

## Henry Marc Brunel – Civil Engineer

In the euphoria surrounding Isambard Kingdom Brunel, it is often forgotten that the Brunels were an Anglo-French family. Marc Isambard (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 1<sup>st</sup> April, 1799.

There were three children of the marriage who survived into adulthood, Sophia, Emma and a boy. Isambard Kingdom Brunel (Brunel) was born on the 9<sup>th</sup> April, 1806 at Southsea, Hampshire. Although he had settled in England, Marc retained his loyalty to all things French, which 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 at the time. 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.

The integration of the Brunels into British society was well underway by this time. Marc strove to become a member of British society, a process which was completed by his son. Brunel married Mary Elizabeth Horsley on the 5<sup>th</sup> July, 1836. He was 30 years of age, she was about 22. He had first met her in 1831, about the time of the Clifton Suspension Bridge design competition. When 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. Perhaps he felt that if he was to progress further, he needed a "trophy" wife. If so, in Mary Horsley he had just such a person. 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 27<sup>th</sup> 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, a house which doubled as Brunel's office and the family home. It 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 "high 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 had just left Harrow School when his father died on the 15<sup>th</sup> September, 1859. He was only 17 years and 2 months old. 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. As he lacked fluency in French, both his father and grandfather were bilingual, Henry spent time studying the language in Switzerland, although he had no need for it in his private or professional life. During 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. His ventures into mechanical engineering were, on occasion, disastrous. His choice of engines for the Great Western Railway could have led to grave difficulties. His inspired choice of Daniel Gooch as Locomotive Superintendent of the GWR helped him to resolve the problems. Richard 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. He also contributed to the engineering of the Royal Albert Railway Bridge across the Tamar at Saltash. After Brunel's

death he set up his own consultancy office at 18 Duke Street and remained there for over 30 years, during which time he was joined by his son Cuthbert. 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 and was involved in the atmospheric propulsion fiasco, 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.

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, Cape Town, 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 manufacturing explosives in Europe.

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. To 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 substantially 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. This was to become 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.

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 was the well established format of following the manufacturing processes in the factory which produced, amongst other products, hydraulic machinery as well as armaments. Henry started in the foundry, this was to be followed by the pattern shop, machine shops, erection shops with a period in the drawing office and then on to outside erection.

Armstrong was an old friend and colleague of Brunel. He did not draw a clear line between Henry's training and his long standing 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.

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, both 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.

Henry left Armstrongs to join John Hawkshaw's consultancy firm as a pupil engineer in September, 1863. 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 plus 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 due to lack of money. 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.

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, replacing his father's suspension structure, which carried the rail tracks over the Thames was his work and he was involved in the detailed drawings of the new station building at Charing Cross as well.

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 a model of the new Clifton Suspension Bridge being shown at the International Exhibition of 1862, held in London. 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. 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. Like on other occasions in which Henry was emotionally involved, such as the Great Eastern, he was unwilling to acknowledge the facts of the situation. As 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.

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 years of age at the time and still a pupil.

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. 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. 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 the brothers had their own careers to follow, both of which were 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 Brunel's difficulties. In particular the atmospheric railway debacle, about which Robert Stephenson had cautioned him, required careful presentation. There were also financial and engineering problems surrounding the Great Eastern which they tried to blame entirely on John Scott Russell, the builder of the ship.

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 structure on both sides of the Channel was 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 sea bed between Dover and Calais. This task was given to Henry. Why he was chosen, Henry was as yet 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.

Such was the nature of Henry's task. The technology which was available at the time did not permit trial borings to be made at sea. The best that could be done was to sample the sea bed with a gravity corer which would limit the depth of the sample to inches rather than several feet. 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.

Henry hired a vessel and started sounding, scraping and sampling the sea bed off South Foreland in November, 1866. 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 sea bed 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 due to broken tools and lack of good charts. Nevertheless, progress was made slowly and intermittently, but this was 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 sea bed was 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 had serious problems in the construction of the Thames Tunnel, in part due to 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.

Henry's three year pupillage with Hawkshaw finished in October, 1866. He was appointed "Assistant Engineer" but despite his 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. 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. 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 which would scrutinise the plans and sections he prepared required 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. Although John Clarke Hawkshaw, Hawkshaw's son, 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 becoming a dock specialist, Penarth, Maryport and then Hull.

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. A few weeks later Henry recorded in his Diary that he had "resigned" from Hawkshaw's. The probability is that he was sacked. There had been signs earlier that Hawkshaw was becoming increasingly fed up with his lack of commitment to his work. A surprising aspect 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 as an independent engineer. Henry was on his own for the first time.

Within a few months, December 1868, Henry was receiving work from John Wolfe Barry. He was the fifth son of Sir Charles Barry, the architect of the new Palace of Westminster which replaced the buildings destroyed by fire. He had also been an engineer on John Hawkshaw's staff and so probably knew Henry quite well. He had set up as a consulting engineer on his own account the previous year. Wolfe Barry was six years his senior.

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. He failed to secure the appointment so he was probably pleased when Barry suggested that 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 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 Richard Brereton and Arthur Lucas as office accommodation. Brereton, as has been mentioned before, had been one of Brunel's principal assistants. Henry, in writing to his mother about what was happening, was careful to stress that while he had set up practice as a civil engineer, he was not in partnership with Barry.

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. 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 a gross income, that was before expenses were deducted, of £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, Cleveland and District Railway, London Central Railway, Metropolitan Railway, the Thames Subway and Montevideo lighthouses, all for Barry. The work which he did for Hawkshaw included preparing the Parliamentary papers for Tawe Dock, Swansea. There was also a task supplied by Brereton on the Neath Railway.

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, Armstrong 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. As the port was handling an ever increasing amount of traffic, Henry was asked to put forward a scheme for the further development of the facility to Transportes Urbanos, the company which owned the dock, advising what additional plant was 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



Lacerdo, who was in charge for Transportes Urbanos in Brazil, was accused of misappropriating funds and taken off the job.

Henry's gross 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 in the year from his mother. The following year his gross 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 vessel afloat at the time. This rapid change in Henry's fortunes demonstrated the weakness of his position. He continued to depend upon others for his work. This was, however, to change when Barry offered him a partnership in his firm in 1878.

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 him into the business and was thus in a position to control

Henry's 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. In 1879 Henry's gross 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 4<sup>th</sup> 1879. Henry's relationship with Froude had been long and close. Henry wrote "Since my father died nearly 20 years ago, Mr. Froude has shown (me) 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 even 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 was living nearer to them in central London. A 60 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. May died on the 25<sup>th</sup> June, 1881, only eighteen months later. She had outlived her husband by nearly 22 years.

During the closing years of her life, Mary Brunel must have realised that her younger son was at last prospering. But the inequality of Henry's relationship with Barry was further indicated by the sale of Henry's share of the lease of 23 Delahay Street to Barry in 1891. Although Henry retained a professional office in Delahay Street, it was at number 21. He was joined there by Brereton and his son Cuthbert as well as by Barry. Number 23 became the Barry family home. The connection between the house and the Brunel 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. 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 were sent to the Great Western Railway at Paddington. Brunel's private Letter Books and Diaries and Sketches were retained by Henry. They came to be the basis of the Brunel archive at 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 his partner's sister-in-law, 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 20 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. 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 had, of course, 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. Isy was, like most of her immediate family except her father, a convert to Roman Catholicism. Mary was a rabid Protestant. Although Henry was sympathetic to the Anglican High Church movement, his theatrical bent was probably attracted by its flamboyant and colourful ritual, 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. The deadline for the submission of Parliamentary papers for consideration by the next session of the Lords and Commons was approaching fast

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 put forward by Horace Jones, Architect to the Corporation of the City of London. John Wolfe Barry was his Engineer. The design, after certain changes had been introduced to facilitate the entry and exit of ships into the Pool of London, was approved by Parliament in 1885. 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 he was followed by his assistant, George Daniel Stevenson, his influence was much less than that of his predecessor. Barry was given overall responsibility for the project.

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 not apparent at first glance, Tower Bridge is a form of suspension bridge. 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 bars which run through the elevated walkways at the tops of the towers. Despite its appearance, Tower Bridge is a steel framed structure. Individual members were made in Sir William Arrol's steel works in Glasgow and shipped from there to the Thames. The structure was pre-assembled in the factory before despatch to ensure easy assembly on site. The design of the steel frames and the bridge leaves were conservative and took account of the findings of the Enquiry into the Tay Railway Bridge disaster where problems were due to, amongst other things, to excessive wind loading. The same approach was also followed in the design of the Forth Railway Bridge. It was also built by Arrol's. It was the first major steel bridge in the world. Architecturally, the concept was that Tower Bridge should appear to be a mediaeval 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."

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 7<sup>th</sup> 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 Marc Isambard. While his father inherited or acquired the skills and attitudes of his grandfather, these characteristics passed by Henry. 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 sidelined by the temptations of the social world, the theatre, the dining table, clubs and in his early years the attractions of the Froude household in Devon. Henry's tastes were not highbrow. He inclined to Gilbert and Sullivan not Brahms and Beethoven. On one occasion he asked W. S. Gilbert for a copy of the libretto of one of the Savoy operas. He did not get it, even though he assured its author that it was for private use only. The plays he saw have been long forgotten. He was not a devotee of any writer who would be easily recognised today, certainly not Shakespeare. The names of those mentioned as dinner guests were usually professional colleagues and their families, although the frequency of dining out must have meant a much wider circle of friends and acquaintances than that. Probably club life brought much of the company that the life long bachelor enjoyed. Taken together, these social activities occupied a disproportionately large proportion of his waking hours. The point was made at the beginning of this paper that Henry was born into a meld of upper middle class society and cutting edge technology and his pattern of behaviour reflected these competing threads throughout his life. In a sense the Isambard Kingdom Brunel in him urged him to become a great engineer, the Mary Elizabeth Horsley contribution to his character impelled him towards the social whirl. He enjoyed both: but neither ever dominated for an extended period of time. He lived a balanced life: he was not "driven" like his father and grandfather.



It is worth adding, however, that 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 it. 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."

It would be easy to dismiss Henry's life as "clogs to clogs in three generations". This was not so. By any reasonable standards, he was successful both as an engineer and in his social life. Although short of money in his early days, this was relative to his expectations, there was no poverty about it. There were always servants in the house. Marc had been in a debtors' gaol and knew hard times. He had to carve out his career in an alien environment. Henry did not have to face that. Brunel was ambitious, some would argue that he was the author of his own destruction brought on by overwork and, latterly, by the worry of the Great Eastern. Although he could, and did, enjoy himself, his social life often had his professional goals in mind. There was purpose to what he was doing beyond just pleasure. For Henry, pleasure was an end in itself. We cannot know whether it would have been "clogs to clogs" in four generations as there never was a fourth

generation so the possibility of several generations of soft living eventually destroying ambition and enterprise did not arise for the Brunels. Henry Brunel had ambition of a sort but if one had to choose one reason for his shortfall relative to his father and grandfather, one would choose the lack of an innovative mind. Engineering at its best is a much more creative profession than most.

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's contribution to this landmark.

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