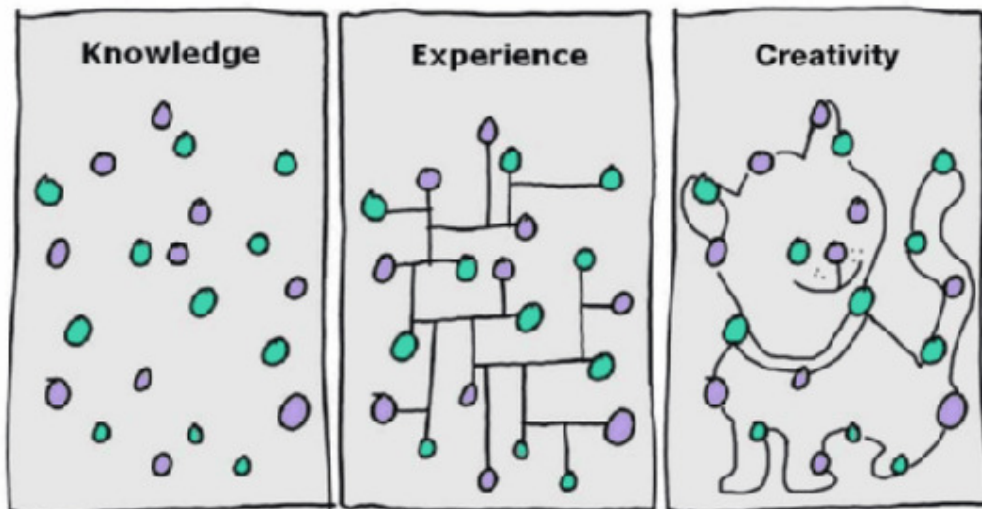


## Myths and Legends

### The Origins of Standard Gauge Railways

#### Introduction

Everyone involved in communicating complex information knows that the best way to be understood is to tell a story. A well-structured story changes a framework of cold facts into something that is easy to understand and relate to<sup>1</sup>. However, while developing a good story is undoubtedly a creative process, this creativity needs to be carefully constrained. The boundary between ‘joining the dots’ to make complex data easy to understand and the creation of an unsubstantiated myth is an easy one to cross. Correlation is not causation and the links in a story need to be as reliable as the facts they connect.



One example of a myth founded on fact is the story of the creation of standard gauge railways in the 19<sup>th</sup> century. Standard gauge is used by approximately 55% of the railway lines around the world and is the reference point against which narrow gauge and broad gauge are determined<sup>2</sup>. So, while standard gauge is definitely a standard, the myth that links the legacy of Roman wheel ruts, to the creation of the traditional dimensions used to space the wheels on carts, and as a consequence the creation of the standard gauge for railways is not so certain.

We know George Stephenson built the first railways powered by steam locomotives, starting in the early 1800s, and the rail gauge he chose for his first intercity railway of 4 feet, 8½ inches (1.435 m) was initially adopted by other railway builders in the UK where it eventually became the standard gauge for railways and was then exported around the world. But was this choice of gauge influenced by Roman chariots?

<sup>1</sup> For more on *effective story telling* see:

[https://www.mosaicprojects.com.au/WhitePapers/WP1090\\_Effective\\_Explinations.pdf](https://www.mosaicprojects.com.au/WhitePapers/WP1090_Effective_Explinations.pdf)

<sup>2</sup> The term gauge refers to the distance between the two running rails of a railway track measured from the inside face of the rails. Standard gauge is 1.435m, narrow gauge railways have the rails closer together, broad gauge further apart. There are many different gauges in use around the world:

<https://www.britannica.com/technology/gauge-railroad-track>.

## The Myth of Standard Gauge

Until relatively modern times, the Roman road system was the only comprehensive paved road system in the UK. These roads were well constructed and lasted for centuries after the collapse of the Roman Empire. The existence of these Roman roads has given rise to a mythology that the space between the rails of a standard gauge rail network was derived from the specifications used by the Romans for their various carts and chariots. The myth generally follows this form:

*The standard railroad gauge (distance between the rails) is 4 feet, 8½ inches (1.435 m) which is a very unusual dimension. Why was that gauge used?*

*Because the first rail lines were built by the same people who built the wagon tramways (wagonways), and that was the gauge they used. So, why did they use that gauge for the wagonways?*

*Because the people who built the wagonways used the same jigs and tools to build the horse drawn rail cars that they had used for building wagons, which meant that same wheel spacing was used, setting the rail spacing. Why did the wagons have that particular odd wheel spacing?*

*Well, if they tried to use any other spacing, the wagon wheels would break more often on some of the old, long-distance roads in England. That was the spacing of the wheel ruts worn into the roads. So, who built those old rutted roads?*

*Imperial Rome built the first long distance roads in Europe (including England) for their legions. Those roads have been used ever since. And what about the ruts in the roads?*

*Roman carts and chariots formed the initial ruts, which everyone else had to match or run the risk of destroying their wagon wheels. Since the chariots were made for Imperial Rome, they were all alike in the matter of wheel spacing. Therefore, the standard railroad gauge of 4 feet, 8½ inches is derived from the original specifications for an Imperial Roman chariot. Bureaucracies live forever.*

*So, the next time you are handed a specification/procedure/process and wonder 'What horse's ass came up with this?', you may be exactly right. Imperial Roman chariots were made just wide enough to accommodate the rear ends of two horses.*

As with all myths there is a foundation of truth! But the elaborations are pure speculation.

## What we know about the standard gauge

The elements of the myth described in this paper are the links between wagon makers and wagonways, and the fact that when George Stephenson was hired to build the world's first steam powered railway at the Hetton colliery in 1820, he used a gauge of 4 ft 8 in (1.422 m). The railway was 8-miles (13-km) long, and opened in 1822. This gauge was the same as the one Stephenson was familiar with from his earlier work at the Killingworth

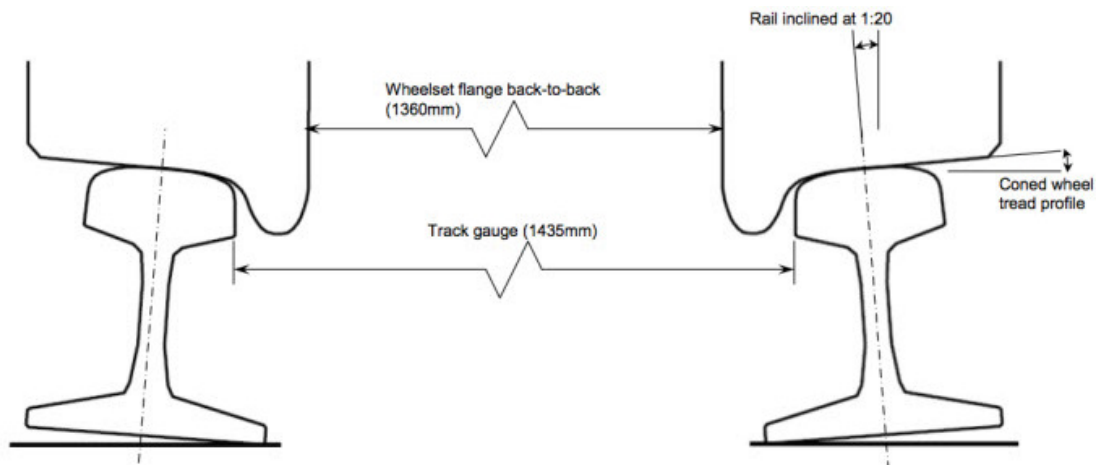


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wagonway<sup>3</sup>, where he had built his first steam locomotive *Blucher*<sup>4</sup> in 1814 (which was used to replace horses). George Stephenson's primary business was making steam engines, including those used on the Stockton to Darlington railway for the first passenger services. Using the same gauge on each of the railways would make manufacture of the steam engines easier.

An additional ½ inch was added to the gauge by George Stephenson in 1829 for his pioneering intercity Liverpool & Manchester railway line in which opened on 15 September 1830. This small increase in width was probably to reduced friction between the wheel flanges and rails, particularly on curves, but no one is certain why the gauge was increased. The Liverpool & Manchester railway was quickly followed by other trunk lines using the same gauge, including the *Grand Junction Railway*, and the London and Birmingham Railway, which together formed a critical mass of standard gauge lines. However, for many years, there were other gauges competing for dominance and the situation was not resolved until the *Regulating the Gauge of Railways Act* was passed in 1846<sup>5</sup> making 4 feet, 8½ inches (1.435 m) the standard gauge for all railways in the UK<sup>6</sup>.

Over time the original square castings for wheels and rails have evolved into a highly sophisticated track geometry while retaining the original standard gauge:



### The Roman influence

Archaeological excavations at Pompeii and elsewhere, starting in the 1870's, have shown that the gauge George Stephenson chose for his first railway was approximately the same as the gauge used for Roman road vehicles. An American engineer, Walton W. Evans, measured the ruts made by carts and chariots at Pompeii and found that the distance between the center of the two ruts was about 4 feet, 9 inches, consistent with a wheel spacing slightly less than that.



<sup>3</sup> The history of *wagonways* is discussed in *The First Railway & Canal Projects*: [https://mosaicprojects.com.au/PDF\\_Papers/P207\\_The\\_first\\_railway\\_and\\_canal\\_projects.pdf](https://mosaicprojects.com.au/PDF_Papers/P207_The_first_railway_and_canal_projects.pdf)

<sup>4</sup> George Stephenson: <https://www.britannica.com/biography/George-Stephenson>

<sup>5</sup> For more on the British 'gauge wars' see: [https://en.wikipedia.org/wiki/British\\_Gauge\\_War](https://en.wikipedia.org/wiki/British_Gauge_War)

<sup>6</sup> To place the events discussed in this paper in a comprehensive historical timeline download *Project Management - A Historical Timeline*: [https://mosaicprojects.com.au/PDF\\_Papers/P212\\_Historical\\_Timeline.pdf](https://mosaicprojects.com.au/PDF_Papers/P212_Historical_Timeline.pdf)



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Later archeology confirmed that this was the Romans' common gauge. So, the Romans did build roads, and the roads did become rutted as this picture of a Roman road shows.

The Romans also used carts and chariots pulled by two horses as shown in this picture of a Roman carving.



But how much of the rest of the myth is correct or speculation? For a start, the vast majority of carts and wagons were privately owned, including those used for the *cursus publicus*<sup>7</sup>. The Roman Empire was very lightly administered from a bureaucratic perspective, and there is no indication of an enforced design standard for wagons.

A viable alternative explanation can be seen in the section from John Constable's *The Hay Wain* (1821) reproduced below. It also shows a cart being pulled by two horses. Given the size of a horse in the 1800s, would be similar to ones in Roman times is it possible the wheel spacing on carts and wagons is simply a result of form follows function? A consistent factor in wagon design is aligning the wheels with the outside legs of the horses pulling the wagon, this means that if the horses can get through a gap, so can the wagon wheels. As English railway historian Charles E. Lee suggested, *the gauge probably represents the optimal size of a road vehicle relative to the indivisible size of a horse. Anything less would have underutilized the horse, and anything greater would have put excessive strain on the animals.*



It is also likely that differences of a few millimeters in the manufacture of wagons in the 18th century would be immaterial - no one was that worried about a 'standard', they just wanted something that worked. The

<sup>7</sup> The *cursus publicus* was the state courier and transportation service of the Roman Empire. It was a system based on obligations placed on private persons by the Roman State. As contractors, called *mancipes*, they provided the equipment, animals, and wagons: [https://en.wikipedia.org/wiki/Cursus\\_publicus](https://en.wikipedia.org/wiki/Cursus_publicus)

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difference in size between a low-land draft horse and the tough highland ponies found in the West and North of England would be far more influential on the wheel spacing of wagons.

### Wagonway Gauges

We know a wagon wheel gauge of around 4 feet, 8 inches worked because it was widely used although many different gauges ranging from 4 feet 0 inches to 6 feet 2 inches were used on various wagonways. Some examples include:

- Redruth and Chasewater Railway (1825) in Cornwall chose 4 ft (1,219 mm)
- Monkland and Kirkintilloch Railway (1826) in the West of Scotland used 4 ft 6 in (1,372 mm)
- Dundee and Newtyle Railway (1831) in the north-east of Scotland used 4 ft 6½ in (1,384 mm)
- Arbroath and Forfar Railway (1838) with a gauge of 5 ft 6 in (1,676 mm)
- Ulster Railway (1839) used 6 ft 2 in (1,880 mm)

At the time these railways were being constructed, there was no consideration of a future connection to other lines, and selection of the track gauge was a pragmatic decision based on local requirements and prejudices; probably determined by existing local designs of road vehicles, and the fact different wagon makers used different jigs to make their wagons.

From a practical perspective, it was only after railways started to become an interconnected network that the need for true standardization occurred. George Stephenson's gauge was initially adopted by other railway builders in the UK, and then exported around the world with British built engines and rollingstock, but it was not the only gauge used in the UK or elsewhere. Wide gauges were seen as better for load carrying, comfort and speed (for example, Brunel's Great Western Railway), narrow gauge lines were cheaper to build. Different engineers had different ideas in different locations<sup>8</sup> and this continues to the present day.

### Conclusions

The elements of the myth supported by the research reproduced in this paper are:

1. The Roman roads were rutted, and the ruts are spaced at a gauge close to the standard gauge adopted by Stephenson, but by the early 19<sup>th</sup> century, there were very few Roman roads left in use.
2. There appears to be a link between wagon makers and wagonways, it is highly likely the gauge used on a wagonway was based on the gauge used by the local wagon maker for road vehicles.
3. George Stephenson was hired to build the world's first steam powered railway at the Hetton colliery in 1820 where he used a gauge of 4 ft 8 in (1.422 m), which was the same gauge he had previously worked with at the Killingworth wagonway.
4. Standard gauge evolved from the work of George Stephenson, but why he added the additional ½ inch to his gauge in 1829 for his pioneering intercity Liverpool & Manchester line is a mystery, and it is this revised gauge that later became the standard gauge by an Act of the UK Parliament.

The connections in the myth that appear to be unsupported by the facts, are:

<sup>8</sup> Much in this section has been sourced from **Trains Magazine** (May 1, 2006) <https://www.trains.com/trn/railroads/history/a-history-of-track-gauge/>



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- The assertion the ruts in Roman roads determined the 'standard' for wheel spacing on wagons. From the available evidence there appears to be no standard gauge used for making wagons. The Roman roads were only a small part of the road system in the UK by the 16<sup>th</sup> century and this assertion seems to be completely unfounded.
- There was a standard gauge used for the wagonways. There was no standardization in the gauges used on various wagonways. Different wagon makers used different jigs to set their wheels and axles, and consequently, while there may have been similarity, there was no standardization.
- Standard gauge was based on a gauge used for wagonways. While the origin of the standard gauge can be tied back to the gauge used on the Killingworth wagonway, standard gauge differs by ½ inch from the gauge of the wagonways Stephenson worked on.

The drivers for the use of standard gauge were the fact George Stephenson built the first intercity railway, and that he, and his son Robert Stephenson, built some of the best early steam locomotives; these two factors led to some of the other early railways using his gauge. But there were many alternative gauges in use, both before and after Stephenson, and it took many years, plus an Act of Parliament for the standard gauge to become standard.

Similarly, while the normal wagon wheel spacing used in the 18<sup>th</sup> century fits the profile of ruts found in Roman roads, it is far from certain this similarity was caused by a need to accommodate the rut spacing in the few remaining Roman roads. The more likely reason the wheel spacings were similar is the fact both Roman wagon builders, and 18<sup>th</sup> century wagon builders, needed to optimize their design to accommodate the indivisible size of a pair of horses. Ockham's razor<sup>9</sup> tells us there is no need to look for complex solutions when there's a simple explanation.

In summary, all we can be sure of is the fact that that standard gauge is derived from, but is different to, the rail spacings on one wagonway, which was likely to have been the same as the wheel spacing used on traditional wagons made by a local wagon maker. The fact Stephenson's gauge became 'standard' would seem to be more to do with him being the first person to build an intercity railway than any intrinsic merit in the gauge itself.

I would suggest on the available evidence, despite being a well-constructed story, this myth is busted!

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<sup>9</sup> The Law of Parsimony states that the simplest or most elegant solution is likely to be the best. This is derived from Ockham's Razor, a problem-solving principle developed by Franciscan Monk William of Ockham in the 1300's. His 'razor' states that when seeking an answer to a problem, among competing hypotheses that predict equally well, the theory with the least assumptions is the best one.



## The Origins of Standard Gauge Railways

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