SOCIETY SECTION
REPORTS OF SOCIETY MEETINGS
THE Q STOCK RESTORATION PROJECT – AN UPDATE
by Geoff Thorne, Technical Leader, Q Stock Project
A report of the LURS meeting at All Souls Clubhouse on Tuesday 14 January 2020

Geoff began the meeting with his career history. In 1968 he joined London Transport as a graduate trainee in the Rolling Stock Department. He spent 16 years with London Transport working through the Control Section (alongside Bob Greenaway) then promotion to Electronic Development Engineer. After those 16 years he went into electronic manufacturing and then travelled the world and the UK as a railway consultant. After that he worked for Railtrack and Network Rail as a Safety Systems Manager for the Train Protection and Warning System roll out. He then became a Principal Inspector for the Rail Accident and Investigation Branch which was one of the most beneficial times of his career.

WHY IS THE Q STOCK IMPORTANT?

It begins with the American connection and its key individuals. Thomas Edison (founder of the General Electric Co.), Charles Tyson Yerkes (financier) and Frank J. Sprague (enabled multiple unit trains to operate). In America before the turn of the 20th century, a lot of cities had rapid transport systems based on elevated structures. A slide was shown of the New York Elevated Railroad. American cities were using these constructions well before electric traction came into being. The steam locomotives were small, smaller than Met. No.1. Geoff then showed a film by the Thomas Edison Company that showed what it was like for those elevated trains in New York. This is where electric traction started in America. The steam operated elevated railroads had fundamental problems that limited their development as ridership increased.

- The elevated structures were only designed for small light locomotives.
- When ridership increased or extensions with steeper gradients were planned the original locomotives were unable to cope.
- Bigger locomotives could not be used due to weight restrictions, curves imposed by the elevated structures and very limited coal and water capacity which required regular replenishing.
- The only solution was more trains but that was limited by the signalling.
- Electric locomotives were proposed but they had some of the same problems as the steam ones, UNTIL –
- Frank Sprague invented multiple unit controls for electric traction.

A slide was shown of a demonstration run on the Chicago South Side Elevated Railroad in June 1892. This was the first use of Sprague's multiple unit control system. On the same slide was a District Railway A Stock of 1903 to show the similarity. This was followed by a Chicago, Aurora and Elgin car of 1902 with a District Railway B Stock of 1905, again to show the similarity.

Geoff then went through some electrification statistics:

- On 7 and 8 November 1899, the first experimental electric train ran between Earl's Court and High Street Kensington.
- But in the USA at the beginning of 1900, matters were markedly different. 2,107 route miles of electrified interurban track was in operation. By comparison in the UK, the newly formed Southern Railway in 1922 had 2,114 miles of track, mostly unelectrified. It was not surprising that investors looked to America for the technology and expertise to run electric railways.
- It would not be until 1903 that the District Railway A Stock appeared.
- By 1916, the electric interurban trackage in America had increased to 15,580 miles!
- At nationalisation in 1948, British Railways route mileage was about 18,000, today the figure for Network Rail is 10,072.

We may have invented the railways but it was America that developed electric traction.

Geoff then showed comparisons between the Chicago Aurora and Elgin Railroad car and the Q38 car. Underneath the bodies they are very similar. The Traction Contactor Interlocks on each car are virtually identical. The Chicago Aurora and Elgin parts date from 1913 and the Q38 from 1920. Although the Q38 car was built in 1939 the parts were re-used from earlier scrapped cars. The design goes back to before 1913. The Q38 car is really a direct development of early American electrical traction. Geoff

couldn't think of another train in the UK that, when it was back in running order, people could ride on using equipment designed in America before the First World War. Geoff then showed the vehicles that complement the Q38 Driving Motors 4416 and 4417. These were the Q23 Driving Motor 4184 and the Q35 Trailer 08063.

CHALLENGES:

- It's not like the 1938 Tube Stock that the museum operates, which has been retained in 'as withdrawn' condition.
- The Q Stock project is much more complex and technically challenging.
- None of the cars are complete. Some electrical, mechanical equipment and saloon fittings are missing or damaged.
- All cars have features that need to be altered either for safety or to make the train operable on a modern railway.
- Many technical documents have not survived.
- Design information about the electrical equipment is rare. Companies were very secretive about their products.
- Clear original photographs of the inside of the cars are difficult to find, especially colour. The intention is to restore each car at a different period of time. The Q35 car will be restored to the condition it was in at the outbreak of the Second World War and will include the first class compartment. When the war started, this compartment was removed. Q38 4417 will be restored to about the 1946 period and 4416 to 1954/56. The date for 4184 has not been finalised and is still under discussion.
- It is the first time the museum has used volunteers to undertake such a complex restoration but over the years confidence has been built up in the team. We are the third group aiming to restore the train to operational condition.
- There is the ever present task of ensuring enough skilled volunteers are available not to mention matters of time space and money.
- Working conditions at the depot pose some limitations with no pit, lifting equipment or heavy workshop equipment.
- Some of the money spent so far has gone on equipment and tools such as a grit blaster, table saw and hand tools.

***Above**: The Museum's former G Class, now Q23, 4184 in Acton Works. Following withdrawal from the District Line, the car was displayed outside the GRC&W Co. factory in Gloucester, but without its traction motors or compressors, leaving LT on 20 January 1972. When the Gloucester factory closed, the car was put into store before returning to Ealing Common depot on 27 February 1993 for preservation by the LT Museum. It was taken from "The Depot" at Acton, to Acton Works by road on 14 September 2009 for restoration work to begin and returned to "The Depot" on 8 May 2017.*

Photo: Geoff Thorne/LT Museum

WHAT IS THE HISTORY OF THE PROJECT?

Trailer 08063 was purchased for preservation by the LURS.

After withdrawal 4416 and 4417 were used as Pilot Motor Cars, shunting in Ruislip Depot and transferring stock between depots:

- They had some equipment removed including door controls, door engines and interlocks.
- They were painted yellow!

During the 1980s and 1990s 4417 received attention from apprentices working under Gordon Hafter and Bob Greenaway:

- Flooring was replaced.
- Paint was removed from marquetry panels on seat backs.
- 4417 was repainted externally and inside the saloon.
- The WT54B traction motors were also overhauled by a contractor.

Following Bob's death the project became less of a priority for the museum and work ground to a halt. A second attempt to continue the restoration started some years later, including significant planning and assessment of the project and an approach to secure Heritage Lottery Funding:

- Metronet provided a guesstimate of £2 million for the restoration of the three-car train.
- The Lottery submission was unsuccessful.
- There were increasing concerns about electrical safety and asbestos.
- Asbestos removal was undertaken on 4417 and 08063.

- The museum veered towards a cosmetic and non-operational ‘platform experience’ restoration.

Bob Bird (Senior Curator at the museum) initiated a re-invigorated approach to restoration in about 2011, recruiting Geoff in 2012:

- This involved arranging a complete truck overhaul, for cars 4416, 4417 and 08063, at Acton Works.
- Bob was successful in finding a team who could become involved in continuing the restoration to operational status. There are five in the team who meet on a Thursday to undertake the work. A mechanical engineer, two electrical engineers, an ex-driver trainer and an occasional carpenter. Hopefully the team will be increased in the future.

A significant amount of work was necessary:

- Planning the technical approach to restoration, addressing missing equipment, equipment overhauls and repairing rust and decay.
- Designing new circuits for electrical safety and the proposed increase in traction voltage from 600 to 750.
- Preparing overhaul specifications for work that could not be carried out at the museum.
- Reclaiming parts from A,C and D stock as they were withdrawn. Parts that were not necessarily identical but could serve the same function.

RESTORATION OVERVIEW

Q35 TRAILER CAR 08063

After withdrawal, 08063 was purchased by the LURS and spent time at Ruislip and Ashford Steam Centre before returning to London. Between 2010 and 2012, Acton Works undertook a full truck overhaul. It is planned to restore the car to 1939 condition with first and second class saloons. A lot of further work is needed:

- Full door overhaul – many doors are immoveable.
- Changes to the lighting circuits to operate from a safe voltage.
- Replacement of heating and lighting contactors.
- Overhaul of the braking system, air reservoirs and fuse boxes.
- Replacing the floor and seat moquette.
- Refitting first class saloon doors.

Geoff then showed several slides of various parts of 08063. The inside was first and Geoff commented that it looks a good serviceable vehicle. However, views of the door equipment and wiring showed that these were not in such a good condition and need a lot of remedial work.

Next was the under seat fuses and heaters. The wooden box containing the fuses still has an asbestos lining which was missed on the earlier strip. The auxiliary equipment case was shown which has had some new wiring added by Acton Works, but there are lots of parts missing, lots of rust and decay and lots of cables that need new terminals on.

***Above**: Rescued for preservation by the LURS, and with a lot of work done on it by a small group of dedicated volunteers, 08063 was donated to the LT Museum on 3 September 1997. Further work was undertaken at Acton Works, where it was located from 14 September 2009 until 10 April 2012.*

Photo: Geoff Thorne/LT Museum

Q38 DRIVING MOTOR 4417

A significant amount of work has been undertaken since 2012 on 4417 including:

- Repair of rusted floor.
- Re-instatement of missing guard's panels.
- Re-instatement of lighting with LED lamps, new glass shovel shades and new stainless steel holders.
- Replacement of burnt out cabling.
- Overhaul of door engines, door suspension brackets and tracks.
- Replacement of missing door engines and valves.
- Overhaul of main contactors.
- Overhaul of all cab equipment.
- Replacement of missing strap hangers and window trims.
- Conversion of 600V control circuits to 50V operation.
- Overhaul of CP30 compressor.
- Drawing up a contractor's overhaul schedule.

Geoff advised that they had concentrated on the restoration of 4417 so that they could learn about the technical issues and processes and apply these to the other cars in the train to avoid a piecemeal approach. The museum has set up a research group using volunteers to collect historical and technical information and knowledge, to assist in the restoration. Some new skills are having to be learned plus old ones re-learned. They have had to develop a technical approach for major changes to the electrical circuits, traction voltage increase, how asbestos is replaced, rust and decay, damaged worn and missing parts and cab signalling. They have drawings which date from 1937 but many have not been updated as modifications were made, so far they have had to produce over 90 new ones. Few records of how to set up and maintain equipment exist and manufacturer's information is very scarce.

***Below**: Looking at the guard's control panels on Q38 DM 4416. The handbrake is to the right of the communicating door. The draught screen woodwork is looking especially smart.*

Photo: Geoff Thorne/LT Museum

Q38 DRIVING MOTOR 4416

Very little has been undertaken so far on 4416 but that is about to change. Asbestos removal has started and when asbestos free it will move into the depot shed to enable restoration work to start. Some work has been done on several items of equipment but access has been limited due to the asbestos.

Some of the overhaul work cannot be undertaken or managed by the volunteer team at the Museum Depot including:

- Lifting the car for a full underbody inspection.
- Non-destructive testing on many safety critical parts: air reservoirs, structural components, bogie centre castings, couplings etc. None of the volunteer team are certified to sign off safety critical parts.
- Installing new or replacement conduit, power cables, ribbon fuseboxes and new translator contactor cases.
- Installing a motor alternator on 4416.
- Overhauling some electrical and braking equipment.
- Undertaking the restoration of the things the volunteer team haven't completed!

Outside contractors will therefore be needed to carry out this work. Geoff would like this to be Arlington at Eastleigh as they have experience of LU equipment and have a 4-rail test track.

Q23 DRIVING MOTOR 4184

4184 poses the biggest restoration challenge of all, as so far it is not funded and will cost a lot more than the other cars to restore. £600,000 is available for a three car train and some of this has been spent already. After withdrawal, London Transport sold it to the Gloucester Railway Carriage and Wagon Co. Further work is required:

- Internally it is virtually complete.
- Many electrical parts were removed by LT (reason unknown), including both traction motors, all the main contactors and circuit breaker.
- For many years, it stood in the open so rust and decay have taken their toll on the structure.
- It has lots of asbestos.
- There are many unknowns about the structural condition of 4184 but it is likely that everything can be fixed, given sufficient money.

- For the missing electrical equipment, the team obtained various items from Standard Tube Stock motor car L130 before it was scrapped, including complete motor truck with WT54A traction motors, which can be made to fit the A2 truck on 4184, and a complete set of main contactors, circuit breaker and reverser. These contactors are essentially the same as those on Q Stock (DB260 and DB260 version 2 respectively). A number of new simple linkage parts will be required to fit the interlock blocks behind the main contacts rather than below.
- The condition of the cable insulation is unknown.
- It is do-able!

Geoff then went on to talk about the CQ Proposal. Geoff didn't know of anybody else who had heard of this. In 1962, to meet changing demands on the District Line, the Chief Mechanical Engineer's Department came up with the proposal to couple Q38 trailer cars and CP units together. It involved: significant changes to the electrical circuits, redistribution of some equipment on the underframe and fitting Q38 trailer cars with spring buffers at both ends. The project has decided to adopt some of these ideas to enable the Q Stock to operate again. Geoff assured the meeting he was not making this up and showed a slide of drawing number 44389 dated 19 October 1962 detailing the proposal. The train was to consist of a CP motor car, a COP trailer, a CQ trailer and a CQ motor car. On other drawings, parts on the underframe of the motor car are moved to the trailer car. They had to make the same changes to the control circuits that the current project is having to do, i.e. change to 50V from 600V.

CHANGES TO ELECTRICAL CIRCUITS TO ENABLE FUTURE OPERATIONS.

- It has been decided to remove all the traction level voltages in the cabs and saloons apart from the heaters.
- Re-purposing high current cables that ran along the train.
- Fitting a motor alternator to 4416 to charge the batteries.
- Replacing damaged cables.
- Overhauling equipment.
- Replacing fuses and removing asbestos.
- One of the most significant changes has been the need to operate on the new (4LM) 750V system. Originally the trains were designed to operate on 600V supply with a minimum voltage of 450V and maximum of 660V.
- For the new high voltage railway with regenerative braking from the S Stock, the (BS EN 50163 and LU) limits are: maximum permanent voltage 900V and maximum non-permanent voltage 1,000V (30 seconds duration).
- The Q Stock will also need to operate over parts of the Piccadilly Line which, for the time being, will be at 600V.
- Hence the Q Stock will have to operate from 450 to 1,000V, quite a challenge for equipment designed over 100 years ago, but Geoff thinks they can do it.
- All cab controls have been converted to 50V.
- The most sensitive parts of the traction equipment are the main contactor control resistors and their coils. Increasing the voltage from 600V to 900V would lead to 2.25 times the amount of heat being generated. This would stress electrical insulation leading to failure. The air gaps in parts such as the master controller and other control switches are totally inadequate, by modern electrical standards, for use at 1,000V. As mentioned earlier, the decision has been taken to eliminate all traction voltage circuits above the underframe except heater circuits. Space will be needed for eight translator contactors to convert 50V control signals to the traction voltage needed by the contactors and reverser.
- The power and control circuits for Q Stock and Standard Tube Stock were very similar. They both addressed the problems of gapping of the leading motor car. Q Stock was fitted with a power bus line that ran the whole length of the train. This ensured there was little likelihood of interruption to traction power or control voltage when travelling over conductor rail gaps. The Standard Tube Stock didn't have a power bus line but a 'Other End On' switch to provide 600V power from the rear of the train. Also, a 'No-Volt' relay was required to limit traction motor electrical surges and jerks at gaps. For Q Stock operation, the power bus line will be isolated as they are not permitted on the modern railway. A 'No-Volt' relay will be fitted to the traction equipment and 50V control voltage will eliminate the need for 'Other End On' switches.
- A new ballast resistor will reduce coil heating in full series and full parallel conditions.

- The motor alternator fitted to 4416 will be from D Stock which Vivarail are kindly supplying. Put simply, the alternator is a rotating machine where 600V goes in at one end and 50V comes out at the other end.
- Cable insulation: All the cars retain much of their original cabling insulated by Vulcanised India Rubber (VIR). This insulation, especially in house wiring, is known to deteriorate over time. On the Q Stock, this is caused by copper migration (which is controlled by tin plating on the conductors), exposure to heat (e.g. from resistance grids) and exposure to ozone (e.g. from the opening of contactors and interlocks). Degradation takes the form of brittleness, ultimately reaching the state where the insulation will crack when bent. Thankfully, the VIR cables on the Q35 and Q38 cars were to a very high specification and do not show signs of significant deterioration. Where they are serviceable, they will be retained. Many cables on the Q38 cars were rewired with Butyl/CSP control cables during the late-1960s.
- Marker Lights: when the train is eventually operated it will need head and tail lights. The intention is to use D Stock style lamp clusters which will be temporarily mounted on the headstock via a plug/socket so they can be removed when on static display.

REPAIRS AND OVERHAULS

Next, Geoff had a sequence of slides showing work being carried out. These included:

- Control resistors that are being repaired in house.
- Master controller before and after restoration.
- Door engine.
- Traction interlocks (the mouldings have a small asbestos content which is being painted orange. Anything painted orange will signify to future LU maintenance teams that care should be taken to examine for any damage).
- Floor of door pocket being renovated.
- Saloon lighting. Originally the lighting operated at 600V but if a lamp was removed or broken the 600V electrical contacts would be accessible, which is obviously rather hazardous. The lighting has been rewired to operate from 50V with LED lamps. The Art Deco shovel shades were specially made in China. Why China? A UK supplier quoted £6,000 for the steel mould and £40-45 each for the shades. The Chinese supplier quoted US$1,450 for the mould and less than £9 per shade.
- Strap hangers. There is a part at the end that covers the fixing arrangement, requiring restoration. Only a few of these were available so silicon rubber moulds were made from these and new replacements cast in black polyurethane resin. The originals were Bakelite, which is a material you can't get moulded easily today.
- Window trims. There were brass covers that went round the bottom and top of the brass window pillar edges. Again, a mould has been made to produce these in polyurethane resin.
- CP30 Compressor. Shown before and after restoration by Lancaster Engines. It is now running beautifully.
- Ribbon fuses. Work hasn't started on these yet.
- Main switch. This was missing on 4417 so a new box and switch has been made.
- Guards end of 4417. All the panels had been removed to be used on 1972 MkII Tube Stock. Unfortunately, the cables had been cut and it took Geoff about three months to trace all the wires – 63 on one side and 48 on the other! The control switch, from CP Stock that Bob Greenaway managed to obtain, is now restored to operating condition.
- Circuit breaker and accelerating relay.
- Auxiliary equipment case before and during renovation. There are cut wires, fuseboxes and fuses missing and contactors needing overhaul or replacement. The brake retarder relays have been overhauled.

OPERATIONS

Geoff's next slide showed the possible train formations when operating. Power bus lines between motor cars will be isolated on LU tracks. This will be achieved by blanking off some of the power receptacles on the car ends – the west end of 'A'-end motor cars and both ends of 'D' motor cars. Auxiliary power will still need to be carried from west end motor cars to the adjacent trailer for heating.

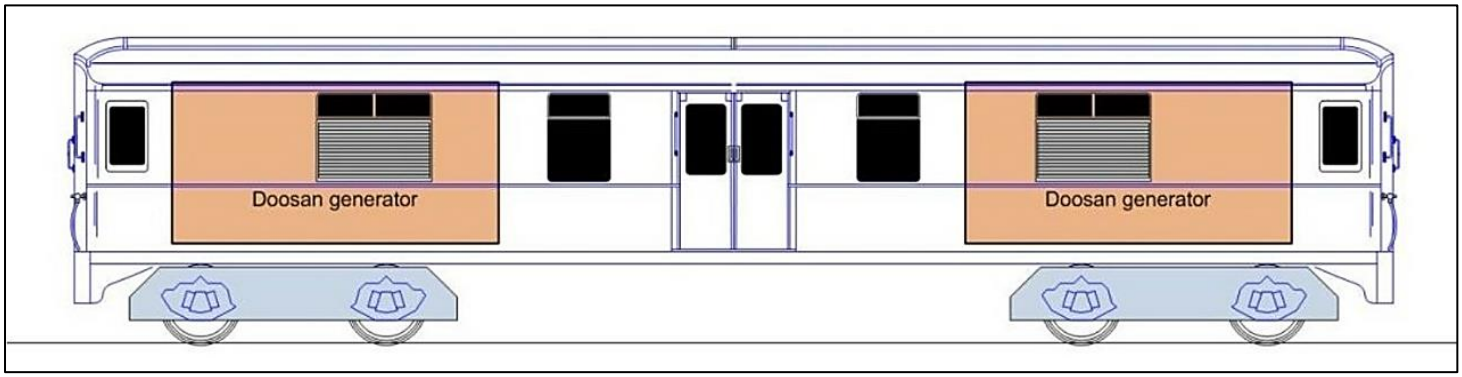
Cab signalling would be very expensive. Where cab signalling prevents operation of a manually driven train, one proposal was to use battery locomotive fitted with communication based train control equipment. An adaptor vehicle would be needed because of the different types of coupler (there are two ex-BR designed brake vans at Acton which could be used). In one direction, the battery locomotive

would lead and in the other direction the Q Stock. The Q Stock would need some additional displays in the cab. Geoff wasn't enamoured with this idea and hasn't given up on a better solution.

They also have ideas to take the unit to heritage railways hauled by a diesel locomotive, using one of the adaptor vehicles as mentioned above. Hopefully these adaptor vehicles will be overhauled soon. A quote was received a year ago but no action has been taken yet by TfL Procurement.

Another idea has taken inspiration from a group in France called ADEMAS (Association D'Exploitation du Matériel Sprague) that operates ex-Paris Métro cars. They have a very interesting site next to the Palace of Versailles, like the French equivalent of Longmoor. It is an ex-military railway leased at peppercorn rent to various railway organisations. They have made a tractor locomotive from two old vehicles and put a generator on it. They have also installed a second one inside the modified shell of motor car M340 dating from 1904.

Geoff then showed a video of the cars in operation, which is available on You Tube. Their generator powers the traction motors on the generator vehicle itself. The Q Stock team's proposal is to have a power generator car using the bus lines on the train to power the original traction equipment. Paris Métro never had the easy option of bus lines but the Q Stock has. The power generator car would be built on the underframe of A Stock trailer 6110 which they have secured at no cost from the Rail Adhesion Train. There would be a Q27 style body on the A60 underframe with two generators.



WHEN WILL IT HAPPEN?

- This is not in the control of the restoration team.
- Some major engineering work is needed that cannot be undertaken at the Museum Depot. This will be done by an outside contractor, which will be expensive.
- TfL need to confirm the technical overhaul specification and undertake the procurement process.
- The restoration team completed the overhaul specification in November 2017 but is still awaiting the issue of an invitation to tender for the work. Had this happened, Geoff thinks one or two of the motor cars could be operating today. The delay is the main risk to the project – nobody is getting any younger!

Geoff finished with a trivia question. What is the widest electric stock that has been operated by London Transport? It was the Q Stock at 9ft 8⅜ins.

Geoff was thanked for his absolutely amazing presentation and appreciation was shown in the usual way. There was just one question from the audience:

Q. Are you expecting to have any problems with clearance on the structure gauges?

A. We've had all four cars checked by the TfL route assessment department. Obviously they can only do static gauging at the moment but because of the type of suspension the opinion is there is no problem. There may be a few additional restrictions if we're ever allowed to run round the Aldgate area because there have been some platform edge alterations. If we could get a cab signalling solution, my understanding is that we could get to Upminster.

Maurice Lees