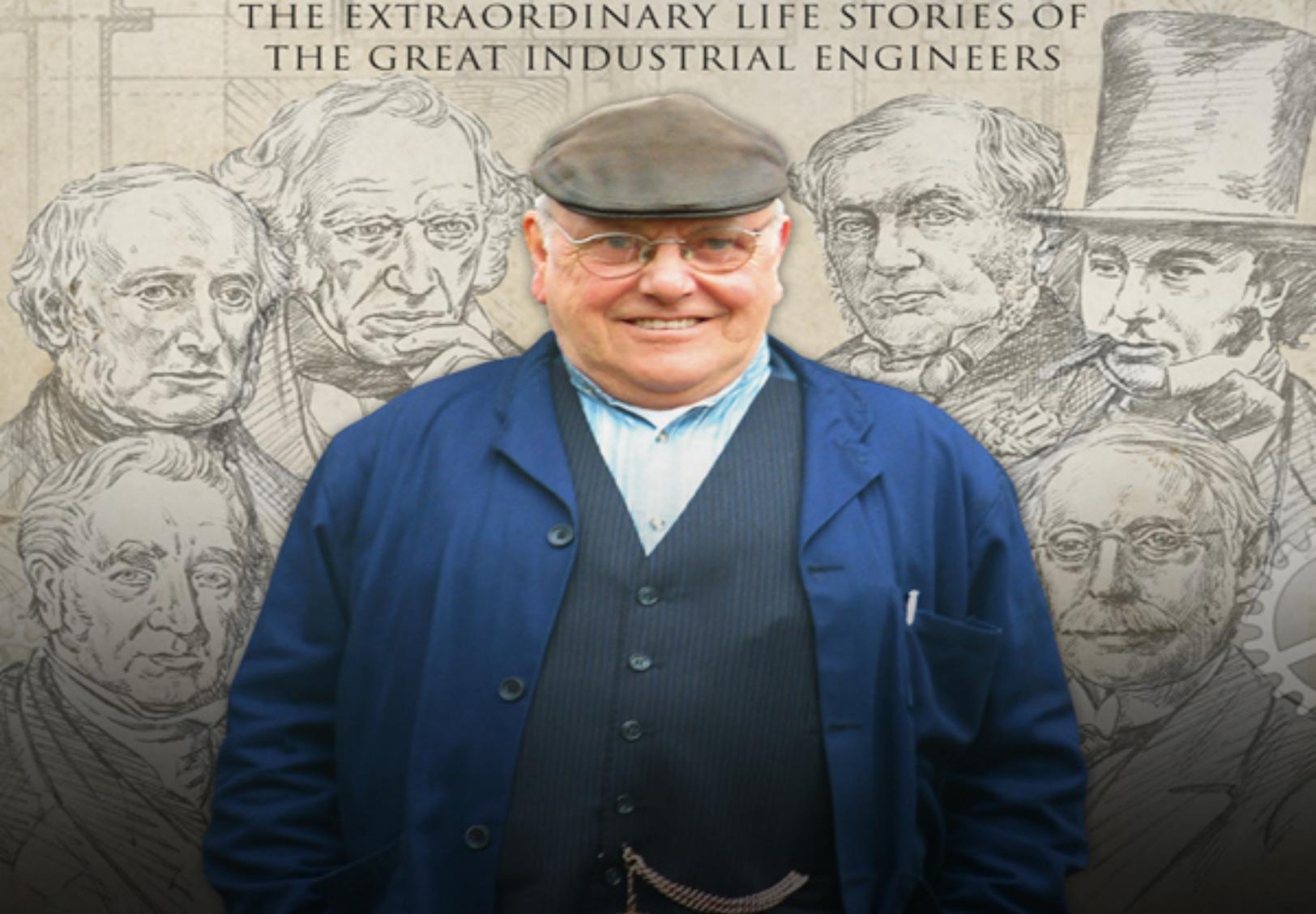


FRED DIBNAH'S

VICTORIAN HEROES

THE EXTRAORDINARY LIFE STORIES OF
THE GREAT INDUSTRIAL ENGINEERS



DAVID HALL

About the Book

Fred Dibnah was a man born out of his time. His era should have been the nineteenth century – the ‘magnificent age of British engineering’: his heroes were the great industrial engineers of the period whose prolific innovations and dedicated work ethic inspired a national mood of optimism and captured the hearts of the British public.

Fred Dibnah’s Victorian Heroes tells the stories of some of these men – including George and Robert Stephenson, Isambard Kingdom Brunel and Joseph Whitworth – and why they were such inspirational figures to Fred. What were their backgrounds? Where did their drive and vision come from? What sort of people were they at work and at home? And what was their contribution to the history of industry and engineering?

Most of them – like Fred – were colourful, larger-than-life characters for whom no challenge was too great. Taking these fascinating characters as inspiration, *Fred Dibnah’s Victorian Heroes* gets to the very heart of what allowed nineteenth-century Britannia to rule the waves ...

CONTENTS

Cover

About the Book

Title Page

Dedication

Introduction: Fred and the Heroic Age of Engineering

1 George Stephenson: The Father of the Railways

2 Robert Stephenson: The First Engineering Millionaire

3 William Fairbairn: The Iron Man

4 Joseph Locke: A Great Railway Engineer

5 Isambard Kingdom Brunel: The Little Giant

6 Daniel Gooch: The Battle of the Gauges

7 James Nasmyth: Machine Tools and Steam Hammers

8 William Armstrong: Building an Industrial Empire

9 Joseph Whitworth: The Nuts and Bolts of the Economy

10 Thomas Aveling: Steaming Down the Road

11 William Arrol: The Pinnacle of Victorian Engineering

12 Charles Parsons: Steaming into the Twentieth Century

Chronology

Picture Section

Acknowledgements and Sources

Picture Acknowledgements

Index

About the Author

Also by David Hall

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FRED DIBNAH'S
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HEROES

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LONDON • TORONTO • SYDNEY • AUCKLAND • JOHANNESBURG

To Suzannah

Introduction

Fred and the Heroic Age of Engineering

Fred's view: The Victorian Age was an age when Britain led the world in the skills of making and inventing things: an age when the skills of mechanics and engineers were highly prized. Those men were the heroes of the day and their exploits captured the imagination of the Victorian public. They were treated like pop stars or footballers are today and for me the greatest one of the lot was Isambard Kingdom Brunel.

FRED DIBNAH WAS, by his own admission, a man born out of his time. He should have lived and worked in the nineteenth century, the age he admired. His heroes were the great Victorian engineers like Brunel, Robert Stephenson, William Fairbairn and William Armstrong; uncompromising men who knew what they wanted and wouldn't let anything or anybody stand in their way. To Fred they were inspirational characters and he looked back enviously at the age that bred them. His house was full of the ornamentation, ironwork and bric-a-brac of the period, and in the workshop in his back garden he used many of the engineering techniques of his Victorian forebears, all driven by the force that powered the age - steam. With his gold watch chain and waistcoat Fred even looked like a Victorian gentleman. Above all, his opinions and attitudes were those of the Victorian Age: he believed in hard work, and that money should be acquired only through productivity and hard graft. If you went back to Victorian

times you would have found a lot of people like Fred. He would have fitted in very well.

Queen Victoria's reign lasted 64 years - the longest in British history - and spanned two-thirds of the nineteenth century. Her coronation in 1838 heralded the dawn of a golden age when her country emerged as a powerful and confident industrial nation at the heart of the greatest empire the world had seen for a thousand years. Between her coronation and her death in 1901, Queen Victoria saw Britain change beyond recognition. As well as witnessing the growth of the rail network across the country, she saw sail give way to steam at sea. She saw industry spread its smoky cities all over Britain. She saw electric trams and even the first motor cars. And one of the last great feats of nineteenth-century invention - the cinematograph - captured the Queen's Diamond Jubilee on film.

Victoria's reign saw the British Empire extend to the far corners of the globe and people felt that Britain led the world. The maintenance of political stability while governments and monarchies were crashing all over Europe brought a period of unparalleled commercial and industrial supremacy. Surging production levels, most notably in iron and steel, coal mining, textiles and engineering, were critical to British domination of the world economy as the nation became the 'workshop of the world'. The engineering industry in particular expanded and diversified, creating tens of thousands of jobs and earning millions of pounds in markets both at home and abroad. Shipbuilding, bridge-building and making all kinds of machinery including steam engines and everything associated with the railways were vital to the country's economic growth. Vast new fields of employment were opened up for mechanics and transport workers and the men who were for Fred the great unsung heroes of the age, the navvies - the men whose labours changed the whole landscape of Britain.

For the Victorians, the force that revolutionized industry was steam power. During much of the period, steam engines were built in modest workshops not much bigger than Fred's own steam-powered workshop, where he delighted in demonstrating the skills of the Victorian mechanics and engineers. 'It would have been nice to be around back in them days,' he used to say, 'in a little workshop just like mine. I'd have been a happy man then, putting all the poverty and awful things that there were in the Victorian period aside. I think if you were of a mechanical bent, you could survive then. I reckon I'd have been all right, I don't think I'd have been out of work.'

During the reign of Queen Victoria, there was a feeling of living at a time when the country was peopled with great men and that greatness was not confined to those who had achieved military victories. Engineers in particular occupied a special place in the Victorian mindset, as the peacetime equivalent of the soldier hero. The man in the street was deeply impressed by the exploits of the great engineers of the day and marvelled at the work of those who covered the land with canals and railway lines, built bridges, harbours and factories, launched ironclad steamships upon the oceans, constructed powerful steam locomotives to transport people and goods, and built huge engines to drive the wheels of industry. Talented and energetic engineers were able to make enormous personal contributions with works that were dramatic and visible, and their projects made an enormous impression on the Victorian imagination. So what was it about this period that made it possible for engineers like Robert Stephenson and Brunel to have such an impact?

In the later part of the eighteenth century, the process of industrialization had built a firm foundation for nineteenth-century growth and expansion. Central to this was a whole series of technological breakthroughs, especially in the field of metallurgy and in the use of steam power, resulting

in the invention of machinery that revolutionized the various processes in the manufacture of textiles. Before 1800, brilliant engineers like James Watt and his entrepreneurial partner Matthew Boulton had made steam power a practical reality. By the nineteenth century new machines and production methods – not just in the textile industry but in iron and steel, coal mining and engineering – helped Britain dominate the global economy. To be able to take maximum advantage of these technological breakthroughs, however, there was another prerequisite – the availability of ample natural resources. Britain was blessed with vast quantities of coal and iron ore, plenty of fresh water to work machinery and a surplus of capital wealth available for investment.

At the beginning of the nineteenth century, steam power was adapted to provide revolutionary new means of transport. Thanks to railway pioneers such as Richard Trevithick, William Hedley, Timothy Hackworth and George Stephenson, Britain saw the development of the first steam locomotives and the world's first railways. With the opening of the line between Liverpool and Manchester in 1825, the railway age began in earnest, and by 1837, when Victoria came to the throne, armies of navvies were building railways that criss-crossed the land. The railways swiftly became the symbol of Victorian industrial and technical ingenuity, fundamental to the nation's prosperity. They produced massive changes in society and there was rapid economic growth as industrial cities and regions became connected to one another and to the ports. Fred's greatest hero, Isambard Kingdom Brunel, not only built the Great Western Railway to link London to the port of Bristol but also built the world's first steam-powered iron ship to connect the city to New York.

Engineers like Brunel were the architects of change and became the most important figures of the age, their projects attracting massive publicity and public interest.

The Queen's husband, Prince Albert, took great interest in their achievements and worked with many of them to set up the Great Exhibition of 1851. It was the world's first trade fair, where the industries of all nations were on display, but more than anything it was an unashamed demonstration of British industrial and technical might. Overseas trade was one of the foundations of Victorian industrial and economic supremacy and great profits were made abroad by British railway engineers, technologists and industrialists. In the early years of Queen Victoria's reign, Britain's standing as a global industrial and trading power was unrivalled.

Colonial development was crucial in this regard and the expansion of the British Empire was inevitably tied up with the commercial exploitation of the colonies. In the 1860s 100,000 tons of British rolling stock and ironwork were exported to India to begin the construction of the sub-continent's railway network. India was also critical to the Lancashire cotton industry, being far and away the largest single market. Profits were high and vast fortunes were made, but all this was cloaked in the pious conviction that Britain's wealth was God's doing and that the British had been chosen to do great work for mankind. Above all, though, the empire was a market. The explorer H. M. Stanley knew exactly how to combine commercial interests and piety when he addressed the Manchester Chamber of Commerce on 21 October 1884:

There are forty millions of people beyond the gateway of the Congo and the cotton spinners of Manchester are waiting to clothe them. Birmingham foundries are gleaming with the red metal that will presently be made into ironwork for them and the trinkets that shall adorn those dusky bosoms and the ministers of Christ are zealous to bring them, the poor benighted heathen, into the Christian fold.

The British public loved it all. They liked the idea of a big, powerful Britain and for Fred, over a hundred years later, the fact that the Victorian Age was the time when Britain led the world was what made it great. He loved the jingoism of the age and was immensely proud to be British (although to Fred it was always England). He took pride in the achievements of an era when, in his words, 'we made the heavy stuff that we're not making now'. It was a time when Britain probably contributed more to progress than any other nation in the world. There's no reason to be ashamed of this, yet today, because of the exploitation of the working class and the evils of colonialism many people seem to be embarrassed to talk about those great days. So, it's good that Fred was able to say that, and say it with pride and enthusiasm. By drawing attention to the great achievements of our Victorian forebears, Fred made us realize that it wasn't all dark satanic mills.

Another element that characterized the Victorian Age was civic pride. The success and prosperity that the Industrial Revolution brought to towns like Fred's native Bolton left us with some magnificent buildings - town halls, libraries and swimming baths - and one of his favourites was Bolton Town Hall. The Victorians had a great respect for the past and wanted their buildings to reflect the values of an earlier age: they made their town halls look like Greek temples, and the new Houses of Parliament in London matched the medieval splendour of Westminster Abbey next door.

Fred had a great appreciation of the quality of Victorian workmanship, whether in buildings or engineering. 'The Victorians,' he said, 'went to great lengths to make things pleasing to the eye, whether it was a great civil engineering project or something as small as a window catch. In Victorian times the skills of making things were highly valued.' He would have liked to have lived then, 'when we made beautiful things like the whistles and the

lamps on my engines. The modern equivalent wouldn't be anything like as beautiful.' Fred relished the fact that everything was made to a very high standard; that most things were made by hand and everything was built to last. He was very comfortable with the things the Victorians made, with their technology, and he was a great admirer of their craftsmanlike approach. He shared their values and their confidence and always wanted to draw attention to their achievements, their inventiveness, their workmanship and the sheer scale of their ambition. In this respect Prince Albert was a true representative of the age, a passionate believer in the moral and material rewards to be reaped from the advance of science, industry and technology. So the Great Exhibition wasn't just a celebration of British innovation but also a salute to the Victorian virtues of hard work and self-reliance. 'One of the virtues of the Victorian Age,' Fred said, 'were the business of self-help. If you worked down the pit or in the foundry, you could stay there for the whole of your life if you wanted to. There weren't much chance of them going out of business like they do now.' If a man wanted to get ahead, he could go to places such as the Mechanics' Institute and learn to read and write.

If you showed your mettle, what you were capable of doing, Victorian society admired them men and made them into heroes like Brunel. Weaknesses of any sort were frowned upon and you'd got to keep going at all costs. George Stephenson couldn't read or write but he became the father of the railways and one of the most famous men in the whole of England and his son became a national hero.

Self-Help, Samuel Smiles's book of 1859, encapsulated this Victorian philosophy of deserving men making good through hard work and application. In Smiles's own words,

the purpose of *Self-Help* was 'to illustrate and enforce the power of George Stephenson's great word - perseverance'. Smiles advocated the cultivation of the intellectual and moral working-class self. Church and chapel, the mechanics' institutes and public libraries, he argued, all provided opportunities of self-improvement for the working man. The book reflected the spirit of its age and proved to be a bestseller.

Smiles came to regard the pioneering British engineers of the eighteenth and nineteenth centuries as archetypes of this ethos and he devoted himself to gathering biographical evidence to back this up. The result of his research was the three volumes of *The Lives of the Engineers*, which helped to turn these men into the heroes of the Victorian Age. Smiles's ideal was someone of humble origin, such as George Stephenson, who achieved great things through self-improvement. 'If we look carefully into the narratives of the lives of the most remarkable engineers,' he wrote,

we shall find that they owed very little to the seven years' rut in which they were trained. They owed everything to innate industry, energy, skill, and opportunity. Thus, Brindley advanced from the position of a millwright to that of a canal engineer; Smeaton and Watt, from being mathematical instrument makers, advanced to higher positions - the one to be the inventor of the modern lighthouse, the other to be the inventor of the condensing steam-engine. Some of the most celebrated mechanical and civil engineers - such as Rennie, Cubitt, and Fairbairn - were originally millwrights. All these men were many-handed. They had many sides to their intellect. They were resourceful men.

They were also, as Fred observed, a new breed of men. Their confidence and dynamism were unbounded, their

energy immense. Innovation was what they lived by and they felt they possessed the materials and techniques to build a new world. Fred admired them for their courage and their ingenuity, and because they were colourful, larger-than-life characters who had an unwavering confidence in their own ability to overcome any obstacle. They were men for whom no challenge was too great, whose 'tackle anything' approach was one that Fred shared. Many of them went on to make a fortune, especially if they belonged to the aristocracy of the profession, the civil engineers, and it was the building of the railways that gave them their greatest opportunities. What excited Fred was the way in which the British civil engineering industry rose to that challenge.

The inventiveness and the grand scale of many of the engineering projects captured the public imagination. Because of their heroic status, engineers were given special dispensation with regard to budgets and timescales. Brunel's Great Western went more than two and a half times over budget and he lost £400,000 on his unsuccessful attempt to build an atmospheric railway in Devon, but people felt that the scale of his achievements justified the cost. For a Victorian engineer the embarrassment of an overrun budget would soon be forgotten, but the glory of achievement would last for ever. Brunel's legacy, and that of contemporaries such as Robert Stephenson, James Nasmyth, Joseph Locke and William Fairbairn, was Britain's world leadership in industry, civil engineering and technology. Achieving this meant that risks were always being taken and not all experiments proved to be successful. It was the price that had to be paid for innovation. Backing big engineering projects in the nineteenth century could be a bit of a gamble. Brunel's SS *Great Britain* is now regarded as a landmark in ship design, but she was never really a commercial success and eventually bankrupted the company that built her.

For men like Brunel and Robert Stephenson, there was no problem in civil or mechanical engineering that an individual could not confront and conquer through his own inventiveness and application. But when these men died, their passing marked the beginning of the end of this can-do era for individuals. They and their generation bequeathed a sum of knowledge that had become too large and complicated to be mastered by a single mind. From then on, all scientific and technical development depended to an ever-increasing extent upon specialization. The great industrialists of the second half of the nineteenth century, like Armstrong and Whitworth, were businessmen first and foremost.

At the mid-point of Queen Victoria's reign, Britain was still reaping the benefits of industrialization. Record production levels in cotton textiles, iron and steel, coal mining and engineering were the linchpins of British domination of the global economy. The engineering sector in particular provided an ever-expanding range of products, creating thousands of jobs and earning millions of pounds in exports. The manufacture of machines, tools, steam engines and general products achieved unprecedented levels of technical precision and this, along with exports of heavy engineering, ships, locomotives, hydraulics and armaments, continued to secure Britain's position as world leader. But it couldn't last. Other countries, such as the United States, were quick to learn the lessons of industrialization and had much greater resources at their disposal than Britain.

The confidence of British engineers, industrialists and the governments of the day in the country's industrial lead was one of the factors that led to the loss of this advantage. The wholesale export of technology meant that other nations could use it to further their own industrial sectors and, in so doing, provide competition for Britain. Engineers continued to build larger and more impressive structures

than ever before, and to adopt powerful new technologies in the shape of electricity and the internal combustion engine. After 1860, however, continental and American engineers came to take an increasingly prominent share of such innovations. Britain ceased to enjoy the unchallenged supremacy that had characterized the years around the Great Exhibition, and during the 1870s began to concede leadership in one area after another. As a result, the idea of empire began to hold even greater appeal. British people wanted something to feel proud of as well as having new markets for their goods. Empire meant not only an abundance of jobs for civilians but also regular military employment. British technology was used throughout the empire to build railways and assist the exploitation of natural resources to feed Britain's industries. Disraeli, as prime minister, spoke of the working classes as 'proud of belonging to a great country; proud of belonging to an Imperial country', and flattered the Queen's imperialist aspirations by bestowing on her the title of Empress of India in 1877.

But British industry had become very set in its ways. In textiles, for example, cotton-spinning mills still used the old system of mule spinning while foreign competitors had switched to the more advanced technology of ring spinning. British industry in general was slow to switch to any new technique such as electrical power in place of steam. The problem was that textiles, engineering and iron and steel continued to make profits. Many companies were still family firms and their owners were often reluctant to develop new products or invest in new machinery so long as the money kept coming in. Industrialists preferred the safety of tried and tested technology, even as it became increasingly outdated. Coming to the game later, Germany and America not only benefited from the export of British technological expertise but were willing to invest in the latest technology. The American steel magnate Andrew

Carnegie pointed out that most British machinery was still in use twenty years after it should have been scrapped.

As he worked on his traction engine in his garden, Fred would talk of the gradual decline of British industry at this time, as complacency set in and people with the skills to do the sort of work he was doing on his engine virtually disappeared: 'By the end of the nineteenth century Germany and America were both benefiting from an emphasis on the practical and technical in their education systems - the very things that Brunel and Stephenson had had passed on to them by their fathers - while Britain failed to recognize the importance of science and technology in their education system.' For Fred, Brunel and Stephenson represented a lot of the values of an age when the skills of making things were highly regarded, when there was little sympathy for weakness and none at all for idleness. Above all, there had been an unbending faith in the ability to get things done, however great the challenge. 'They are all values which we've lost,' said Fred. 'If we still had them today Britain would still be a major industrial power.'

The decline of British industry certainly coincided with the loss of these values, but there were many other factors involved. Although the natural resources of coal and iron ore remained, the surplus capital and the willingness to take risks that had characterized the earlier part of Victoria's reign had gone. With growing competition, the markets of the past were no longer as secure. But perhaps, above all, the British were no longer prepared to accept the sort of jobs and working conditions that people had endured in earlier times. The dirty, dangerous, heavy manual work of the Victorian Age, when Britain was a developing country, became less acceptable as the twentieth century progressed and newly developing countries took it on instead. The heroic age of British engineering was drawing to a close.



George Stephenson
1781-1848
The Father of the Railways

It was in the coalfields of the North East that railways as we know them really began to operate and it's the Northumbrian engineer George Stephenson who is credited as being the father of the railways. He came from a poor background and didn't get a proper education, but through his hard work, his passion for the locomotive and his technical genius, he became one of the world's most famous engineers. Stephenson wasn't the inventor of the locomotive but he played the leading part in turning the invention into a practical means of hauling coal and transporting passengers over long distances.

GEORGE STEPHENSON WAS THE archetype for Samuel Smiles's philosophy of self-help. He came from an underprivileged background but through his own efforts he rose to become one of Britain's most famous engineers. In his day he was known for another quality that he shared with other engineers of his time: sheer physical toughness. But he was a stubborn, cantankerous character who didn't suffer fools gladly and was difficult to work with.

Everything Stephenson knew he learned on the job, not in a classroom or lecture theatre, and he always had a deep distrust of academics and engineering theorists. He was a man after Fred's heart but he was, and still is, a

controversial figure. For some people, including Fred, he was the 'father of the railway' but many historians claim that all he did was copy the ideas of other men working in this field and exploit them and their skills. What is not in doubt, though, is that he was a man of great vision, determination and entrepreneurial spirit, backed up by sound and cautious judgement and an absolutely indomitable will, who demonstrated conclusively that steam railways were an efficient form of transport and pioneered the engineering techniques of railway construction that changed the landscape for ever.

The son of a colliery fireman, Stephenson was born on 9 June 1781, in the small colliery village of Wylam on the north bank of the River Tyne about eight miles west of Newcastle. In his *Lives of the Engineers* Samuel Smiles described it as a place where the traveller 'sees the usual signs of a colliery in the unsightly pumping-engines surrounded by heaps of ashes, coal-dust, and slag; whilst a neighbouring iron-furnace in full blast throws out dense smoke and loud jets of steam by day and lurid flames at night'. George was the second of six children and the family's poverty meant that they all had to live together in one room of a cottage. Three other families shared the other rooms.

The cottage was close to the horse-drawn tramway for Wylam Colliery, where Stephenson's father worked as a fireman, stoking the engine that pumped water from the mine. The wooden wagonway had been built in 1748 to take the coal from Wylam Colliery to the coal-loading jetties on the River Tyne. With six children to support on a wage of only 12 shillings (60p) a week his father was not able to send any of the family to school, but Stephenson grew up with a keen interest in machinery. As a child he was employed as a cowherd but would keep himself amused by making model engines in clay. He soon showed great mechanical talent and an unusual love of study.

Stephenson had a variety of other jobs as a young lad. One of the earliest was working down the pit as a trapper boy. For only tuppence a day, trapper boys would sit behind a trapdoor for twelve hours at a stretch, opening and closing it for the men who worked at getting the coal to the surface.¹ As a trapper boy, he couldn't leave the door when coal was being transported. If he did, not only would he be in trouble with the boss but he would also get a clip across the ear from the miners. Working from such an early age meant that most of Stephenson's youth was spent in total darkness, either underground or on his late return home. At the age of eight, George got a job on the surface as a picker at the Dewley Burn Pit, cleaning the coal of stone, slate and other impurities on a starting wage of sixpence (2½p) a day.

As he grew older he never missed an opportunity to learn about the construction and management of machinery at the colliery, and at 15 he was promoted to the position of fireman where he would keep the steam-powered pumps at the mine running. He quickly established himself as a steady lad and his intelligence and attention to duty soon led to further promotion. At the age of 17, he was placed in charge of Water Row Colliery in Newburn, where his father was now working as fireman.

By the turn of the century, stationary steam engines were being introduced to many of the collieries in the North East and, with his mechanical aptitude, it was natural that Stephenson would find himself operating them. When a vacancy came up at Black Callerton Pit in 1801, he was given the job of brakesman on the steam winding engine, which hauled coal tubs from the coal faces to the shafts and from there to the surface. Although he'd received no formal education, Stephenson was ambitious, and while he was at Callerton he began a systematic course of self-improvement. After a day's work at the colliery, in the evening he taught himself to read and write. He then

started to go to night-school classes in the nearby village of Walbottle and within a few years had achieved basic literacy skills. This wasn't something that came naturally to him and for the rest of his life he disliked these laboriously acquired skills so much that he never wrote a letter if he could avoid it and rarely read a book.

During his time at Black Callerton he met and fell in love with a woman 12 years older than him called Frances Henderson. Fanny, as she was known, worked as a servant at the farm close to the pit where George had lodgings. After working at Callerton for about two years, he received an offer to take charge of the engine used to haul coal wagons from Willington Quay Colliery near Wallsend. The money was better so he decided to accept it and, at the same time, to marry Fanny. He was only 21, but he had managed to save enough money to take a cottage at Willington Quay and furnish it in a humble but comfortable style. It was only one room but that was all a pit worker could expect. Here he set up home with his new bride. To earn extra money he repaired clocks and watches and mended shoes when he got home from work in the evening. He also started to build a reputation for fixing machinery and to be recognized as an inventor. His little cottage was always filled with models of engines and machines of various kinds, including a steam-engine brake mechanism and a model of a machine designed to create a means of perpetual motion.

While he was living at Willington Quay, on 16 October 1803 George Stephenson's only son, Robert, was born. The child was the apple of his father's eye and life in the Stephenson household was good. This happy existence was short-lived, however. Fanny suffered from poor health and died of consumption in 1806 shortly after giving birth to a daughter, who survived her mother by only a few months. George had been very close to his wife and felt her loss deeply. He thought about emigrating but his son's

education was a priority and he decided to stay in Britain. Another factor was his fascination with the development of the earliest forms of railway locomotive, which was taking place locally. In 1804 the Cornish engineer Richard Trevithick was employed by the owner of Wylam Colliery, Christopher Blackett, to build a locomotive that would replace the horses used to draw the coal wagons. At five tons the Wylam locomotive proved too heavy for Blackett's wooden wagonway. The project was abandoned and the colliery reverted to the use of horses but Stephenson's interest in the potential of locomotives had been aroused.

In 1804, when Stephenson was 27, he got a job as an engineman at Killingworth Colliery. His sister Eleanor, known as Nelly, moved in to live with him at the West Moor cottage and look after young Robert. While he was at Killingworth he increased his reputation as a man who was good at mending machinery and engines and he struck up a friendship with a young trainee manager called Nicholas Wood, who shared his enthusiasm. He worked night shifts at the colliery, knowing that this would give him time for further study, particularly in mathematics and the principles of mechanics. He did his sums on a slate hung at the top of the shaft and got these corrected by a teacher during the day, who then gave him more to complete that night. For this he paid the teacher fourpence a week.

The engines at Killingworth included machines made by Thomas Newcomen and James Watt. Every Saturday Stephenson took these engines to pieces to help him understand how they were constructed. In doing this and being able to put them back together again, he showed so much mechanical aptitude that by 1812 he had been put in charge of the operation, maintenance and repair of all the engines and machinery in the collieries owned by the Grand Allies, a partnership of all the principal coal-mining families of the North East. This was a major step forward. His pay was increased to £100 a year and he was now

recognized as a skilled worker. He constructed stationary engines for several collieries for underground haulage work and replaced the horse-drawn coal sleds with wagons rolling on rails. Colliery owners had been watching developments in the field of steam locomotion with interest and some were beginning to see the sort of steam-driven locomotive running on rails that Stephenson was experimenting with as an economically viable alternative to horsepower.

For a man who had received no formal education, Stephenson's achievements were remarkable and they provided an early example of the natural talent he had for anything to do with engineering. He knew that the wealthy colliery owners were relying more and more on men with engineering skills to help their businesses grow and that with education a young mechanic could gain increased recognition from them, so he was keen to learn more. In 1813, hearing of attempts by William Hedley and Timothy Hackworth to develop a locomotive at Wylam Colliery, he went there to study their engine. He also visited Leeds to see an engine that John Blenkinsop had developed for the Middleton Colliery. At its trials Blenkinsop's locomotive had pulled a load of 70 tons at a speed of 3 mph, but when Stephenson saw it he was certain he could do better. He was determined to build his own locomotive and it wasn't long before he managed to convince one of the local mine owners, Lord Ravensworth, of the advantages of a travelling engine. Ravensworth advanced Stephenson the money that he needed and he started work on his first locomotive in the Killingworth Colliery workshops just behind his home at West Moor.

By 1814 he had constructed a locomotive that could pull 30 tons up a hill at 4 mph. Stephenson called his locomotive *Blucher* (after the general in the Prussian Army who would help Britain to defeat Napoleon at Waterloo). Like other machines made at this time, it had two vertical

cylinders let into the boiler. These were attached to piston rods that drove the gears. There was nothing new in this design but there was one important difference in the way it worked. Where John Blenkinsop, William Hedley and Timothy Hackworth had built locomotives with gears that drove rack pinions, Stephenson's gears drove flanged wheels.

On 25 July 1814, *Blucher* was successfully put into operation on the Killingworth Waggonway. With it Stephenson became the first man to make and run a locomotive with flanged wheels on a track laid with cast-iron rails. *Blucher*, however, proved to be defective and the cost of running it was found to be about as great as that of using horsepower. One of the problems was that the engine could not travel round a curve, and those unwilling to believe that railways would ever succeed were amused to hear the story of the driver who had to shout out to his wife, 'Hey, Jean, come oot and gie us a shove round the turn!' People were not impressed and many said of Lord Ravensworth, 'A fool and his money are soon parted.' Like the other locomotives that had been developed, *Blucher* was rough, crude, slow and not very manoeuvrable - no more than a machine for moving coal around at a colliery. But Stephenson wasn't prepared to give up on the idea. He continued to try to improve his locomotive, and in 1815 he changed the design. The connecting rods now drove the wheels directly, and these wheels were coupled together by a chain. The new machine proved much more efficient than the original *Blucher*.

George Stephenson's name is always associated with railways but at this early stage of his career steam locomotives were not the only things he was working on. As a colliery man, he was well aware of the large number of accidents caused by explosive gases. One of the greatest perils facing miners working underground was methane gas (firedamp), which could cause fatal explosions if it

came into contact with the naked flame of a candle or oil lamp. So, in his spare time, Stephenson began work on a safety lamp for miners. He tested it by taking it into a particularly volatile region of the mine and, although the experiment was risky, he emerged safely. By 1815 he had developed a lamp that did not cause explosions even in parts of the pit that were full of inflammable gases. Unknown to Stephenson, Humphry Davy was busy producing his own safety lamp. After some dispute as to whether the lamp was invented first by Stephenson or by Davy - who claimed the £3,000 reward that was on offer - a sum of £1,000 was raised and presented to Stephenson by north-eastern industrialists. For Stephenson, however, the lamp was to be a short-lived diversion, and with the success of his second locomotive he began to devote all his energies to making more efficient railway locomotives.

From 1815 onwards, he carried out key experiments at Killingworth Waggonway, and by 1818 the track had been entirely relaid with cast-iron edge-rails. This use of iron rails was an important advance as wooden ones were too weak to withstand the great weight of locomotives. By 1820 Stephenson had built sixteen engines at Killingworth. Most of these were used locally but some were produced for the Duke of Portland's wagonway from Kilmarnock to Troon. Haulage by horse virtually disappeared at Killingworth and the owners of the colliery were so impressed with Stephenson's achievements that in 1819 he was given the task of building an eight-mile railroad from Hetton Colliery to the River Wear at Sunderland.

While he was working on this, Stephenson became convinced that, to be successful, steam railways had to be made as level as possible, so he laid out the line in sections. The first part was worked by locomotives and this was followed by fixed engines and cables. After the railway had reached a height of 250 feet the coal wagons travelled downhill over two miles of self-acting inclined plane. This

was then followed by another two miles of locomotive haulage. When it was all finished, it was the first-ever railway that was completely independent of animal power. Stephenson's engines were remarkably well made and, in the words of one contemporary enthusiast, 'superior beyond all comparison to all other engines ever seen'. The Hetton Colliery line became a showpiece for Stephenson's railway-building and locomotive design skills.

While he was working on the Hetton Colliery Railway, Stephenson married again, 15 years after the death of his beloved Fanny. His bride was Elizabeth (Betty) Hindmarsh, a farmer's daughter from Black Callerton whom he'd courted in his teens, before he met Fanny Henderson. The couple had wanted to get married but Betty's father said no because of Stephenson's lowly status as a miner. Now that he was wealthier he was finally allowed to marry his first love.

Around this time he heard of a proposal to build a railway to transport coal from the collieries at Shildon in County Durham to a quayside on the River Tees at Stockton, with a branch line running to Darlington. The man behind the idea was Edward Pease, a Quaker wool merchant from Darlington. In 1821, with a group of businessmen, Pease formed the Stockton & Darlington Railway Company. The initial idea was that horses would be the main motive power with possibly some stationary engines, and on 19 April that same year Parliament passed an Act that allowed the company to build such a railway. As soon as Stephenson heard about the project, he arranged a meeting with Pease and suggested he consider building a locomotive railway instead, informing him that the locomotives he had built at Killingworth were 'worth fifty horses'.

Pease took up Stephenson's invitation to visit Killingworth and, seeing *Blucher* at work, he realized immediately that Stephenson was right. He was also

convinced that Stephenson was the man to take charge of the construction of the line and the building of the locomotives, so he offered him the post of chief engineer of the Stockton & Darlington Railway Company. A further Act of Parliament now had to be applied for which would include a clause stating that Parliament gave permission for the company 'to make and erect locomotive or moveable engines'.

It was at this point that the width of the track that our trains still run on to this day was fixed. Stephenson made up his mind about this before the first passenger carriage was built and he never changed it. Edward Pease suggested that he should make the width equal to that of country carts and Stephenson, with characteristic thoroughness, had measurements taken of around 100 carts used by farmers in the neighbourhood. The average width of these carts between their wheels was 4 feet 8½ inches and that, said Fred, 'was good enough for Stephenson for the rest of his life and he went on to defend it against all comers'.

Stephenson now had to decide on the type of rail to use. William Losh, who owned an ironworks in Newcastle, had developed, with Stephenson's help, a new type of cast-iron rail and this was the first choice. But another local ironmaster, John Birkinshaw from Bedlington, was producing wrought-iron rails and when Stephenson went to see them he could tell at once that they were superior, so he decided to use these rather than the ones he was making with Losh.

With the help of his son, Stephenson began surveying the Stockton & Darlington line in 1821. It was the start of the most famous and successful partnership in railway history. Work on the track began in 1822 and it was kept on the flat as far as possible, in line with the thinking of the canal engineers. Where there were changes in level, wagons would be hauled up the inclines by means of stationary engines at the top. Stephenson oversaw the

laying of the new malleable iron rails, which were laid on wooden blocks for 12 miles between Stockton and Darlington; then the 15-mile track from Darlington to the collieries at Shildon was laid on stone blocks. The honour of laying the first few lengths of rail in the presence of the mayor of Darlington and other dignitaries fell to Mr Meynell, the chairman of the Stockton & Darlington Railway Company.

Speaking to his men when the line was being built, Stephenson said:

Now, lads, I venture to tell you that I think you will live to see the day when railways will take the place of almost any other method of conveyance in this country; when mail coaches will go by railway and railways will become the great highways for the King and all his subjects. The time is coming when it will be cheaper for a working man to travel on the railroad than to walk on foot. I know there are great and almost insurmountable difficulties to be encountered but what I have said will come to pass as sure as you live.

Many of those supplying the money for the line were still not keen on using the 'shrieking thing', as they called the steam locomotive, and would rather have had the carriages drawn by horses, but Pease continued to support Stephenson. He was so keen on getting steam locomotives to provide the power for the line that he not only backed Stephenson's design for the railway's first locomotive, *Locomotion*, but advanced £1,000 to help him begin the business of locomotive-engine construction at Newcastle.

By this time Robert was working with his father and in 1823 the world's first locomotive factory was set up at South Street, just off Forth Street in Newcastle upon Tyne. It became known as the Forth Street Works and the