Thomas Telford (1757-1834), by Samuel Lane, 1820-22

Telford, Thomas (1757-1834), civil engineer, was born on 9 August 1757 at Glendinning sheep farm in the parish of Westerkirk, Eskdale, Dumfriesshire, the second son, the first of the same name having died in infancy, of John Telford, an Eskdale shepherd, and his wife, Janet Jackson (*d.* 1794). Four months later his father died and Telford was brought up by his mother.

Early life

The close knit Eskdale community, in particular Telford's mother's brother Thomas, believed to have been factor to Sir James Johnstone of Westerhall, helped to support the family. Although brought up in poverty, Telford is said to have been so full of fun and humour that he was known as 'Laughing Tam' (Smiles, 296). He gained a good basic education at Westerkirk parish school, interspersed with occasional farm work. At school he met the younger generation of leading local families, and formed a close friendship with Andrew Little, later a schoolmaster in Langholm, his subsequent correspondence with whom until 1803 represents the main source of information on his early life.

On leaving school about 1772 Telford was at first apprenticed to a stonemason at Lochmaben, from whom he is believed to have run away after being badly used, and then to Andrew Thomson at Langholm, working on the simple buildings of that remote locality. Langholm Bridge, probably built about 1778, is said to bear Telford's mason's mark, and he is reputed to have carved the Pasley family memorial and headstone to his father's grave which still exist in Westerkirk churchyard. Whenever an opportunity arose, Telford diligently gleaned knowledge from books borrowed from Eskdale's scanty shelves, for example, on literature and poetry from the elderly Miss Pasley of Craig, who befriended him. In 1780, having mastered such mason-work as Eskdale could provide, he went to Edinburgh to improve his prospects and presumably worked on its New Town or possibly at Ramsey Lane where his reputed mason's mark was found during demolition of a building in 1973. While there, in his spare time, he learned to draw and studied the architecture of the locality, sketching and admiring the Gothic splendour of Melrose Abbey and Roslin Chapel, a style which later influenced much of his own work.

In February 1782 Telford's restless ambition drove him to seek more challenging and better paid work in London where, through John Pasley, an eminent merchant and relative of Miss Pasley, he met architects Robert Adam and Sir William Chambers and obtained employment as a stonemason on the building of

Somerset House. The following year he seriously considered, but decided against, entering into business with a fellow stonemason, Mr Hatton, to contract for work at Somerset House. While in London Telford was consulted by Sir James Johnstone of Westerhall about alterations to his house in Eskdale and was instructed in the matter by his brother, William Pulteney (1729–1805). Pulteney, who had changed his name on marrying the heiress of the earl of Bath, was impressed by Telford's work and personality and employed him on the restoration of Sudborough rectory, Northamptonshire, in 1783–4. Other commissions followed and within a decade a close friendship had developed between them to the extent that Telford was known in Shrewsbury as 'young Pulteney'. His career owed much to Pulteney's powerful patronage.

In 1784 the funding for building Somerset House stalled and Telford obtained employment in Portsmouth, working on the dockyard commissioner's house and chapel designed by Samuel Wyatt. Before long he was superintending the contract, his first important position of independence and responsibility. While at Portsmouth he widened his knowledge by observing harbour and dock work under construction, and studying limes and mortars from copies of the lectures of Joseph Black and Antoine François de Fourcroy, adding to the compilation of useful data which became his vade-mecum. Telford was a freemason and in a letter of February 1786 wrote that he was about to direct the fitting up of a lodge room to his plans at The George inn. On completion of the dockyard buildings later in the year Telford went to Shropshire at Pulteney's invitation (he was then an MP for Shrewsbury) to undertake the restoration of Shrewsbury Castle as an occasional residence. In July 1787, with a reference from Robert Adam, he became clerk of works for the new county gaol at a salary of £60 per annum. Soon afterwards he was operating as county surveyor of public works, a post which he held for life, later through his able deputy, Thomas Stanton, at Ellesmere, directing work on public buildings including at least forty-two bridges.

Telford lived in and practised as an architect from Shrewsbury Castle during and after restoring it in the Gothic style. Other work upon which he was engaged in 1787–93 included the county infirmary, private houses, street improvements, drainage, and the following church work: restoration of St Mary's, Shrewsbury, and All Saints', Baschurch, the new churches of St Mary Magdalen, Bridgnorth, which Pevsner calls 'a remarkable design, of great gravity inside and out, and apparently done in full awareness of recent developments in France' (Pevsner, *Shropshire*), St Michael's, Madeley, and, almost certainly, the basic plan for St Leonard's, Malinslee. In 1788 at Pulteney's request Telford advised on St Chad's, Shrewsbury, accurately predicting its fall just before the event actually occurred. He also superintended the excavation of the ruins of the Roman city of Uriconium, on Pulteney's estate near Wroxeter, the plan and sections for which, in Archaeologia, 1789, represent his earliest-known published drawings. In 1793 he added greatly to his knowledge of architecture and antiquities from a study tour of Bath, Oxford, London, and other cities.

In 1790, at Pulteney's instigation as a director of the British Fisheries Society, Telford's lifelong connection with the society began. He advised on the improvement of numerous harbours and settlements in northern Scotland including Lochbay, Tobermory, Ullapool, Keise, Staxigo, Broad Haven, Wick, Sarclet, Clyth, Lybster, Forse, Dunbeath, Helmsdale, Brora, and Portmahomack. The largest, Pulteneytown, at Wick, executed to his designs over several decades, with its impressive Argyll Square, still survives as a fine testimonial to his architectural and planning skills. In 1796 Telford tested and soon after used at Lochbay pier a newly patented aluminous hydraulic cement, later known as Roman cement, which set very quickly. His support for and extensive use of the cement influenced its nationwide adoption for many years in facing, pointing, and brick-jointing mortars. Telford's work for the society led to his involvement in governmental surveys of the highlands in 1801–2 and to his wide-ranging recommendations for improvement which resulted in the setting up of commissions for making the Caledonian Canal and highland roads and bridges. In 1834 the society made Telford a present of inscribed silverware 'in grateful acknowledgement of the numerous and valuable professional services gratuitously

rendered during a long course of years' (Dunlop, 59).

Canals

Telford's engineering career developed from 1793 on his appointment as 'General Agent, Surveyor, Engineer, Architect and Overlooker' (Gibb, 28) to the important 68 mile Ellesmere Canal, joining the rivers Mersey, Dee, and Severn. The canal, now a thriving leisure facility, still makes use of many buildings and structures designed and built under Telford's direction. The most remarkable is Pontcysyllte cast-iron aqueduct over the Dee, based on his embryo sketch design of March 1794, except for the piers, but not developed until after the iron trough concept had been proved operationally at Longdon-on-Tern aqueduct on the Shrewsbury Canal in 1795–6. At Pontcysyllte, with the support and approval of William Jessop, Telford deviated from traditional bulky masonry construction by building eighteen upright masonry piers and forming nineteen arches with cast-iron ribs supporting an iron trough with 1 in. thick sides, 1007 ft long and 126 ft high. The ironwork was made and erected by William Hazledine, the masonry was built by John Simpson, and the whole supervised by Matthew Davidson. The result, the supreme engineering achievement of the canal age, was still in service in 2003. Sir Walter Scott thought it 'the most impressive work of art he had ever seen' (ibid., 35). A misleading attempt by Hadfield in 1993 to question the traditional attribution of the concept and design of the aqueduct to Telford is incompatible with authoritative early evidence.

The 60 mile Caledonian Canal constructed across the highlands of Scotland in 1804–22 was engineered by Telford and Jessop jointly until 1812, afterwards solely by Telford, basically with the same team that built Chirk and Pontcysyllte aqueducts. Davidson superintended work at the eastern end and John Telford, succeeded by Alexander Easton, at the western end. Simpson was the main contractor, with John Wilson and John Cargill working as his foremen masons. In engineering terms the 100 ft wide ship canal, with its twenty-eight huge locks and deep summit cutting at Laggan, was then the most advanced in the world. In making it, innovation abounded in the use of iron railways, machinery, equipment, steam engines for pumping and dredging, and in lock construction, notably at Beauly where a 55 ft depth of mud was preconsolidated before excavating the lock-pit.

Despite its hard-won achievement and provision of much-needed work (in 1811, 1385 men were employed), the Caledonian Canal was in other respects one of Telford's less successful projects. Costs escalated with high inflation and unforeseen difficulties, additional funding was in short supply, and some workmanship, for example at Banavie and Fort Augustus locks, proved defective. A. E. Penfold attributed the latter to a lack of close site supervision arising from a management structure favouring the contractors. The canal, which eventually opened in 1822, had a depth of 12 ft instead of 20 ft, had cost about twice the estimate, and had taken eighteen years instead of seven to cut. By then, through no fault of Telford's, the reasons for creating it had largely evaporated and, relative to its capacity, the canal, although important locally, has never been much used, except in 1918 when there were 6254 passages associated with mine-laying in the North Sea. The canal is now a major tourist attraction.

In Sweden the Trollhätte Canal, comprising the western end of the Gotha Canal, had been completed in 1800 under the direction of its promoter, Count von Platen, and engineer, Samuel Bagge. From 1808 Telford, at the invitation of the king of Sweden, acted as consulting engineer for its 114 mile eastwards extension from Lake Vänern to the Baltic at Söderköping, with at first Bagge and later Lagerheim superintending operations in Sweden. In 1808, with his assistants William Hughes and Hamilton Fulton, Telford met and surveyed the line with von Platen, provisionally fixing lock sites, sizes, and other details. It was the start of a close friendship which lasted until von Platen's death in 1829. Construction commenced in 1809 and four years later 7000 men were employed, including John Wilson and James Simpson from 1813, but there were delays and the canal was not completed until 1832. Telford's

guidance was transmitted to von Platen in a voluminous correspondence. In 1809 Telford was made a knight of the Swedish royal order of Vasa in recognition of his valuable services, his letters from Sweden afterwards being addressed to 'Sir Thomas Telford'. His international reputation was now such that he was also consulted by the Russian government on canal navigation schemes.

Telford worked in various capacities on at least thirty-three canal projects in Great Britain and on the Welland Canal in Canada and the Panama Canal, and was involved with eleven river navigation projects. He also investigated the development of fast canal boats and in 1832–3 hundreds of experiments were made at the Adelaide Gallery, London, by his chief assistant, John Macneill, in an unsuccessful attempt to compete with steam locomotion on railways.

Telford was the last of the great canal engineers of the industrial revolution. Of his later projects, Harecastle Tunnel, on the Trent and Mersey Canal, was one of the most remarkable feats in tunnelling history. More than 2920 yards long, it was constructed, in exact accordance with his plans under the supervision of resident engineer, James Potter, in less than three years from fifteen shafts. The Birmingham Canal improvement, engineered to his characteristically direct line and level by means of the best practice and a prodigious cutting at Smethwick, saved 8 miles in length and offered maximum benefit to its users in other ways. This, too, ranks as one of the finest canal engineering projects. Similarly, the Birmingham and Liverpool Junction Canal effected a 12 mile saving in length, but required long cuttings up to 90 ft deep in what turned out to be slip-susceptible marl, and a diversion at Shelmore to avoid Lord Anson's game preserves which involved a mile-long embankment up to 60 ft high. Both features presented Telford with great problems as his health declined, problems which were eventually overcome under William Cubitt's direction. To the north, Telford's canal–seaport warehouse interchange at Ellesmere Port, greatly used for over a century, represented a peak of efficiency for the time.

Road making

Telford's main achievements in road making were the London to Holyhead and Bangor to Chester roads as engineer to the Holyhead road commissioners from 1815, and the Glasgow to Carlisle, Lanarkshire, and highlands of Scotland roads as engineer to the highland roads commissioners from 1803. These long-distance arteries of the heyday of coaching declined in use from the 1840s as the railway network developed, to be resurrected in the twentieth century as Telford's vision of mechanical propulsion was fulfilled by the motor vehicle. Abroad, for Tsar Alexander I, Telford advised on the 100 mile Warsaw to Brzesc major road towards Moscow, completed in 1825. Unexecuted or partially executed improvements on roads which he surveyed for the government or others included the Carlisle to Portpatrick, Birmingham to Liverpool, Carlisle to Edinburgh, London to Milford Haven and south Wales, and the Great North Road from London via York and Edinburgh to Inverness.

Between 1803 and 1821, with the valuable assistance of John Rickman, James Hope, and John Mitchell, respectively, secretary, agent, and chief inspector to the highland road commissioners, Telford was responsible for the provision of about 1200 miles of new or improved roads in the highlands, with 1100 bridges. These works opened up Scotland west and north of the Great Glen, in Telford's own words, 'advancing the country at least a century' (Smiles, 389). His connection with the Holyhead and Scottish roads continued through inspections for the rest of his life. In terms of construction his major roads were commodious, well-drained and incorporated a hand-pitched stone foundation beneath a layer of conventional road metal. Unlike J. L. McAdam's roads, they were properly engineered to improved lines and gentle gradients, and, although more expensive initially, facilitated traction and reduced maintenance costs. Sir Henry Parnell considered the Holyhead Road to be 'a model of the most perfect road making that has ever been attempted in any country' (Parnell, 35). Much of it is still in use and considered 'a long-lasting memorial to Telford's skill and vision' (Penfold, Engineer, 58).

Bridge building

Throughout his lifetime Telford designed, built, or advised on, thousands of masonry bridges, including 1100 to a standard specification on highland roads alone in 1803–21. His bridges ranged from simple culverts to the sophisticated 150 ft elliptical span of Over bridge, Gloucester (1826–30). His first major bridge was erected over the Severn at Montford in 1790–92 using convict labour. Six years later it was followed by Bewdley Bridge, which, with its segmental arches and classical balustrades in a gentle arc, is considered 'one of the most elegant bridges in England' (Ruddock, 154). Telford's finest Scottish bridges include Dunkeld (1805–9), also with its extrados on the arc of a great circle, and his *ne plus ultra* of architectural experimentation and excellence of construction, Dean bridge, Edinburgh (1829–32), with its intricately achieved slenderness. Gibb considered the bridges at Broomielaw, Glasgow (1833–5), and Dean, 'a fitting crown to Telford's creative life' (Gibb, 261). Both were constructed by John Gibb under the competent supervision of resident engineer Charles Atherton. In construction terms, from 1790 Telford developed, and by example widely influenced, the beneficial adoption of hollow piers and spandrels in large-span bridges, which resulted in a stronger structure, facilitated internal inspection, and reduced weight on foundations. Telford's architectural experience enabled him to impart grace and beauty to the appearance of many of his bridges.

Telford's innovative practice was also most effectively applied to cast-iron road bridges. Buildwas Bridge (1796), probably the second major iron bridge to be completed in Britain, differed considerably in concept from Coalbrookdale iron bridge in that Telford modelled it on the principles of timber rather than masonry construction. In applying this more appropriate concept, particularly if its iron was as ductile as that which he used later, he achieved a bridge of half the weight of that at Coalbrookdale with a considerably increased span. Four years later Telford, with a young associate, James Douglass, made a very bold proposal for a 600 ft cast-iron arch over the Thames to replace London Bridge. From 1800 it was promoted in a superb Malton aquatint, later issues of which were dedicated by Telford to George III. Expert opinion on the practicability of the proposal, widely canvassed under Telford's direction by a parliamentary committee, varied greatly and although the project was seriously considered for many years it was not implemented, in Skempton's opinion because of 'the unprecedented scale of the project, coupled with lack of knowledge of and agreement on the technical factors involved' (Penfold, Engineer, 79).

In 1810 Telford, drawing on his previous experience and experiments, designed an economical prefabricated, lozenge-lattice spandrel arch for use at locations where it would be more expensive or impracticable to construct in masonry. At least nine arches with standardized spans of 105 or 150 ft were cast and erected by Hazledine in 1812–30, of which those at Craigellachie, Chester (Eaton Hall), Holt Fleet, and Birmingham (Galton) are still in use, as is another at Tewkesbury of larger span. The prototype at Bonar Bridge over Dornoch Firth, erected in 1812, lasted until 1891. Of Telford's cast-iron bridges, Rolt aptly commented, 'No other man has ever handled cast iron with such complete assurance and understanding, his exact knowledge … enabling him to achieve that perfection of proportion which gives strength the deceptive semblance of fragility' (Rolt, xiii).

Suspension bridges

Telford's creation on the Holyhead Road of the elegant Menai wrought-iron suspension bridge, with an unprecedented span of nearly 580 ft, was his greatest work and the most outstanding bridge development of the early nineteenth century. Its final form evolved from his experimentally based proposal of 1814–18 for Runcorn Bridge, further experimental work, and an almost continuous design process, to its triumphal opening in 1826. In 1814 Telford had correctly anticipated modern practice in envisaging parallel wire main cables, but eventually opted for flat chain-bar links as being more practicable to achieve and

maintain at that time. The masonry, which is of exceptional quality, was executed by John Wilson. Hazledine manufactured the ironwork, the testing and fixing of which under the supervision of resident engineer William Provis, his brother John Provis, and Thomas Rhodes, was at the forefront of technology. Nearly 36,000 bars and plates, including all those used in the bridge, were tested to about twice their design load. A relatively minor but significant drawback of the bridge, which gave Telford an anxious time in 1825–6, was that its deck undulated in strong winds, but fortunately only moderately during his lifetime. (This was adequately remedied at moderate cost under Provis's direction in 1839.)

Telford's experimental results were widely propagated in leading textbooks and in 1828 Provis published a magnificently illustrated account of the Menai Bridge project dedicated to Telford. In 2003 the Institution of Civil Engineers and American Society of Civil Engineers recognized both bridges as 'international civil engineering landmarks'. The project led to a surge in suspension bridge building and exercised a fundamental influence on the practice and development of I. K. Brunel, J. L. Clark, J. M. Rendel, and others between 1818 and 1840, establishing this type of bridge in its true role as the most economic means of achieving the largest spans. From about 1840, according to J. A. Roebling in 1867, because suspension bridges were not considered rigid enough for railway use, Telford's great achievement was mistakenly left unappreciated and greatly undervalued. The Menai Bridge was tastefully reconditioned in 1940. Conwy suspension bridge, created by means of the identical technology, also opened in 1826, still has its original ironwork. Telford's other suspension bridge projects included his controversial Clifton Bridge proposal of 1830, in which he envisaged possible deck undulation being inhibited by means of smaller spans, at the same time offering an opportunity for two splendid Gothic revival towers rising dramatically from the floor of the gorge. The design is understood to have received general approval, but it failed to attract sufficient funding.

Railways and steam carriages

Telford believed that a fundamental disadvantage of carriage by railway, as distinct from canals and tramways, was that all traffic would have to be handled by the company owning the line, thus creating monopolies to the disadvantage of the user. He considered that steam power could best be applied to land transport in the form, not of railways, but of self-propelled vehicles operating on roads. He supported the setting up of and gave evidence to a parliamentary select committee in 1831, which reported that steam carriages were practicable and safe and should be protected from high tolls. By 1833 Telford was a leading promoter in a steam carriage company intended to operate on the London to Holyhead road and took part in an experimental journey on the London to Birmingham section in Dance's steam carriage. The size of the engine proved to be insufficient and the carriage only reached Stoney Stratford, 57 miles from London, at an average speed of 7 m.p.h. High tolls, opposition from vested interests, mechanical shortcomings, and Telford's death in the following year, all contributed to the demise of this initiative.

Railway projects on which Telford acted as engineer or advised included the Stratford and Moreton line (1821–6), operated with horse traction, and the Clarence (1828–9), Newcastle and Carlisle (1829), and Liverpool and Manchester (1827–9) railways; the latter's directors had offered him the post of engineer in 1825 but he declined, possibly out of loyalty to some of the canal companies by whom he was employed. During construction, following some difficulties, he inspected this work with George Stephenson in connection with a £100,000 exchequer loan and was instrumental in persuading the company to abandon the idea of fixed engines and inclined planes in favour of a level line suitable for locomotive haulage. Important railway proposals which he planned, but which were not executed, included the Glasgow to Berwick line (1810), to be operated with horse traction and steam-powered inclined planes; the London to Dover (1824), locomotive operated; East and West India docks (1828); and the Glasgow, Forth, and Clyde Canal to Broomielaw (1829), which was mainly in tunnel.

Other engineering works and public service

Telford made an important contribution to the drainage of the English fens. In 1818–21, jointly with the elder John Rennie, he advised on the execution of the Eau Brinck Cut which bypassed the meandering Ouse above King's Lynn. The cut, the width of which had been specified by Joseph Huddart, proved to be insufficient and soon afterwards it was widened at Telford's instigation with most beneficial effects. Telford also worked on the Nene outfall cut from Wisbeach to Crab Hole in the Wash, executed in 1827–30 for about £200,000. It was on this work, while visiting Crab Hole with the younger John Rennie, that he was soaked to the skin in a storm and caught a severe chill. On his way back to London, Telford was taken with a violent diarrhoea at Cambridge, where he was confined for a fortnight and nearly died. His health never fully recovered and the complaint returned from time to time with increasing severity until his death. Rennie found Telford 'a most agreeable facetious companion' (Rennie, 201). Telford's most important achievement in this field, made possible by the Nene outfall cut, was the drainage of about 48,000 acres of the North Level. For this work, carried out in 1830–34 for about £150,000, he was the sole engineer.

Telford advised on or acted as engineer for the improvement of more than 100 harbours, docks, or piers, including many in Scotland for the highland road commissioners using forfeited estates funds. In addition to the British Fisheries Society harbours already mentioned, these included, between 1801 and his death, those at Aberdeen, Peterhead, Ardrossan, Glasgow, Fraserburgh, Dundee, Leith, Belfast, Holyhead, Howth and Dunmore, Greenock, and Dover. At St Katharine's Dock in the Port of London, on a restricted and awkwardly shaped site which had required the demolition of more than 1250 houses and the excavation of 27 acres, in 1826–8 Telford designed an entrance lock giving access to a basin interconnecting two irregular-shaped docks. This arrangement enabled each dock to be cleaned out separately without interrupting shipping operations. The loss of water through lockage was compensated for by an ingenious arrangement of pumps which delivered water from the river into either the lock or basin as required. The work, which was the most advanced of its kind, was executed under the diligent supervision of Rhodes as resident engineer.

Telford advised on numerous water supply schemes, one of the earliest, in 1799–1802, being a piped supply to Liverpool pumped by steam engines from springs at Bootle. In 1806 he was appointed engineer of the Glasgow waterworks and, in association with James Watt, completely reorganized its defective and impure supply. An innovative feature was a cast-iron main with flexible joints specially invented by Watt to enable water to cross the Clyde. In 1810–22 Telford was consulted on Edinburgh water supply and in association with local engineer James Jardine was involved in the construction of Glencorse Reservoir, with what was then one of the tallest earth dams in Britain. With characteristic attention to detail, all the pipes in the main leading into the city were proved at a pressure equal to that of a column of water from 300 to 800 ft high; they are still in service. The Scotsman in 1825 considered these works 'the most extensive, perfect and complete ever executed in modern times' (Paxton, 17). In 1827–34 Telford, with assistants John Macneill and James Mills, was engaged on his largest water supply project, to supply London with much-needed pure water. In 1834 Telford proposed to bring it in from the Verulam near Watford and the Wandle at Beddington at an estimated cost of £1.177 million. Although not implemented, according to Smiles, these proposals strongly stimulated the water companies and eventually led to great improvements.

Between 1823 and 1830 Telford superintended the design and provision of highland churches and manses at many sites from Islay northwards to the Shetland Islands. In 1823–4, as superintending surveyor to the highland churches commission, he prepared plans, specifications, and estimates for standardized structures based on the proposals of his three surveyors, of which those of William Thomson for the churches were closest to the form finally adopted. The basically austere structures, most of which still

exist, are often enlivened by a touch of Telford's architectural artistry. He estimated that the churches were capable of containing 22,000 persons without inconvenience.

After Waterloo severe economic depression spread over Britain and in 1817 the exchequer bill loan commission was created to assist the financing of worthwhile public works projects in order to provide employment. Telford was appointed its adviser on all works requiring the information of a civil engineer and during the first ten years of the commission's existence he recommended nearly £1 million of assistance which was duly authorized. It was a time-consuming and important task. At least twenty projects had come under his review by 1829, those receiving more than £20,000 being the Regent's Canal (part), Rennie's Southwark Bridge, the Gloucester and Berkeley Canal, Portsmouth and Arundel Canal, the Tay ferry at Dundee, Portleven harbour in Cornwall, Kingston Bridge, the Liverpool and Manchester Railway, and the Ulster Canal. James Mills frequently acted as his surveyor.

Publications and poetry

Telford's publications consisted mainly of engineering reports, but he wrote authoritative articles for the Edinburgh Encyclopaedia, of which he was a leading shareholder. These were 'Bridge', with co-author Alexander Nimmo (first published 1812), 'Civil architecture' (1813), 'Navigation inland', also with Nimmo (1821, partly written in 1814), and almost certainly 'Jessop' (1817); altogether they amounted to over 300 pages with eighty-two plates and were particularly influential before 1830 when the whole encyclopaedia was issued. Telford's early technical publications included his Experiments ... on Mr. James Parker's Cement (1796), articles in the Philosophical Magazine on the proposed iron arch replacement for London Bridge (1801), canals (1803), and his highlands report (1803), and 'Canals' in J. Plymley's General View of the Agriculture of Shropshire (1803). Telford's novel proposal to suspend arch bridge centering by means of radiating iron stays in A Journal of Natural Philosophy (1813) encouraged the design of catenarian and stay suspension bridges. His compilation, General Rules for Repairing Roads, widely circulated from 1819, and from 1833, Parnell's Treatise on Roads, propagating the road-making practice applied on the Holyhead Road, together exercised a fundamental influence for over a century.

Telford's most important publication, despite its shortcomings as a personal narrative, was his autobiographical Life (1838), edited by John Rickman; it was written from 1831 as his health, hearing, and new commitments declined. Although its magnificent atlas of engraved plates and its appendices constituted an invaluable record of his practice and achievement, the book was not very successful commercially at a price of 8 guineas. By the time it was eventually published, four years after his death, the nation was in the grip of railway expansion and it was to some extent outdated as a working manual. The unsold stock was bought by James Walker, who succeeded Telford as president of the Institution of Civil Engineers, and copies were awarded as Telford premium prizes for many years.

Telford's enjoyment of the books lent to him by Miss Pasley marked the start of his lifelong love of poetry and an almost excessive admiration for literary ability. This interest led to his friendship with the Revd Archibald Alison, author of an essay Taste in 1790, whom he had met at Sudborough rectory about 1783, and who had introduced him to Thomas Campbell. Rickman introduced him to Robert Southey. All became his close friends. His earliest-known printed poetical work was an eight-verse poem in W. Ruddiman's Weekly Magazine, or, Edinburgh Amusement on 5 May 1779, which ended:

> Lang may ye sing, weel may ye phrase,
> Hae routh and plenty a' your days;
> And I shall gar a' our green braes
> Ken weel your name,
> I'm sure ye still sall hae the praise

O'ESKDALE TAM.

This poem was closely followed by Eskdale, first published separately at London in 1781, probably for the Pasleys, prefaced by his introduction as a 'stonemason ... a young man of no education but common reading, assisted by some books lent him by neighbouring gentlemen'. It was reprinted on several occasions and was well thought of by Southey. At least twelve poems are known to have been written by Telford during his lifetime, many of which are mentioned by Samuel Smiles. The last known was a tribute to some verses by his fellow Eskdaleman, Sir John Malcolm, in 1831. Telford sometimes initialled his writings TT, but his usual signature was Thos. Telford. From about 1806 he did not join the letters o and s. The most widely circulated was a manuscript poem to Robert Burns, which Dr Currie considered of 'superior merit' to other poems found among the poet's papers: he printed twenty-six verses of it in many editions of Burns's works from 1801.

Professional connections and character

Telford was the first president of the Institution of Civil Engineers in 1820–34. Soon after taking office he established the valuable tradition of recording the proceedings and discussions of meetings and the substance of papers read. His diligent and invaluable fostering of the institution as a forum for engineering knowledge included such activities as encouraging membership, provision of a library of books and drawings, urging members to present papers, and even chasing up and making good the subscriptions of Gotha Canal engineers Lagerheim, Edström, and others. His position as parliament's engineer gave him considerable influence with the political establishment and he was the driving force behind the obtaining of the institution's royal charter in 1828. In his will he left the institution his largest bequest, of more than £3000, and his books, drawings, and papers. His next two largest bequests were to the parish libraries at Westerkirk and Langholm. Telford's contribution to the institution was fundamental to its early development. He was elected to fellowship of the Royal societies of Edinburgh and London in 1803 and 1827 respectively.

Telford never married and according to John Rickman 'lived life as a soldier always in active service' (Life of Thomas Telford, 283). From 1800 he needed a permanent base in London and lived in rooms at the Salopian Coffee House, Charing Cross, until taking possession in 1821 of 24 Abingdon Street, where he lived until his death. From 1800, for more than thirty years, Telford's contact with the Revd Archibald Alison and his family was probably the nearest approach to home life that he ever enjoyed. Little of Telford's character is to be gleaned from his publications, but the opinions of some of his contemporaries are informative. Rickman stated that Telford's most distinguishing character trait was a benevolence which made him accessible to all who came to him for information. His pupil, Joseph Mitchell, recounted his master's 'great delight in his work. The perfect good faith and honour of all his transactions, his clear conscience, and his cheerful temper cast a halo of happiness throughout our establishment' (Mitchell, 102). In 1793 Catherine Plymley wrote after meeting Telford that he was 'an excellent architect and a most intelligent and enlightened man. His knowledge is general, his conversation very animated, his look full of intelligence and vivacity' (Penfold, Engineer, 2). She also praised the liberality and cheerfulness of his charitable donations.

Southey wrote of Telford, 'there is so much intelligence in his countenance, so much frankness, kindness and hilarity about him flowing from the never-failing well spring of a happy nature, that I was upon cordial terms with him in five minutes' (Southey, 7). Telford was not a lover of concert music: he wrote, 'the melody of sounds is thrown away upon me, one look, one sentence from Mrs. Jordan has more effect upon me than all the fiddlers in England' (Gibb, 294). Sir David Brewster wrote of Telford's apparent sternness of manner which created difficulties at times in his relationships, and belied the genuine benevolence and kindness of his nature. His comment was that Telford's

> quick perception of character, his honesty of purpose, and his contempt for all other acquirements, save that of practical knowledge and experience which was best fitted … have enabled him to leave behind him works of inestimable value … which have not been surpassed either in Britain or in Europe. (Brewster, 46)

Telford died on 2 September 1834 at 24 Abingdon Street, of a bilious derangement. He was buried in Westminster Abbey.

Lasting influence

With hindsight, a more theoretical approach would have benefited Telford's structural design practice, but his reliance on experimental and practical procedures was the best available means of achieving the desired result at the time. An essential factor in his immense achievement was his sound judgement in selecting capable and reliable assistants and contractors, to whom he was able to devolve responsibility without losing control. Under his direction they translated his designs into effect often at, and even extending, the frontiers of engineering technology and knowledge. Telford's beneficial influence is most alive today through his many surviving works, modern contract procedures, and the Institution of Civil Engineers as a forum of engineering excellence. Of Telford's surviving works, although leisure interest in his canals is increasing, his roads and bridges, for which he was aptly dubbed by Southey 'Colossus of Roads' and 'Pontifex Maximus' (Smiles, 476), now make the greatest contribution to society. L. T. C. Rolt, who was also the biographer of George Stephenson and Isambard Brunel, believed that Telford's 'achievement was as great as theirs and of equal historical significance' (Rolt, xi). Smiles, Rolt, Penfold, and others have all helped to restore his reputation from its low ebb during the 'railway mania' era. He has a lasting modern memorial in the new town, Telford, which was created in Shropshire in the 1950s. Telford was undoubtedly one of the greatest civil engineers of all time.

Roland Paxton

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Likenesses

H. Raeburn, oils, 1812, Lady Lever Art Gallery, Port Sunlight · S. Lane, oils, 1820–22, Inst. CE [*see illus.*] · G. Patten, oils, 1829, Kelvingrove Art Gallery, Glasgow · H. Meyer, engraving, *c.*1830 (after portrait), Ironbridge Gorge Museum Trust · W. Raddon, engraving, pubd 1831 (after S. Lane), NPG · P. Hollins, marble bust, exh. RA 1832, Inst. CE · W. Brockedon, pencil and chalk drawing, 1834, NPG · E. H. Baily, memorial statue, 1839, Westminster Abbey · D. A. Francis, bronze medallion, 1928, Westerkirk · A. Zydower, sculpture, 1957 · W. C. Edwards, line engraving (after S. Lane), NPG · J. F. Skill, J. Gilbert, W. Walker, and E. Walker, group portrait, pencil and wash (*Men of science living in 1807–8*), NPG · oils (as young man), Shrewsbury Borough Museum

Wealth at death

over £16,600; also property amounting to 70 per cent more: Telford, *Life*

Roland Paxton, 'Telford, Thomas (1757-1834)', *Oxford Dictionary of National Biography*, Oxford University Press, 2004 [accessed 29 Sept 2004: http://www.oxforddnb.com/view/article/27107]

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