
# MetroNet brings 21st century technology to the Underground

*By Alan Barrow MRICS, FInstCES, ABA Surveying*

## ABA Surveying are using Laser-scanning to capture gauging data ahead of new rolling stock on the London Underground.

**Faced with a decision to introduce new trains by the year 2009 MetroNet decided on laser scanning technology to provide the survey data needed to begin the rolling stock design. The problem is that to maximise the size of the train it is necessary to know the size of the gap through which it must pass. The gauging of obstacles such as platforms, bridges, structures and tunnels needs to be known. All railway design and maintenance teams use gauging data and historical gauging information is available by the drawer full, but the problem is that it can become out of date as soon as it is published. Tracks are continually on the move as a result of maintenance, tamping, settlement and use.**

For London Underground, a hundred years of maintenance, renewals, additions and modifications have left a bewilderment of cables, lights, signals, electrical boxes and all manner of assets potentially reducing clearances. The problem is made worse by the fact that traditional gauging is, in essence, a profile measured at intervals along the track. Usually the interval will be every 10m or, perhaps, 5m in tight or curved alignments. Unfortunately, anything falling between these regular chainage intervals tends to get overlooked by the traditional profiling survey. MetroNet decided to take a different approach.

### Minding the Gap

There are many things which affect the kinematic envelope that a train will describe as it moves along the track.

*Laserscanning can capture point data from the track very rapidly, as these scans demonstrate. The image on the right which has been rendered is of a station, whilst that below shows the track and a train. The hard work comes in thinning the data to get usable profiles.*

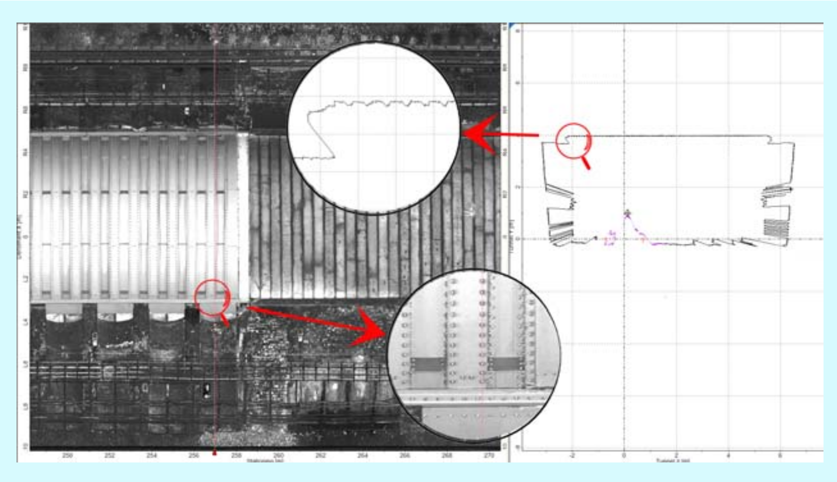
The aspects of data that the geospatial surveyor is required to collect primarily relate to the track position, cant, radius and minimum clearance dimensions to trackside infrastructure that might impact on gauging. These are evaluated against rolling stock design parameters such as length of coach, the design envelope, the position of the wheels and the wheelbase, suspension characteristics and the design speed using a software package called ClearRoute.

The package calculates the clearances between vehicles and the infrastructure, and between passing vehicles. It will also calculate stepping distances to platforms. The software can be programmed with the appropriate clearance standards, and be used to deliver Go / No-go or full reported clearance reports. Clearances may be defined in various positions, and according to defined failure-mode conditions. All that is needed is to collect the data for ClearRoute's database. The initial route priority covered in excess of 80 track kilometres and MetroNet had already started four teams of surveyors on the survey of the track position using Leica GRP3000 rail trolleys. Profile data was needed to merge with the track data to complete the input to ClearRoute.

### New Technology Provides the answer

Fortunately the requirement coincided with the introduction of new kinematic scanning technology from ABA Surveying and after field trials and evaluation ABA was appointed to carry out the work. Their technology is based on the Leica 4500 scanner mounted on a Leica GRP100 rail trolley and collectively known as the GRP5000 system. In this configuration the scanner is mounted on the trolley such that the scan direction is fixed perpendicular to the track. The scan beam rotates at 33 scans per second and is capable of recording 18,000 points in each scan although we only use 10,000 points in this application. Each point of the scan is recorded by the scanner to 3mm RMSE accuracy.

After initialising the start chainage, the trolley is walked along the track at circa 1km per hour. At this speed the forward movement is 280mm per second. The scanner measures 33 scans per second; therefore each scan represents a progression along the track of 8mm. Around the arc of the profile points are recorded every 2 - 5mm depending on the distance from the scanner. No detail is too small that it does not get scanned. The result is a point cloud so dense that it looks like a black and white photograph showing details as small as the rivets in the beams. And so it should at an acquisition rate of one point five megabytes of data per second!



*No detail is too small that it does not get scanned. The image above shows how much detail from within a tunnel is captured.*

## Cutting the problem down to size…

Obviously this wealth of data required considerable intelligent thinning to make it useable in anything less than a CRAY supercomputer. Part of ABA's task was therefore to reduce the data to a typical minimum profile corresponding to each 5m chainage. The data for 2.5 metres behind and in front of this chainage was used to create the minimum profile available to the train. In this way what amounted to 600-plus profiles were effectively reduced to just one but all the data was still used

ABA also wrote software to intelligently thin the minimum profile without losing its shape. After much experimenting a resulting profile of some 12-1400 points was considered the optimum solution. A considerable improvement on the 10,000 points originally selected.

## …and packaging the results

Finally ABA had to take the track data provided by MetroNet, attach to it the profile data that had been suitably corrected for cant, add in the obstructions falling between the tracks and then output perfectly formatted ClearRoute files. Again, special software was written to do this and also to output the ClearRoute data in AutoCAD format for quality checking purposes. Each profile has been visually checked for quality and flyers.

## Did it work?

All survey data was captured in five weeks of three hour "Engineering Hours" shifts. The result is a database of spatial information that includes all visible assets which can be interrogated at any time as required, to precisely measure or position or identify any one of them. If a tight spot is encountered by ClearRoute the database is there to identify the type of obstruction.

*On the open track the scanner measures and records all visible detail including trackside and overhead infrastructure.*
*If it's in the scan it has been measured to millimetres.*

**ABA Surveying, The Lansbury Estate, Lower Guildford Road, Knaphill, Woking, Surrey GU21 2EP**
**Tel: 01483 797111 Fax: 01483 797211 e-mail: alan@abasurveying.co.uk**