

# UNDERGROUND ITEMS FROM THE TELEVISION AN OCCASIONAL SERIES

by Paul Creswell

**“THE FIFTEEN BILLION POUND RAILWAY: THE FINAL COUNTDOWN”.** Shown on BBC2, 21.00 to 22.00 on Mondays 22 and 29 May 2017.

## NOTE BY YOUR REVIEWER:

*These two programmes effectively follow on from those transmitted on Wednesdays 16, 23 and 30 July 2014 and were reviewed in Underground News No.634 (October 2014) on pages 528-530.*

The opening of the first programme informed us that 10,000 workers had been involved in the Crossrail project overall. This was almost certainly the most ambitious rail project in Britain since the days of Brunel. We were told that this was now a race to finish all the associated works for London's new underground railway.

At Farringdon, we met Linda Miller, Crossrail Project Manager, who took us (on foot) down the eight levels (harder up than down she remarked sarcastically!) to be present for the breakthrough of the very last tunnelling machine into the newly-built station tunnel, all this happening whilst the traders at Smithfield meat market continued their trading on the surface above, as well as the jewellers in the Hatton Garden quarter. This marked a new phase in the project, as the completion of the running tunnels meant that work on tracks, platforms, stations and the building of the trains could get started in earnest. Cavernous station areas could now be transformed into stations fit for a brand new transportation system.

The last tunnelling machine was now being dismantled and Linda remarked that she now had one hundred big things to worry about each day and also a million little things!!

Simon Wright O.B.E., Programme Director, remarked that the objective of Crossrail was to help ease the strain on the 150-year-old London Underground system, that today struggles to cope with the demand made of it in peak hours. Crossrail will carry 200m passengers each year, giving relief ‘at a stroke’ and will help keep London moving for many years. Simon commented (rather ‘tongue in cheek’) that all those involved in the project are rather like an orchestra, with many players, many skills, but all having to play to the same tune! It is expected that the first trains will run in less than three years.

Crossrail will reach from Reading and Heathrow Airport to the west of London, pass under central London, both the west end and the east end and continue on to Abbey Wood and Shenfield. Heathrow Airport will be just 26 minutes travelling time from the west end at Oxford Street, a journey which currently takes over an hour on the Underground.

Returning to Farringdon, Linda Miller (see above) told us it will be, when complete, Britain’s biggest railway station, certainly in terms of passenger numbers, at 150,000 passengers per day. In terms of size, if one were to lay The Shard (currently Europe’s tallest building) on its side, it would fit into the Farringdon excavation, which is over 300 metres in length. Linda is a former U.S. army pilot and paratrooper and trained in engineering. She assisted with the construction of the N.A.S.A. launch complex in Cape Canaveral. The construction of this £375m station will be her biggest challenge to date.

The first task at Farringdon is to dig out two eight-storey deep holes, which will allow the two station ‘boxes’ that form the two ticket halls, one at each end of the station, to be constructed. Then the newly-built running tunnels must be widened out to create the platform area. Then passageways have to be built to connect the platforms to the booking halls. Geological ‘fault lines’ pass through the area, also an ancient underground river, which gives rise to pockets of sand and water – these could be encountered at any time as the work progresses. All concerned had to be aware of the possibility of collapses during the construction work.

The running tunnels now need to be doubled in width where the platforms are to be built. Quick-drying concrete is sprayed on the walls as soon as they are completed, this drying almost as it touches the

wall, hopefully preventing any chance of the new wall collapsing. Then a plastic waterproof membrane is added, which gives quite an effect, being orange in colour.

The scene moved to Whitechapel, home of the bell foundry that produced 'Big Ben' and a bustling street market beside the station. £111m is being spent on this station, built, we were told, in 1876. Jim Forrest, a proud Yorkshireman, is the site manager here and he had a long history in construction work, stretching back to about 1960 and including many jobs, such as the Humber Bridge. Jim told viewers that this was one of the most confined and most complex sites on the Crossrail project. He felt that the existing station was haphazard and 'not fit for purpose'. As an example, the Underground passed over the main line below it. (*Your reviewer wonders if he realised that this is more an example of history at work than a 'haphazard' station?*).

A new station cannot be squeezed into the existing site, so engineers had to build a 180m-long 'floating bridge' from north to south across the existing station, to provide some of the new facilities. This involved some 6,500 pieces of steel. An artist's impression of the finished construction was slightly spoilt by a train, clearly 'tube' (rather than sub-surface) in size, passing through! This 'bridge' included aluminium cladding, to reduce train noise. Jim added that the whole project was made more difficult by the need to keep trains (on both lines concerned) running throughout.

Viewers next joined Jim in the roadway (Whitechapel Road) outside the station early one morning. He was expecting two lorries with some of the steel parts mentioned above. To stay in line with granted 'traffic orders', the lorries had to arrive and park-up before 06.00, which they made with little time to spare. Traffic marshals (reporting to Jim) had to stop the traffic in both directions while the lorries reversed into the little space available for them. Due to the oversize load and very restricted manoeuvring space, the lorries were equipped with steerable rear bogies, which viewers saw in use. The steel delivered had been prefabricated in the Netherlands and now had to be formed (on site) into larger sections, which then would be craned into their final positions.

Some of the local market traders had been obliged to make a temporary move for the construction work. One philosophised to the camera that at least he might expect more customers once Crossrail was running, in a form of 'compensation' for his being moved!

We then returned to Farringdon to meet, once again, Linda Miller (see above) who was being faced with one of her many daily problems. As the platform works continued, plans had to be made to get the teams preparing the track to be able to carry out their work without hindrance. Access for them and, more importantly, their heavy equipment, was vital and this needed a solution, as the existing ways into the station were, it seems, going to be too small. The solution was to construct a new vertical shaft, 30m deep, to the platform area. The only place available was on the platform at Barbican station, fairly close to the running trains.

We were introduced to Steve Parker, Site Manager (Tunnels) who explained about the construction of the shaft, which had an initial ring with cutting edges; upon this other rings were built and the whole structure was forced further and further downwards, as each set of rings were added.

Moving eastwards to Liverpool Street, we were able to see the 23,500 square metre hole dug for the booking hall. We met Jay Carver, the Lead Archaeologist for the project. He told viewers this was a rare opportunity to obtain a slice of some 2,000 years history of a cross section of London from west to east. In five years, some 10,000 items of archaeological interest had been revealed from a total of 40 sites. This included, for example, 25 skeletons of victims of the Black Death (mainly from the east side of London). Jay described Roman London (then known as Londinium), which had some 60,000 inhabitants. It was thought that movement in the city was congested even then and that the Romans might have built a 'North Circular Road', outside the two-mile-long city walls, as an aid to movement in the city.

Returning to Farringdon, we learned that Linda Miller and Steve Parker (see above) had managed to complete the new access shaft in just eight weeks. We next met Construction Manager Gregg Purcell, who was responsible for the track work in the Farringdon area. He introduced us to one of four track laying machines in use on Crossrail. These could perform multiple tasks, including lifting rails and other equipment and laying track at a rate of up to six hundred metres of sleepers a day. It could lift up to 15 tons, using its multi-purpose gantry. We were also shown a 465-metre-long concreting train. Gregg felt that this was a once in a lifetime opportunity to be involved in a project of this scale.

An additional problem faced by Gregg was that the railway at Barbican passed close to the Barbican complex, which included a concert hall some two storeys below ground, putting it about 17 metres from

the Crossrail tunnels. This had meant that special track fastenings had been needed, including 'springs' in the track base, which would absorb the energy (and hence the noise) of the passing trains. A special concrete is used for this track base, called 'MagnaDense'. 150 tons is utilised, together with steel reinforcing, to produce just 30 metres of finished track. It is very expensive, at some £1,000 for a cubic metre, about ten times the cost of normal concrete. However, it is successful in reducing vibration and hence helping to protect concertgoers at the Barbican centre from noise intrusion. Once the concrete has set, the supporting springs are manipulated so as to raise the underside of each slab to its correct height.

Returning to Whitechapel, Jim Forrest (see above) was seen supervising the joining of two of the 'floating bridge' steel sections together. Due to the severely restricted space available for such operations, this was being done in an adjacent school yard (but on a Sunday!), resulting in a 40 ton section of the bridge. This had now to be craned into place above the station, meaning part of an obstructing handrail had to be removed and also that Jim had to 'keep his fingers crossed' that wind speeds did not get too high, which could mean the structure might start swinging against adjacent properties.

Back at Liverpool Street, Jay Carver (see above) showed viewers part of the Roman road mentioned previously. This was originally about seven or eight metres wide, but was later increased in width to about 11 metres. It ran, broadly, east to west and probably formed a sort of 'ring road'. It was full of debris, probably from other parts of the then city of Londinium. Jay's team will analyse what has been recovered from all the Crossrail sites and hope to put together some secrets of London's lost past.

Returning to Farringdon, Linda Miller's team (see above) had completed the platforms and the track was now in place. The wall and floor of the ticket hall were also now finished. Work was now concentrated on the ceiling, which was to consist of shapes to remind passengers of the historic significance of nearby Hatton Garden. This had been the centre of the diamond trade for some 150 years and, since the 1930s had accounted for some 90 per cent of the world's diamond trade.

The ceiling consisted of a 'jig saw' of 105 concrete segments. Some 42 of these formed frames and the remaining 63 were to sit within those frames. 'Plugging-in' this puzzle was another addition to Linda's list of daily problems, with the fresh challenges involved. Viewers met Andy Scholes, Site Manager (Farringdon), who had the task of erecting a network of steel supports for the ceiling. He hoped that the overall effect would be a 'huge visual striking welcome' to passengers entering the new station.

The sections of the new ceiling were being manufactured in Derbyshire. Each segment was poured into a bespoke casting and required some two weeks to completely set. Each one had to then be transported the 130 miles to London. We witnessed the arrival of one piece at Farringdon, where traffic marshals had to stop both traffic and pedestrians to allow the lorry concerned to reverse into its parking space. Andy Scholes added that, upon arrival, each piece had to be checked that no damage, such as chips, had occurred during transit.

Next, we were back at Whitechapel with Jim Forrest (see above). Construction of the 'floating bridge' had required closure of parts of the railway for some 40 days in a two-year period. Once the bridge was complete, the pace then quickened, with the walls and curved canopy following next. Over the next few months, Jim's teams will fit out the ticket hall and complete the canopy with a glass roof and cedarwood plants.

Returning, once again, to Farringdon, Andy Scholes' team (see above) were gearing up to assemble the diamond shaped sections of the station's vast ceiling. Each piece, when delivered, was identified as to its exact position in the roof. Each one, weighing some ten tonnes, had to be craned into its exact position with great care, as the site was right next to the operational Thameslink station. Andy had an accurate drawing from which to work and described the procedure as following a giant jigsaw puzzle! Linda Miller (see above) felt that the full results of all the work were now really beginning to be seen and that 'diamonds were forever', well, for at least 120 years!!

Viewers were now taken along the line to Bond Street, at the time of a very special visit. This was by Queen Elizabeth, who was to give the new railway a 'royal seal of approval'. The occasion also saw the line renamed 'The Elizabeth Line', in the Queen's honour.

It was now time to press on to complete all the works, with trains scheduled to run in less than 18 months.

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The second programme commenced with Simon Wright, O.B.E., Programme Director, commenting that we would have to go back to the time of Brunel to find a project as complex as the Elizabeth Line. The journey time from Heathrow Airport to the City of London will be under 30 minutes. Key main line stations will be connected to the West End, the Square Mile and the new business district of Canary Wharf.

Attention then turned to the trains required. A £1b contract had been awarded to train builders Bombardier at Derby, to produce the 594 carriages required.

Viewers met Martin Wilson, Chief Engineer for the project (at Bombardier). He explained that the firm had two years to design, build and construct the fleet. (According to the voiceover, all being done by Martin, which your reviewer would question!). If any deadline was missed, there were severe financial penalties and it was vital to deal with any problems arising very quickly, as making alterations to the finished fleet would be very expensive and time consuming. The stakes were high indeed!

The trains had to be capable of 90mph and were over 200m in length. They were constructed very largely of aluminium and had a capacity of 1,500 passengers. Full air conditioning and passenger information systems were provided.

We were then introduced to Kane Jelleyman, the Production Manager. He informed us that these were the largest underground trains to be seen for a long time. (Your reviewer got the impression that he thought that the Elizabeth Line was actually part of the London Underground). Kane demonstrated how the assembly line commenced with the underframe, to which the roof was then added. Finally, the two sides were fitted, to complete the basic carriage. Kane was a fourth generation train maker, following in the footsteps of those before him. The works had started back in the 1840s making steam trains (*did they really mean locomotives?*) and, by the 1920s were producing some 40 each week.

A visit was made to Bombardier by John Hunter, head of Design at Transport for London. John has responsibility for all aspects of design for TfL and this includes trains. He was shown a mock-up of a finished carriage and made one or two points of concern he had about some aspects, including the distance some standing passengers would find themselves from a convenient grab rail. He found himself 75 per cent happy with the mock-up, as seen.

We were advised that there were some 125,000 components to each train. We saw a cab front being brought to join its carriage; this weighed some three tons and contained some £0.75m of electronic components. Viewers also saw a test being made to check if a carriage leaked, by spraying it with water – it was essential that water did not leak into the carriages, as each train contained more than 93 miles of cables and 43,000 connectors. It must be watertight. The leak found was rectified.

The scene then moved to Tottenham Court Road station, which, when the tunnelling work was in progress had been called 'threading the eye of the needle' with the Crossrail tunnels having to make their way between the existing underground railway and passageway tunnels. We met David Crabtree, Project Construction Manager Tottenham Court Road Station. He described the complexity of this part of the project, competing with shoppers, buses and taxis to complete two large ticket halls and associated works between them. It was like building something the size of an aircraft carrier while all around continued their lives. As the holes to contain the ticket halls were constructed, the amount of earth removed would fill 18 Olympic sized swimming pools. As the holes got deeper, massive 35-metre props had to be inserted to keep the surrounding earth from collapsing whilst the walls were built. At the end, these props had to be very carefully removed, once there was no danger of the constructed walls themselves collapsing. A monitoring office was on site, with 180 gauges from the surrounding walls and earth connected to it. Once the props were to be removed, any movement in either the walls or the earth could be quickly detected, before any damage took place.

Viewers were present to witness the removal of the first 'prop', keeping the constructed walls apart. Edel Power, Temporary Works Engineer Tottenham Court Road station, explained the procedure, assisted by Tim Harman, Project Engineer Tottenham Court Road station. The need was to remove the pressure on the 'props' a bit at a time, so that the monitoring equipment could register any changes in pressure on the walls. In the monitoring office, we saw a graph on a computer screen, with the permissible limits of movement indicated by yellow and red lines. If the system moved towards the yellow line, investigations had to be made of the worsening situation – if the registrations moved

towards the red line, work had to cease immediately. In the period (for the removal of the first 'prop') viewers were present, there were only very small movements on the screen, thus no problems.

The prop was removed by cutting out small sections of it, about six inches square. This process was repeated until a complete section of the prop had been removed. The cutting process used a combination of oxygen and propane and reached some 2,500 degrees centigrade. Once a section of the prop had been cut out, it had to be very carefully craned out, as hitting any of the remaining props could, fairly obviously, possibly trigger a disaster! Once the first prop was removed, there were just 39 more to go.

With just eight months to go before the first trains were to run, we met, once again, John Hunter, head of design at Transport for London (see also above). One of John's tasks was to add the Elizabeth Line to the existing tube map. The iconic map, so familiar for many years, had been invented by Harry Beck, a draughtsman in the signal engineer's department back in 1931. During a period of redundancy, he had studied the maps of the day, which were all totally geographical in nature, following the patterns of the streets above the rail lines; he felt that they lacked a measure of clarity. Harry designed his version of the map following the way that electrical diagrams were produced and kept lines to vertical, horizontal and 45 degree components. This was all explained to us by Elizabeth Scott, Head Curator at the London Transport Museum. John Hunter drew attention to the area around Euston/King's Cross, which he found particularly problematical to resolve. Elizabeth told us that she believed that Harry Beck had struggled with the very same problem for over a quarter of a century! John was left to face the problem of squeezing the Elizabeth Line on to the map, whilst making it still as recognisable as possible.

The scene now moved to Paddington, built over 160 years ago by Isambard Kingdom Brunel and now serving some 100,000 passengers each day. We met David Shepard, Site Manager Paddington station, who told us that this station presented quite a challenge. A new ticket hall, 260m in length by 25m in width, was in course of construction. This would require removal of earth amounting in volume to 44 Olympic size swimming pools. Above this was to be a ten metre tall steel canopy, with a glass roof, which would permit daylight to reach the Elizabeth Line platforms.

The need for construction traffic and consequent road closures has caused problems for some of the existing station's traders. Viewers were shown members of the construction team 'loaned out' to assist delivery lorries getting their wares to the traders concerned – we saw them helping roll barrels of beer from the lorry concerned to a drinking establishment, receiving its weekly supply of alcoholic beverages! Wooden objects, similar to house bricks in shape, had been found during the construction work and these were thought to have formed the base of the station's approach roadway, constructed in that manner so as to partially silence the horse's hooves during night time deliveries of foods and drinks, back in the Brunel era!

To clad the walls of the ticket hall area, 103 panels of pre-formed bricks were to be positioned. Each one weighed some ten tons. Because of obstructions, not all of these could be craned directly into place. The answer was to provide a 'vertical railway', so the panels could be lowered and then 'skated' along the 'railway' into position. The final panel fitted with just a few centimetres to spare on either side. Eastbourne Terrace had to be closed each night, to allow the crane access, though then only for about seven hours.

Viewers were now taken back to the Bombardier works at Derby, where they once again met Kane Jelleyman, Production Manager. He told us that there were 594 carriages to be produced, giving 66 trains in all.

John Hunter, TfL's Head of Design, returned to Derby. He pointed out one or two small items to Kane, but was generally impressed with the trains. Each train was subjected to a 'cold' test, where the temperature was reduced to -25 degrees (whether Celsius or Fahrenheit we were not informed, and there is some difference!). Viewers were also told that the trains were tested at top speed. Earlier we were informed that the top speed was 90 miles per hour (see above). Your reviewer questions whether anywhere near such a speed could be achieved on a test track that certainly appeared to be in or near the Derby works, unless it was at least some miles in length!

We now returned to Tottenham Court Road and met David Crabtree, Project Manager there. It had taken 26 weeks to remove the 'props' at this site (see above). Much of the work on platforms, subways etc., was now completed and one major task left was to provide the roof to the booking hall, which had been designed to have a spacious feel to it. This had meant that support pillars had been kept to a

minimum, but the need for a seven storey development of shops and living accommodation then meant that the roof had to be extremely strong. It had to support the structure above it, with little more than the walls of the booking hall to take the huge weight involved. The answer to this problem was that the roof would include 'tendons', these being thick cables, encased in tubes, and running north to south and east to west across the roof. Once these were installed, reinforcing steel was laid and then, finally, all was concreted into place. A complex logistical operation was needed to ensure that the 33 lorry loads of concrete involved kept arriving continuously, as it was essential that there were no joins in the roof, which would provide points of weakness and lead to a possible future collapse. The cost of all this amounted to £10m.

We then met Marijan Harris, Site Engineer Tottenham Court Road station. He emphasised that once the concrete pouring was started, it just must not stop, so there were no 'second chances'. Eight lorries an hour would deliver the concrete and two pumps were used in the pouring. At roof level, one man was directing the flow whilst two others assisted in bedding it down and ensuring that all 'nooks and crannies' were filled. The concrete would set in just two hours from leaving the production site, which was some two miles distant. Lorries regularly arrived with more concrete and, following a slight hitch, viewers saw several lorries parked in a 'holding area'. Luckily, this delay did not cause any lasting problems.

It took six days for the concrete to set and Marijan felt, upon inspection, that everything had worked and the completed roof was meeting expectations. The station building, finished in black and gold, would include apartments, retail units, offices and a theatre.

Crossrail, we were informed, has seen a massive regeneration of the parts of London through which it passed. In some areas, property prices had risen by half as a result of the project. Not everyone welcomed this aspect. We met Dusty O, a former club promoter and drag performer who lamented the loss of many of the shops in the Soho area, as a result of the price increases meaning owners could not afford to remain there. In the last ten years or so, about one-third of the shops in Soho had closed. He felt that Soho now just looked like any other part of London.

The scene moved to London Underground headquarters at St. James's Park, where John Hunter (see above) was discussing how to fit the 96km Elizabeth Line on to the existing tube map with Alan Foale, from the design team. It could not be one straight line, which might have been preferable. It had to bend, as also had the Central Line, to make room for it.

Returning to Paddington, we saw the last of the panels of 'pre-formed' bricks (see above) being gently lowered into place, completing some five weeks of night shifts involved in this aspect. David Shepard, Site Manager (see also above) thought that Brunel would have been proud of their achievement!

Retaining the connection with Paddington, artist Spencer Finch and architect Richard Brown were discussing how images were to be embedded in the glass roof panels. Due to the transparency and translucency of the glass, a 'cloud' feature had been decided upon. The only factory capable of manufacturing this type of glass was in Weinberg, Germany, which Spencer and Richard visited to try some different patterns of possible finished work. They had a crane raise some trial sections of glass ten metres into the air above them and thus could observe, against a background of real sky, the visual effect, just as it would appear at Paddington. The most effective piece was then selected for the roofing glass sections. Each piece is heated to 300 degrees (as this was in Germany, your reviewer assumes this was Celsius), so as to bake the ink used into the glass, the heating also serving to strengthen the glass.

With only weeks to go before the first Crossrail train commences test runs from Liverpool Street station, the project is on 'the home straight', quoted Linda Miller (see beginning of review of programme transmitted on 22 May 2017). Amongst many tasks still to complete there are still over 20 platforms to fit out, 70 escalators to be installed, ticket halls to be painted and furnished.

The programme finished at Liverpool Street, where the first phase of the Elizabeth Line will commence, with an overground section. We observed the first test train running in and leaving, commencing a series of (empty) test runs. The driver regarded the stock as an improvement on the existing trains and John Hunter, TfL's Head of Design seemed satisfied with the completed train. Simon Wright O.B.E., Programme Director, told viewers the whole project was "a glowing example of modern British engineering at its finest".

This was an extremely good production by Windfall Films (dated MMXVII – 2017). Your reviewer could find no serious fault with it, though there may well have been some, in aspects with which he is not familiar?