member, particularly the Athenaeum and the Garrick, but there were others as well. Henry was very clubbable. In addition to his social life in London, he was a devotee of amateur theatricals. He took full advantage of the opportunity afforded by extended Christmas holidays of encouraging the Froude family to appropriate their houses in the earlier years at Paignton and later at Chelston Cross, Torquay as stage sets. The younger members of Froude's large family seemed very happy to join him in his enthusiasms.

In moving from Armstrong's to Hawkshaw's, Henry had changed from mechanical to civil engineering. Soon after his arrival he was put to work designing girder bridges and like structures for Hawkshaw's Indian Railway assignments. Henry also prepared Parliamentary papers for extensions to the Metropolitan Railway line, on occasion based on surveying and levelling work he had carried out himself. More poignantly, he was at one stage assigned to work on the London Bridge and Charing Cross Railway. Part of the design of the girder bridge over the Thames, replacing his father's suspension structure, was his work and he was involved in the detailed drawings of the new station building at Charing Cross as well.⁸

Henry's Diary and Letter Book are singularly silent on the Clifton Suspension Bridge project which must have been in Hawkshaw's office when he joined the firm in 1863, although part of the engineering may have been the responsibility of William Barlow who was joint engineer with Hawkshaw to the Clifton Suspension Bridge Company. Before he joined the Company, Henry had taken exception to the model of the new Clifton Suspension Bridge being shown at the International Exhibition of 1862, held in London, for no reference was made to Brunel's involvement in the original project. In Henry's view, Hawkshaw and Barlow had taken all the credit to themselves.⁹ Although the brothers were invited to the formal opening of the completed bridge in December 1863, they did not attend this ceremony. It is also noteworthy that, although Isambard Brunel was amongst those who sponsored the completion of Clifton Suspension Bridge, he did not take up shares when the Company was formed. As on other subjects in which Henry was emotionally involved such as the Great Eastern, he was unwilling to acknowledge the facts of the situation. As Chairman Mark Huish was careful to point out at the first meeting of the Company after the bridge was completed, the structure, while being a memorial to Brunel, was very different from the original design and incorporated many improvements based upon experience gathered in the intervening 20 years.¹⁰

While Henry spent much of his time in the office in Westminster, he did, on occasion, have the opportunity of working on site. Hawkshaw was, with Samuel Dobson, joint engineer for the design and

construction of a new dock system at Penarth in South Wales. Dobson's occasional absence from the site gave Henry his first "Resident Engineer" experience. He was responsible not only for the detailed design of the structure but also the execution of the work on site. While it is a characteristic of the Victorian period that engineers were given responsibilities of substance when young, Henry was only 22 to 23 years of age at the time and still a pupil.¹¹

Despite his intimate involvement at Penarth, Hawkshaw did not hesitate to recall him from South Wales when priorities in the office at Westminster demanded his presence. In October 1863 Henry found himself working on the design of the Gorai Bridge piers and superstructure for the Indian railway.¹²

Henry's elder brother shared his enthusiasm for their father's achievements. He was also anxious to protect and promote Brunel's image. In 1864 Isambard decided to write a biography of Brunel.¹³ As he was an ecclesiastical lawyer, not an engineer, he had to rely upon Brunel's colleagues and his brother to provide most of the engineering input to his work. Much of the burden fell on Henry who, in his turn, called upon input from others. Froude provided most of the material on the Thames Tunnel, the South Devon atmospheric railway and the Great Eastern. Progress on the initial drafts was slow as both brothers had their own careers to follow, then in their formative stages. The task of completing the Brunel biography was unusually difficult as both Henry and Isambard, while anxious to ensure the integrity of the text, were conscious of the difficulties which their father had experienced, in particular over the atmospheric railway about which Robert Stephenson had cautioned him: this required careful presentation. There were also the financial and engineering problems surrounding the Great Eastern, which they tried to blame entirely on John Scott Russell, the builder of the ship.

The Channel Tunnel Survey

The South Eastern Railway and the London, Chatham & Dover Railway both ran boat trains from London to the Kent coast where they connected with cross-Channel ferries to Boulogne and Calais, amongst other ports. This was a lucrative source of business and, with the development of the rail system in Continental Europe, an ever-increasing business opportunity by the 1860s. Both companies were interested in the construction of a rail tunnel under the Channel. The South Eastern's proposal was for the tunnel to go from a point near Shakespeare cliff just east of Folkestone to a point near to Calais at Sangatte. The London, Chatham & Dover favoured a route from St. Margaret's Bay, east of Dover, to Sangatte. Hawkshaw was retained by the London, Chatham & Dover to carry out the initial surveys and to conduct trial borings to demonstrate the feasibility of constructing the tunnel through the strata which lay beneath the sea bed.

The common view was that the geological strata on both sides of the Channel were very similar, if not identical. The theory was that the Channel had been formed by the washing away of the upper layers of the strata by the sea. So, in addition to conducting trial borings on land in Kent and the Pas de Calais, it was necessary to survey the seabed between Dover and Calais. This task was given to Henry. Why he was chosen, as he was still only a pupil engineer, is not clear from his Diary and Letter Book, but Hawkshaw, while concerned about Henry's application to his work, seems to have held him in high regard as an engineer. His knowledge of French, although far from fluent, was a plus point as he would have much to do in France with Government, not only in Paris, but also in the Department in which the workings were to take place.

Henry first became involved in the Channel Tunnel project in 1866. While the descents necessary to reach the level at which the sub-aqueous part of the Tunnel commenced, would present little difficulty to experienced tunnellers, continuity of the structure under the sea bed, without significant faults, was essential if the Tunnel was to be built without undue difficulty. If the Tunnel could be bored through the grey chalk strata which was impervious to water penetration, this would be ideal.¹⁴

Such was the nature of Henry's task. The technology available at the time did not permit trial borings to be made at sea. The best that could be done was to sample the seabed with a gravity corer, which

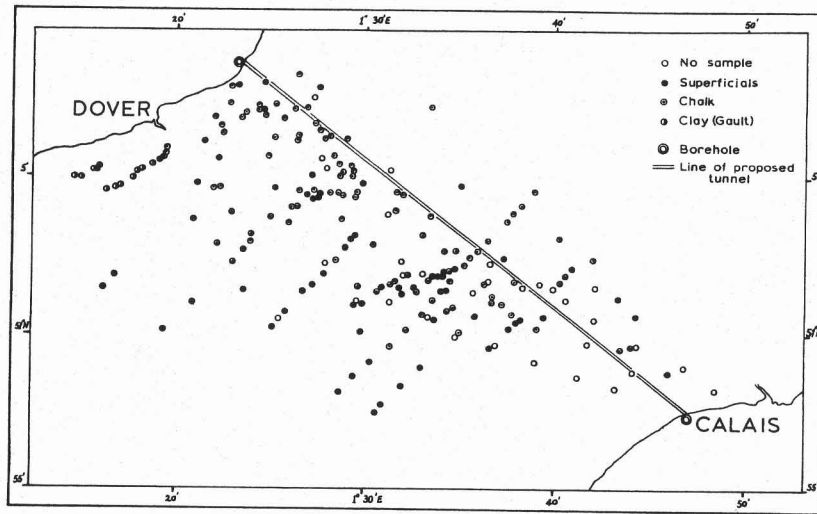


Fig 3. Map showing the location of samples taken in the English Channel by Henry M. Brunel, November-December 1866.

would limit the depth of the sample to inches rather than several feet.¹⁵ There was also an anchor dredge for scraping the sea bottom. Henry turned to Froude to help him in the design and development of the sampling equipment. The tools were proved in the sea off Torbay. After a period of improvisation and progressive improvement, satisfactory equipment was developed.¹⁶

Henry hired a vessel and started sounding, scraping and sampling the seabed off South Foreland in November 1866 (Fig 3). The intention was to follow the line of the proposed tunnel from that point to the French coast. There was also to be sounding, scraping and sampling along lines at right angles to the line of the Tunnel itself to check the continuity of the structure of the seabed in these directions as well. A worse time of the year could not have been chosen. In addition to bad weather, which included fog, there were delays resulting from broken tools and the lack of good charts. Nevertheless, progress was made, slowly and intermittently, and eventually speeded up by working at night as well as during the day. Henry was determined to finish before Christmas. He was anxious to be in England for the festivities, so the nearer he got to France, the fewer the soundings and samplings became. This is evident from the charts which he completed in the early days of 1867. Although the survey has obvious limitations in that the strata beneath the seabed were inferred rather than proven, the fact remains that Henry's survey was the first major project of its type. While he was proceeding with this work, he was probably conscious that his grandfather, Marc, had experienced serious problems in the construction of the Thames Tunnel, in part resulting from the inadequacy of the survey work carried out before tunnelling started. His father had surveyed the bed of the Tamar carefully and successfully before the Royal Albert Bridge was constructed at Saltash.¹⁷

Henry's three-year pupilage with Hawkshaw finished in October 1866. He was appointed Assistant Engineer but, despite this change in status, his work remained as before. From August to November 1867 Henry was in Cumberland surveying and levelling for a new dock at Maryport.¹⁸ Further, he was responsible for laying out the rail access to and sidings for the new facility as an extension of the Carlisle and Maryport Railway.¹⁹ It was important that this work was well done, as the usefulness and effectiveness of the new dock facility depended upon its access to the national rail network. The

Parliamentary Committees scrutinising the plans and sections he prepared would require satisfying that the economics of the new docks were sound.

In early 1868 Henry was put in charge of the construction of the Royal Albert Dock at Hull. He was responsible for ensuring that the detailed drawings of the facility, forwarded from Great George Street, were fully comprehensive and that the docks, as built, would prove to be satisfactory. This entailed not only the close supervision of the work force but also ensuring that the materials used were of good quality (Fig 4). Although John Clarke Hawkshaw was notionally in charge, his prolonged absence ensured that Henry bore full responsibility for this major work. So, at 26 years of age, he was fast becoming a dock specialist: Penarth, Maryport and then Hull.²⁰

In between his various assignments, Henry continued to work on his father's biography. When he was engaged on a survey of Dover harbour, Hawkshaw offered him the appointment as Assistant Resident Engineer for the construction of a breakwater at Alderney in the Channel Islands. This was an important assignment as the purpose of the breakwater was to provide the Royal Navy with a safe haven should its ships not have access to ports in France. Despite being at the apogee of her power, Britain was still concerned about the possibility of hostility, if not war, from France. Henry declined Hawkshaw's invitation, saying that he wished to remain in England to complete Brunel's biography.²¹ A few weeks later Henry recorded in his Diary that he had "resigned" from Hawkshaw's. The probability is that he was sacked, but he was at least gracious enough to write to Hawkshaw thanking him for the kindness and consideration he had been shown during the seven years since he had first joined him as a pupil.²² There had been signs earlier that Hawkshaw was becoming increasingly fed up with his lack of commitment to his work, but one of the surprising aspects of Henry's career was Armstrong's and Hawkshaw's tolerance of his cavalier attitude to his training and his employer. Despite leaving Hawkshaw's, he continued to work for them on a fee basis as an independent engineer, but Henry was, in reality, now on his own for the first time.

John Wolfe Barry

Since December 1868, Henry had been receiving work from John Wolfe Barry, the fifth son of Sir Charles Barry, the architect of the new Palace of Westminster (Fig 5). He, too, had been an engineer on John Hawkshaw's staff and probably knew Henry quite well, although he was six years his senior.²³

When Henry first accepted assignments from Barry, the latter's office was in Parliament Street. Despite this assistance, Henry found it difficult to secure sufficient work overall to make a significant contribution to the running expenses of 18 Duke Street. He was even prepared to consider becoming Clerk of Works of the East and West India Docks to solve his financial problems.²⁴ As he failed to secure even this appointment he was probably relieved when Barry suggested that he and his professional office be moved to Duke Street. Henry and Barry purchased a ten-year lease on the property from Brunel's estate. Mary Brunel moved out to live with Isambard and his wife, Georgina (née Noble), as a temporary

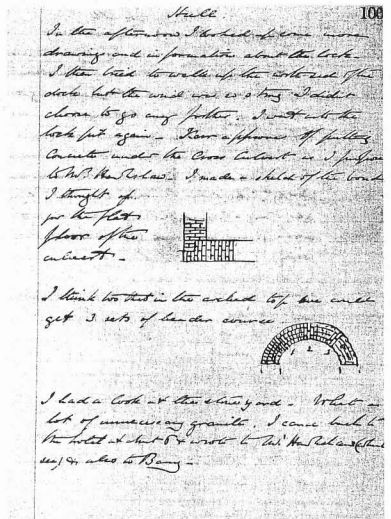


Fig 4. Construction of the Royal Albert Dock, Hull from Henry M. Brunel's Private Diary 1867-8 (reproduced with permission of the Director of Information Services, University of Bristol).

expedient. There was some rearrangement of the accommodation at number 18. Henry and Barry occupied the first floor as offices. They used the second floor as living accommodation. Neither of them was married. The ground floor of the house was let to Robert Brereton and Arthur Lucas as office accommodation. Brereton, as has been mentioned before, had been one of Brunel's principal assistants. In writing to his mother, Henry was careful to stress that while he had set up practice as a civil engineer, he was not in partnership with Barry.²⁵

Henry Brunel, Consulting Engineer

Froude soon found him work in Devon, assisting him in his experimental work on HMS Greyhound. This was the first ship built for the Royal Navy which had no sails. She did, however, have a low freeboard which concerned the Admiralty as they had lost HMS Captain, another vessel with a low freeboard, in a storm in the Bay of Biscay.²⁶ Mention has been made earlier of the working relationship between Froude and Henry in model testing and ships' trials. The work on the Greyhound represented the start of a much closer association which extended to ship design as well as the testing and proving of other engineers' work. Froude developed ground breaking formulae relating the results obtained from model testing to the ultimate performance of ships derived from the models.

In his first year as a consulting engineer, Henry earned £554 1s 0d of which £329 14s 6d was from Barry and £97 13s 0d from Hawkshaw. So £427 7s 6d came from just two sources. More significantly, Henry had no major client of his own. The work included assignments on the Buenos Aires and Rosario Railway, The Cleveland and District Railway, The London Central Railway, The Metropolitan Railway, the Thames Subway and Montevideo lighthouses, all for Barry. The work completed for Hawkshaw included preparing the Parliamentary papers for Tawe Dock, Swansea. There was also a task supplied by Brereton on the Neath Railway.²⁷

In 1874 Sir William Armstrong emerged from the past. He decided to use Henry's knowledge of hydraulic engineering garnered while he was at Elswick, and sent him to Bahia in Brazil to appraise the condition of the hydraulic hoists, cranes and lifts already supplied by his firm to the dock complex there.²⁸ As the port was handling an ever-increasing amount of traffic, Henry was asked to report on the proposed development of the facility to Transportes Urbanos, the company which owned the dock, about the additional plant which might be required. Henry did an excellent job, not only in appraising the existing machinery, but also advising how it could be better maintained and more economically used in addition to the extra equipment needed. He worked on the project from February to December, 1874, initially in Brazil and later in England. The Bahia assignment was the most exacting Henry had been asked to do but, unfortunately, the scheme fell through as Lacerda, who was in charge for Transportes Urbanos in Brazil, was accused of misappropriating funds and taken off the job.²⁹

Henry's total income for 1874 was £1,180 10s 3d. This sum was dominated by £837 10s 3d from Armstrongs. It is worth noting that at this date he had a private income of £229 0s 0d and he was still getting an allowance from his mother. The following year his professional income fell to £325 6s 5d, largely for work on the Devastation and the Shah. HMS Shah was a vessel of interest as she was the fastest ship afloat at the time.³⁰ This rapid change in Henry's fortunes demonstrated the weakness of his position: he continued to depend upon others for his work. However, this was to change when Barry



Fig 5. John Wolfe Barry (1836-1918).

offered him a partnership in his firm in 1878.

In Partnership with John Wolfe Barry

By this time Henry had expressed his lack of confidence in securing work for himself. However, the agreement he entered into with Barry catered for the possibility that he might secure his own assignments in the future. In writing to his mother he said that each of them would keep his own clients, but the split of profits in the partnership described the true situation: it favoured Barry. Up to a gross income of £4,500 per annum for the partnership, Henry was limited to 10% of the net profit. This is a strong indication of where the two of them expected the income to come from. Once the agreement had been signed, 18 Duke Street (now called 23 Delahay Street) was upgraded; the doors were changed, the staircase improved and the building made more suitable for professional use. These changes were desirable as Barry's career was developing rapidly.

By entering into partnership with Henry, Barry clarified his relationship with him. He tied Henry into the business and was thus in a position to control his freelancing with Froude. Despite Barry's burgeoning business, Brereton retained his professional office in Delahay Street.

The formation of the partnership put Henry's finances on a firmer footing. If he had no work of his own, which was usually the case, he had the right to participate in Barry's projects.³¹ In 1879 Henry's professional income was £1,235 15s 0d of which £639 9s 0d came direct from Barry. Notwithstanding his improving finances, Henry still had his worries. Froude's health was worsening. At the invitation of the Admiralty, Froude went on a trip to South Africa to convalesce. Although his health improved during the voyage, he caught dysentery on arrival at Simonstown near Cape Town, South Africa. He died at Admiralty House there on May 4th 1879.³² Henry's relationship with Froude had been long and close. Henry wrote "Since my father died nearly 20 years ago, Mr. Froude has shown not only the kindness of a father to me but the confidence of a friend. I think I may say that I have had his opinion or advice in every step of importance I have taken." This eulogy can be nothing but the truth. Froude had seen Henry through the devastating experience of Brunel's death in September 1859, tutored him during the formative years of his professional career and been a support to him in his private life. In short, Froude had stood in loco parentis for the best part of a generation.

By this date, Mary Brunel was becoming more difficult. She had never been an easy person, demanding much of her sons throughout her life. Although Mary was only 65 years of age in 1879, she was possibly becoming senile and was looking for even more support. In July that year Henry started to design an invalid staircase chair for the house at Chesney Wold, Weybridge where she was living at the time. Shortly after the chair was installed, the brothers decided it would be better if their mother were living nearer to them in central London. A sixty-year lease was taken on a house in Palace Gardens Terrace, Kensington. Mary moved in with her nurse companion in December 1879. Henry had an hydraulic passenger lift installed, a quite advanced facility for the time. But, it was not to be for long: Mary died on the 25th June 1881 only eighteen months later. She had outlived her husband by nearly 22 years.³³

During the closing years of her life, Mary Brunel must have taken comfort from the fact that her younger son was at last prospering, but the inequality of the relationship with Barry was further indicated by the sale to him of Henry's share of the lease of Delahay Street. Although Henry retained an office there, any connection of the house with the Brunels as a family was finally severed. Furniture, portraits and other effects were moved to his brother's, or mother's house, or to store. The family papers were also dispersed. Most of Marc's records were sent to the Institution of Civil Engineers where he had been a Vice-President for a period. "A vast collection" of Brunel's drawings and papers was sent to the Great Western Railway at Paddington. Brunel's Private Letter Books, Diaries and Sketch Books were retained by Henry, and these now form the most significant part of the Brunel Collection at the Library of the University of Bristol. Henry moved into a rented flat in Queen Anne's Mansions, Queen Anne's Gate.

Later that year he bought the lease of 21 Abingdon Street from Mrs. Edward Barry, a five-storey house in need of much renovation.

While Henry's income continued to increase, if averaged over the years, it was subject in the shorter term to the business cycles of the engineering world. This inevitably influenced his professional activities. After a lull in 1880-81 his work picked up again. Clearly prosperous, he bought more shares, particularly in enterprises in which he had a personal interest. He lent money to his brother and to Eddie Froude. With an increasing amount of money to spare, he was free to indulge his passions. He had a twenty-foot long rowing boat for use on the Thames, built by Searle & Son of Lambeth. Theatre going occupied more of his time, and he joined additional clubs. In 1885 he only dined at home 180 times in the year, and even then he frequently had company. There were 19 parties of six or more people: he was only alone on 70 occasions. This must be set against the background that Henry never married. He employed staff in his house to cater for him, so the burden of preparing a social occasion never fell on him personally.

At one stage, marriage to Isy, one of Froude's daughters, seemed possible. Henry was at pains to assure his potential father-in-law that he had the income to keep his daughter in the manner to which she was accustomed but both William Froude and Mary Brunel opposed such a relationship.³⁴ Isy was, like most of her immediate family except her father, a convert to Roman Catholicism. Mary Brunel was a determined Protestant. Although Henry was sympathetic to the High Church movement in the Church of England, there was never any prospect that he would follow Isy to Rome. Eventually, she married Baron Anatole von Hügel. Although Henry could have attended the wedding, when the invitation arrived, he excused himself on business grounds.

Tower Bridge

Henry's first involvement in the Tower Bridge project was to prepare a case against Joseph Bazalgette's proposals for the bridge when they came before the Parliamentary Committee in 1878. Bazalgette was a strong contender for the assignment as he was Chief Engineer to the Metropolitan Board of Works and had already distinguished himself with the construction of the Victoria and Albert Embankments and the comprehensive drainage and sewage system which had made such a marked contribution to the improvement in the health of Londoners in the late 1860s and 70s. Bazalgette's proposals for Tower Bridge were rejected. A scheme for a bascule bridge was then put forward by Horace Jones, Architect to the Corporation of the City of London. John Wolfe Barry was his Engineer. The design was approved by Parliament in 1885 after certain changes had been introduced to facilitate the entry and exit of ships into the Pool of London. Work started in April 1886, the Prince of Wales laid the foundation stone, and all was going well in the construction of the foundations of the piers when Jones unexpectedly died. Although his assistant, George Daniel Stevenson, replaced him, his influence was much less than that of his predecessor: Barry was given overall responsibility for the project.³⁵

Barry delegated much of the work involved in the detailed design to Henry, who was also made responsible for planning and supervising the construction of the bridge. This was work to which he was well suited as it gave him the opportunity of taking advantage of his extensive experience in dock construction. Further, the opening leaves of the bridge and the lifts in the towers were hydraulically operated. Henry had much knowledge of such equipment, having been involved in the manufacture of hydraulic motors and hoists at Elswick, and he also had his experience in Bahia to fall back on: this, of course, was particularly valuable.

Although it is not apparent at first glance, Tower Bridge is a form of suspension bridge (Fig 6). The chains are anchored on either side of the river. They run over small intermediate piers and then rise to the full height of the towers. The chains from the two banks of the river are joined by a bar which runs through the elevated walkways at the tops of the towers. Despite its appearance, Tower Bridge is a steel framed structure. Architecturally, the concept was that Tower Bridge should appear to be a mediaeval

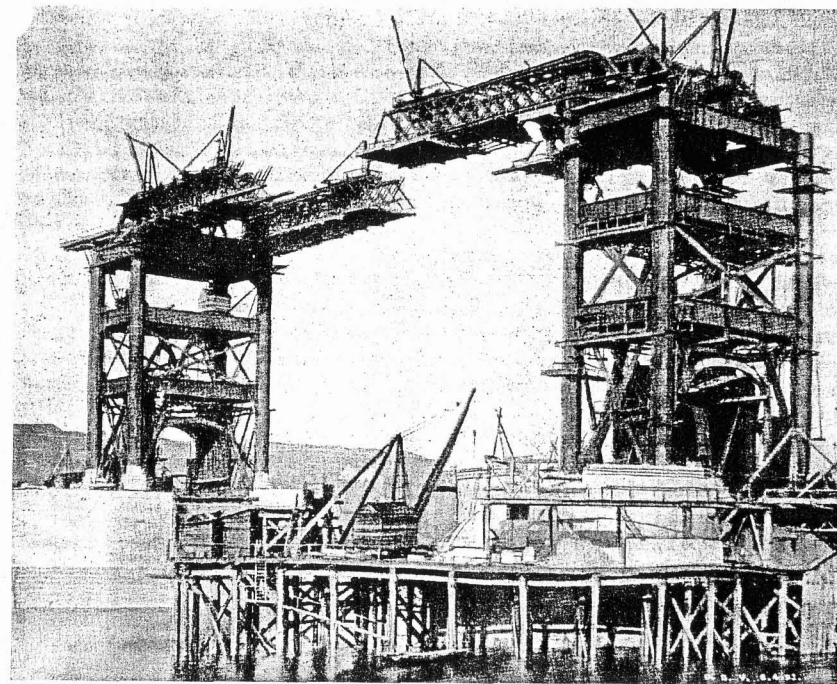


Fig 6. Tower Bridge under construction.

drawbridge to the Tower of London. It is the kind of conceit of which the Victorians were inordinately proud. Despite its complexity, the bridge was completed without undue difficulty. It has been representative of London ever since in the eyes of the world, joining Barry's father's Palace of Westminster in that exclusive role.

Barry was fulsome in his praise of his partner when he gave a lecture on Tower Bridge shortly before it was finished. "First and most important of all my acknowledgments are due to my partner, Mr. H. M. Brunel, who has supervised the whole of the complicated calculations and the details of the structure, and has taken a very active share in carrying out the work from first to last."³⁶

Henry's work on Tower Bridge was probably the apogee of his career. Other tasks followed on: the Greenwich Railway, the East Lincolnshire Railway and several schemes for the London and North Western Railway and the Great Western Railway. Usually his contribution was surveying and levelling preparatory to the submission of plans and sections to Parliament for authority to proceed. If this was obtained, his detailed design work was usually connected with the bridges. Although he had been deeply involved in the mechanical engineering aspects of Tower Bridge, his forte was civil engineering. He also found time to assist Eddie Froude, who had succeeded his father, in the testing of model hulls at Torquay and in sea trials if these were needed.

Henry Brunel suffered a stroke in 1901 and died at his home in Abingdon Street on the 7th October 1903. He was the last to carry the name Brunel in England. His brother had already died childless.

Henry Marc Brunel was the third and last of the Brunel engineering dynasty. He did not possess the creativeness of Isambard Kingdom or Isambard Marc. While his father inherited or acquired the skills and attitudes of his grandfather, these characteristics passed Henry by. There is little evidence to indicate

he had innovative talents. What ideas he had seem to have flowed from, very largely, his mentor, William Froude whose inventive gifts and creative capabilities are beyond dispute. Henry was also beset by a lack of sustained dedication when he had a task to carry through. He was easily sidetracked by the temptations of the social world, the theatre, the dining table, the London clubs and, in his early years, the attractions of the Froude household in Devon. Taken together, these activities occupied a disproportionately large part of his waking hours and days in the year. Also, until Henry was "adopted" by John Wolfe Barry as a partner, his income was always a problem, especially when related to his expectations and lifestyle. During his mother's declining years, he was the very model of a dutiful son and put up with much aggravation from Mary who could be very trying and unreasonable as for many years she failed to accommodate to her reduced circumstances following her husband's death.

In sum, Henry lived a useful life. He was a disappointment to himself professionally but he came to accept this. Understandably, his obituary in the Minutes of the Proceedings of the Institution of Civil Engineers chose to stress his personal characteristics. "Henry Brunel's personal character endeared him deeply to all his friends. His keen and singularly whimsical humour, which, with some reserve of manner with strangers, at first sight seemed his chief characteristic, was thrown into the shade for his intimates by his rigid principle, high purpose, sympathy and warmth of heart."³⁷

Barry went on to become President of the Institution of Civil Engineers; he was also knighted. Although an engineer of distinction, he is little remembered today. Few associate him with Tower Bridge and even fewer know of Henry Brunel's contribution to this landmark.

The editors regret to report that Derek Portman died on November 28th. 2005, while this article was in proof. Correspondence should be addressed to Nicholas Lee, Arts and Social Sciences Library, University of Bristol, Tyndall Avenue, Bristol, BS8 1TJ

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2. L.T.C. Rolt, *Isambard Kingdom Brunel: A Biography* (1957).
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15. Peter Haining, *Eurotunnel: An Illustrated History of the Channel Tunnel Scheme* (1973), page 35. Letter Book 07265, HMB to W. Froude, 10 October 1966. Letter Book 07268, HMB to W. Froude, 11 October 1866. Letter Book 07275, HMB to W. Froude, 16 October 1866.
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22. Letter Book 10263, HMB to J. Hawkshaw, 28 July 1870.
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25. Letter Book 11268, HMB to Mary Brunel's Nurse, 7 July 1871.
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27. Letter Book 14093, Income Tax Return, 8 July 1873.
28. Diary, 12 February 1874. Letter Book 15290, HMB to Sir W. Armstrong, 14 February 1874.
29. Letter Book 18134, HMB to C. Vaughan, 24 March 1875. Letter Book 18163, HMB to Sir W.G. Armstrong & Co., 3 April 1875.
30. Letter Book 19138, Income Tax Return, 1 April 1872 to 31 March 1875, dated 1 November 1875. Letter Book 21011 Income Tax Return, 1 April 1873 to 31 March 1876, dated 8 October 1876.
31. Letter Book 26170, HMB to I. Brunel, 7 October 1878. Letter Book 28072, Income Tax Return, 23 September 1879.
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