Early Railways

The First Public Railway, The first Broad Gauge engine, and four more Famous Steam Engines

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Introduction

These essays were created as introductions to steam and railway history.

They cover two of the more unsual pieces of railway history, The Surrey Iron Railway and the North Star, the first broad gauge engine. We conclude with a selection of other steam engines, as ideas for projects of further research.

The author would like to thank Ragged Angel Ltd for taking on the task of reformatting these essays for Smashwords.

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The Surrey Iron Railway - The world's first public railway

The Surrey Iron Railway was the first dedicated railway scheme in the world, and the first railway open to the public. Very different to the railways we see today, the carriages were horse-drawn and in the main it ransported goods instead of passengers. Operating for forty years, it laid the way for the modern rail networks and public transport, until the advent of steam engines made it obsolete.

The Surrey Iron Railway

In 1801, in a small town south of London, work began on what would be the first public railway in the world. Built before the advent of steam engines, the carriages were drawn by horses and ran on iron rails. The Surrey Iron Railway operated successfully for forty years, before the growth of steam power made it uneconomic but during its working life it proved that the idea of public railways was practical.

The Birth of the Railway

With the growth of industry and the industrial revolution, there was a need for a fast and efficient way to ransport trade goods from quarries to the towns and factories. Road conditions were extremely poor, making it difficult for horses to transport heavy loads particularly in bad weather.

Private railways had been built, but these were often simply iron plates inlaid into a dedicated road, making it easier for the horses to pull carts. They were also all private enterprises, running for short distances and only used by their owners.

Canals were another popular alternative. In 1799, an eight mile long canal was suggested, to transport trade goods between Croydon and Wandsworth. However this proved impractical due to the need for water, which would cause problems for the factories nearby, and the chalky soil which made construction difficult.

Due to these problems, the plans were changed, and it was proposed that the route of the canal would be used for a railway. In 1801 Parliament passed an Act approving the construction of the Surrey Iron Railway, which would be the first dedicated railway scheme in the world. The name railway had not yet been coined, so in documents of the time it is often called a plateway, or a tramway after its designer.

Building the Railway

The railway was designed by Benjamin Outram, who later gave his name to the transport vehicle "Tram". Built with two cast iron rails, laid four feet two inchs apart in what is now called narrow gauge, the railway had a double track so wagons could run in both directions at the same time. Wooden flanges by the tracks prevented the wagons from derailing. Rather than the single cart that a horse could pull on the poorly maintained public roads, the tramway allowed a single horse to draw four or five carriages to transport goods to market.

Initially an eight mile stretch was built, which opened in 1803. Already distinguished as the first dedicated railway scheme, what made this railway notable was that it was the first railway open to public use. For payment of a toll, farmers and tradesman could use the railway to move goods to market. Since use of the tramway allowed a single horse to pull twenty tons in a train of four or five carriages at three miles an hour, there were obvious benefits. By 1805 it had proved so useful it was extended to eighteen miles, and now linked Merstham, Croydon and Wandsworth.

The End of the Railway

Built to benefit factory owners, the railway's function as a public toll-paying railway was secondary and it never made a high profit. As steam developed the railway slowly became less cost-effective compared to the new engines. As early as 1823 the owners began to investigate the use of steam engines on the tracks to improve efficiency.

Unfortunately converting the route to steam engines proved impossible. The railway had been built with cast iron rails not steel, and it was too weak to take the weight of the steam engines. Re-laying the route with steel rails was possible, but the cost made it impractical when alternative railway routes were already in development. Increasingly outdated, it was left further behind as steam technology progressed.

In 1846 the last horse drawn train ran on the route, and it was closed.

The aftermath

As early as 1855 a purely steam route was laid over part of the line. After all, as the work of creating the route, cuttings, and bridges had been done, it saved costs for the new railway.

Now, in the twenty-first century Croydon Tramlink runs where the horsedrawn railway used to. Sections of the old route, particularly around Wandsworth, now carry the advanced electric trams that are part of London's new transport policy. It is interesting to wonder how many locals and commuters on one of the most modern transport vehicles in the world, realise they are travelling the same route that the first public railway passengers in the world took over two hundred years ago.

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The South Devon Railway

Introduction

The South Devon Railway was one of Brunel's most famous innovations. The railway was powered by atmospheric pressure - drawing carriages along the rails by pnuematic pressure generated by stationary steam engines.

Innovative and unusual, it was ultimately doomed by the limitations of the technology of the time. In service for less than one year, the railway is still studied by engineers today.

The concept of Atmospheric Railway

Brunel was not the first engineer to work with an Atmospheric railway. His idea for the South Devon Railway was inspired by one already running which he saw in Ireland.

The concept behind an atmospheric or vacuum railway was simple. Instead of a conventional steam engine, the railway would have stationary engines at either end. A pipe ran down the middle of the rails, and the lead carriage had a piston head that fitted into this pipe. The engines would generate a vacuum in the pipe by use of suction, and the pressure change would pull the carriages from one end of the line to the other.

Theoretically this should produce a cost saving, as the engines need not move their own weight or carry fuel with them.

The Dalkey Railway

Brunel's interest was probably peaked by the Dalkey railway in Ireland. A test for atmospheric pressure, the railway only used the pressure for uphill journeys, with the downhill stretch powered by gravity.

The speeds it was capable of were highlighted in an incident. During a test, the motive carriage (the carriage with the piston) was not coupled to the train by accident. When the train was triggered it made the ascent in 1 minute fifteen seconds, at an average speed of eighty-four miles an hour. The terrified engineering student Frank Ebrington, who was the only passenger, was helped out at the far end unharmed but rather stunned.

The Problems with the Concept

Atmospheric railway had some limitations from the start. Because of the way it was designed, trains could only run one way at a time, while almost every railway then was being laid as dual track to enable trains to pass each other. Also crossings and points were out of the question, at least with the technology of the time.

As Ebrington's adventure proved, one of the other problems was that the train were being driven by people running an engine several miles away, with no idea of local conditions and, at that time, no way to let them know of a problem. Also because of the trains' varying weights, the pressure needed would vary, and sometimes trains would stop short of the station or hit the buffers with a bone-rattling impact.

To drive this required huge steam engines. These could have been made from a fairly standard design, but Brunel was pushing the limits of engineering again, and there were frequent problems. Daniel Gooch, the lead engineer, worked out that steam locomotives would be significantly cheaper in terms of coal each year. George Stephenson, when he investigated it for narrow gauge, agreed with this conclusion.

Creating the South Devon Railway

Devoted to the idea, Brunel continued work on his South Devon atmospheric railway despite these drawbacks and other engineers' misgivings.

He persuaded the GWR board that the average life of a locomotive was only ten years, and that the stationary engines would last longer. This must not have sat well with Gooch, whose "North Star" engine worked for almost fifty years and eventually outlived the Broad Gauge rails it ran on. However, since installing the pumping engines took longer than expected, Gooch's engines ended up pulling the first trains on the rails.

Part of the problem was the length of the railway. The pipes for the centre all had to be of an exact diameter, with a slot running down them in exactly the same place. With Victorian methods this precision was not easy to achieve repeatedly over enough components to complete the route. The slots were sealed with overlapping pieces of leather to prevent the loss of pressure but permit the motive piston to pass through. At each joint the pipe rivets were reinfored with caulked yarn to prevent the air entering. Valves were needed at each station, level crossing, pumping station and more.

The Atmospheric Trains In Operation

The first test train ran in February 1847. However, it was not until September that a regular service began. Four pressure-driven trains a day ran on the track. The highest speed recorded with these trains was 68mph, and they regularly towed trains at thirty-five miles per hour.

Then the problems began.

Water in the pipes from rain of condensation rotted leather and affected the seal. A breakdown in the pumping station prevented any train moving on the line, and the entire system depended on a perfect air-tight seal for miles. A nudged or misaligned valve and the trains came to a halt. In winter the leather seals in the slots froze solid.

Another small problem that they encountered was with the seals and yarn that protected the joints. Leather treated with fat and yarns soaked in linseed oil attracted rodents. With rats eating, chewing, and damaging the seals it was very difficult to keep the railway in running condition.

The end of the atmospheric railway

In June 1848, it was confirmed that the valve flaps needed repacing through the entire railway. Chemicals like iron oxide had affected the flaps, and the action of the vacuum had stretched the leather making it pull away from the rivets. The cost of the replacement? £25,000.

The enthusiasm for atmospheric railway was still running high. Patents for valve improvements were being taken out, the directors of the railway wanted it renewed, and there was a lot of public interest in atmospheric railway with other routes being built. Brunel could have gone with the flow and let his railway continue.

Instead he recommended the atmospheric railway be terminated as impractical. He took responsibility for the failure, accepting only a nominal fee for his work until the route to Plymouth was completed for conventional trains.

The directors took his advice. The pumping houses had proved uneconomical, taking three times the amount of fuel to pull the trains that had been predicted.

The huge engines were not wasted. Their sale raised over £42,000 for the Great Western, and they were switched to industrial purposes, such as powering a lead mine. The iron pipework was ripped up and sold for scrap, raising additional funds.

And around the country one by one the other atmospheric railways failed, often taking their sponsors with them. The experiment was over.

In Conclusion

It is still hotly debated today whether the project was totally impractical, or if it was a good idea doomed by the technical limitations of the time and the resources available. However it is notable that, even with modern technology, the atmospheric railway idea has not been returned to. Compared to rails and independant engines, the atmospheric railway's more complex build, higher maintenance costs, and lack of upgradability simply made it uneconomic. Even Brunel, known for taking on almost impossible challenges, eventually declared this a failure.

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The North Star - The first Great Western steam engine

The North Star was both first and last of the Broad Gauge steam engines built for Brunel's Great Western Railway. Pulling the inaugural train on the network, she was also the last broad-gauge engine to be scraped over fifty years later after the death of Broad Gauge in England.

The North Star - The first and last Broad Gauge engine

The North Star was ordered as the first engine for Brunel's new Great Western Railway. Arriving before the rails she would run on had been laid, she would have a productive life in service until the death of broad gauge. Then she was preserved in a museum with the later engine "Lord of the Isles" until 1906, when both were scrapped, making her both the first and last of the original broad gauge engines.

Broad Gauge

Usually train track are laid a distance a little over 4 feet apart, called narrow gauge. Brunel suggested that a broader gauge (greater distance between the rails) would produce a faster, smoother ride, and for his Great Western Railway he implemented this. This produced a number of issues, including the fact that the steam engines which existed at the time would not be able to use these tracks. An entirely new type of steam engine was called for.

Building the North Star

The original design for broad gauge engines was one of Brunel's few mistakes. He had limited the piston stroke and made other restrictions. When the two prototype engines, Vulcan and Thunderer were delivered, they performed poorly.

Daniel Gooch, the chief locomotive engineer, suggested buying two engines that he knew were available - the North Star and Morning Star - and rebuilding them for Broad Gauge. It was not entirely chance that he suggested them, as despite his youth, Gooch was an experience locomotive engineer who had worked for the company which built them. Some sources suggest he was involved in their design and construction.

When they arrived there were immediate issues. The boilers were undersized, and the locomotives could scarcely pull sixteen tons at forty miles per hour. Work obviously needed to be done by the engineers, and the North Star, stuck in a shed until the full Great Western Line it would run on had been laid, became their prototype.

Gooch and Brunel pulled the engine apart, improving pistons, boilers and working on fuel efficiency. When they had finished she could pull forty tons and forty miles an hour, using less than half the coal she had used for her original runs.

In 1838 the North Star pulled the Great Western's inaugural train. It would be the first of many to run on the legendary line.

The Star Class

The changes made to North Star were promptly made to Morning Star, and eventually a total of twelve engines were built to this design. Called the Star Class, they were the first engines to run on the Great Western. Using the knowledge gained from working on the North Star, Daniel Gooch created first the Firefly class, which would be the workhorse of the Great Western and then the Iron Duke class, even faster and capable of pulling the fastest express train in the world.

In 1853 Brunel, the inventor of broad gauge and designer of the Great Western Railway, died. Sir Daniel Gooch replaced him as the champion of Broad Gauge and chairman of the Great Western.

The End of Broad Gauge

In 1892 the gauge wars came to an end. Broad gauge, Brunel's revolutionary solution, lost to narrow gauge. With the rails they ran on removed, the scrappers' yards were full of broad gauge engines which could not be adapted to narrow gauge.

The North Star and one other engine "Lord of the Isles", an Iron Duke class, were preserved. Stored and displayed at Swindon Railworks, they were exhibits that toured the country raising awareness of the railways. Despite the affection held for them by the public and their place in history, this proved to be only a reprieve.

The End of the North Star

In 1905, in a message that has become notorious, the manager of the Swindon Railworks announced that both engines would be scrapped because they "were occupying valuable space". Allegedly the message was sent by George Jackson Churchward, who would use the name "North Star" and the "Star class" for his own narrow gauge engines less than two years later. Despite public opinion firmly in their favour, both engines were destroyed in 1906.

The North Star had been the first and longest-lived of the broad gauge engines. Out-living her creators, and the railway she had been built for, she gave stirling service for over fifty years and had become an icon. Like the Great Western Railway itself, she was destroyed by shortsightedness, rather than economics or lack of demand.

A Replica

In 1925, a replica was constructed for the exhibition. Although the funds were not available to make it run, (and when filmed it was pushed by another engine), parts from the North Star were used wherever possible.

Today the replica sits in pride of place in the York Railway Museum, and one imagines that they would have some harsh words for anyone who called it a "waste of space".

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Four Other Famous Steam Engines

A short piece about four famous steam locomotives; Stephenson's Rocket, The Flying Scotsman, The Mallard and the A1 Tornado. Between them they cover the history of steam from the first recogniseable steam engine to the only engine built in the twenty-first century.

Stephenson's Rocket

Not as some would think, the first steam engine, the Rocket was the first steam engine which resembled the modern engines, and the first to contain some features which we would recognise in engines today. Built for a trial of steam engines in 1829 it won by default; all the other contenders broken down. It did manage a speed of 29 miles per hour, which was a considerable rate in an era when most transport was by horse. In 1862 Rocket was donated to the Science Museum, and remains there to this day.

It also confirmed Stephenson's position in railways, setting the stage for the wars between his narrow gauge and Brunel's Broad gauge that would affect British railways for nearly sixty years.

The Flying Scotsman

One of the most famous engines of all time, the Flying Scotsman was the first engine to break 100 mph, and also holds the record for endurance - the longest journey by a steam engine without stopping or refuelling.

Originally No. 4472, it was named after the passenger service which it pulled, an express route from London to Edinburgh. The engine had become a flagship for the LNER railway company after it appeared at major exhibitions in 1925 and 1926, so when they wanted to attempt the speed record, the Scotsman was the logical choice. In 1934, pulling a test train, it was successfully recorded as the first engine to break 100 mph.

Retired from service in 1963, the Flying Scotsman was restored and toured the country for some years, as well as trips abroad to the USA and Australia. In 1989, over sixty-three years old, it set another distance record in Australia for the longest non-stop run by a steam engine.

In 2004, partially dismantled, it was bought by the National Railway Museum in York, who are currently in the process of restoring her. Hopefully by 2010 the Flying Scotsman will be back on its wheels and setting records again.

The Mallard

When the Germans built the fastest steam engine in the world and recorded a travel speed of 124 mph, the British were determined to recapture the record. The Mallard was the ideal candidate. Built in 1938 she was only five months old, and one of a class of streamlined high-powered locomotives designed to pull high speed trains. She had a double chimney and blastpipe to further improve her performance. It was known that she could reach a speed of over 100 miles an hour - the question was how much faster.

The raceway chosen was Stoke Bank, long and straight with a slight slope downhill. The German record attempt had built up speed on a downhill slope before the race distance, but Stoke Bank did not have this. The race, well-documented, was fast enough that the engine sustained damage but the record had been set. The fastest steam engine in the world, the Mallard reached a speed of 125 mph.

After her successful run, aand the resulting publicity, the Mallard continued in service until 1963 when she was retired. Now she can be viewed in the Railway Museum in York. Her speed record remains unbroken.

The A1 Tornado

The only steam engine built for mainline Europe in the twenty-first century, the Tornado is a Peppercorn Class engine. The original Peppercorn engines were built in 1949, the last mainline steam engines, and were scrapped during the rush to diesel. By 1966 all had been destroyed.

The Tornado was built as the fiftieth member of the class, not a replica of a previous engine and as such has some improvements. Electronic devices bring her up to modern health and safety standards, while increased boiler size extends her range between water-stops to one hundred miles. She is already assessed for travel at seventy-five miles an hour, and like all members of her class can reach 100. It is hoped that she will be assessed as safe to travel at ninety miles per hour on mainline tracks, putting her travel speed up alongside contemporary engines.

The Tornado pulled her first passenger train in 2008, and will spend the next ten years working on the mainline tracks until she requires her next service. Tickets on Tornado services can be gained through Cathedral's Express, where it works alongside such steam engines as Tangmere and Sir Nigel Gresely.

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Resources

L.T.C.Rolt's Biography

A trip to the York Railway Museum

Retracing the First Public Railway (Living History local guide) - by Derek A. Bayliss

The Surrey Iron Railway lens

The Science Museum

Further Reading

http://www.squidoo.com/A1-Tornado

http://www.squidoo.com/Flying-Scotsman

http://www.squidoo.com/Great-Western-Railway

http://www.squidoo.com/Surrey-iron-railway

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About the e-Book

These pieces were originally produced for a local school, and are available online for free distribution. Aimed at a younger audience, they are a brief introduction to engineering history which can then be built on and used for ideas for lesson plans and class projects.

With thanks to Ragged Angel for handling the formatting and upload of this e-book.

Ciamar Price (More on Smashwords)

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Other E-books

In This Series

"The Three Great Ships of Isambard Kingdom Brunel" is another summary book, covering Brunel's three legendary ships, the Great Western, Great Britain and Great Eastern.

Fiction

Ragged Angel also publishes a range of other titles, including games and fiction.

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The Docks

Harry's in more trouble than he knows, and he knows he's in a lot.

His freedom depends on covering his tracks, and uncovering the truth before the police do. One person holds all the pieces. Unfortunately Harry killed him last night.

Murder, manslaughter or self-defence? When Harry agreed to an "insurance" job , he didn't know what was really planned. Then the bomb went off. Now he's confessed to burglary, could be on the hook for murder and is desperately trying to dodge a terrorism charge. On his side, a bunch of crooks and the solicitor he's dubbed Ms. Pitbull. Against him are his former accomplices, the police, and the inspector who sent him down for ten years.

The Docks is a crime novella, available now in ebook.

"I definitely recommend The Docks for a fast, entertaining read!" Gathering Leaves Book Reviews

"Great short story that I highly recommend and I look forward to reading more from this author!" Can't Put It Down Book Reviews

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