The Charles Close Society was founded in 1980 to bring together all those with an interest in the maps and history of the Ordnance Survey of Great Britain and its counterparts in the island of Ireland. The Society takes its name from Colonel Sir Charles Arden-Close, OS Director General from 1911 to 1922, and initiator of many of the maps now sought after by collectors.

The Society publishes a wide range of books and booklets on historic OS map series and its journal, *Sheetlines*, is recognised internationally for its specialist articles on Ordnance Survey-related topics.

Survey of Bicester Pioneer Square complex
Mick Upfield

Introduction

I was an Ordnance Survey (OS) surveyor with more than 39 years' experience. I started working for OS in April 1975 attending a nine-month basic surveyor training course. After that I increased my skills and knowledge through training and practice of graphic survey, air ground methods, Land Registry surveys and requisition replies, preparing Boundary Perambulation Cards in various office in West Wales and Southern England.

Prior to 1987 all survey work was drawn up on plastic Master Survey Documents but after 1987 survey work has been digitally captured and stored.

In 1996 I was introduced to a pen tablet to digitally capture simple line data in the field and this has now evolved into the data capture of today where line work is structured to form polygonised data that is attributed to reflect real world form and function.

I have seen survey instrumentation and capture methods evolve in that time too. I used to work in a team with two or three colleagues using Electronic Distance Measuring (EDM) that measured a laser beam reflected by a prism but due to manpower curs and better more sophisticated equipment I tended to work alone measuring from stations controlled by GNSS (Global Navigation Satellite System) and surveying using Remote Electronic Distance Measurers (REDM) which measure signals reflected off features. Although instrumentation and methods may have changed and is less labour intensive the theory is still the same. I still worked from a framework of known survey points to capture new detail. I also used GNSS for surveying new detail but often had to use a combination of methods due to limitations of that method when satellite signals were obstructed by tall buildings and trees.

I was responsible for updating the geographic OS MasterMap area covering Cherwell and parts of South Oxfordshire to OS specification as well as maintaining the associated layers of Address, Integrated Transport Network and Small Scales Intelligence Data to business defined timescales. I also attended to customer queries and responded to Land Registry survey requests.

I was a trainer and in that role I instructed in the use of the pen-tablet and how to incorporate the survey instrumentation to collect points and features and attribute them to current OS Specification. I wrote best practice sessions delivering to groups of surveyors highlighting specification changes and introduction of new equipment and software.

I was often involved in testing new software, hardware and processes feeding back findings to management verbally and in written form.

This case study describes a survey in June and July 2013 of Pioneer Square, Bicester which is a town centre complex consisting of a Sainsbury supermarket, a VUE cinema and a multi-storey car park along with other smaller retail outlets. For the survey I used GNSS, REDM and Graphic skills to update the OS mapping database. In the case study I demonstrate my competence in Mapping and

Measurement of Land and Property, surveying the site and attributing the line work and polygons to reflect real-world form and function and delivering that data to the current OS Specification.

Planning the survey

In June 2013 I accessed the Geomedia based planning tool known in OS as the Job Planning Client (JPC) navigating to the relevant survey job for Pioneer Square. Noting that it was due for survey I made a site visit. I contacted the site manager who informed me the first phase would be opening late July 2013. On site I confirmed that the footprint of data indicated in JPC covered the whole site. I ruled out using Remote Sensing due to time scales and the need for follow up ground completion, as many features would not be visible from the air due to overhanging rooflines. I decided to survey the site using a combination of GNSS, REDM and Graphic Survey methods for the following reasons;

⌡ GNSS for picking up control stations, new roads and pavements as it was much the quicker method of capturing features of this type to the relevant accuracy standards than REDM and Graphic Survey methods. However, I could not use GNSS for all points and features as the buildings at Pioneer Square were tall and close together raising the possibilities of multipath errors. These occur when satellite signals reflect or bounce off surfaces, increasing the distance they travel to the GNSS Receiver resulting in positional inaccuracies.

⌡ REDM from GNSS positioned stations to pick up all relevant observable points on buildings, fences and posts. The shapes of the buildings are irregular comprising of angled and curved outer walls with juts and recess making well-sited REDM capture ideal given the limitations of GNSS and Graphic capture. REDM would also keep me off the roadways avoiding site traffic.

⌡ Graphic Survey to complete the infill survey of features using short taped lines tying out to points and features captured by the other two methods.

While on site I noted the position for the REDM control stations but did not mark them on the ground as the site was still active and the position could be obstructed when I returned to carry out the survey.

Back in the office I updated the footprint of data I required using the raster back drop on JPC to reference it to local exiting detail.

Accessing the data

During the second week of July 2013 I accessed Job Explorer (JE), an ARC10 GIS software based tool that connects online to JPC, to extract the job item onto my pen tablet. JE is also used online to load the data into another ARC10 based tool, Object Editor (OE). OE is used to record the captured data on site

The survey control framework

I returned to the site and contacted the site manager who informed me that contractors were still actively using plant on site. I assured him I would continually assess risks and mitigate them by wearing the appropriate PPE and avoiding scaffolding and moving plant.

I use OE to load the data into a format to enable the capture of survey lines and to attribute them reflecting real world "form and function" as laid down in the Data Capture and Edit Guide (DCEG).

Once I had the data loaded on to OE I checked the accuracy region of the data by toggling the relevant button and confirmed that it had a relative accuracy of ± 0.42 metres root mean square error (RMSE). This means that all new points I captured should fall within 0.2m of existing detail and that any point under 0.4m would not need action to address the inaccuracy.

I set the tolerances on the GNSS ensuring I had a good RTK fix with a Geometric Dilution of Precision (GDOP) of 3 or less. This meant that I was receiving signals from a spread of satellites with good geometry enabling an acceptable level of accuracy for the captured survey points.

I walked the site and ground marked the positions of my REDM control stations ensuring where possible they were visible from at least two other stations to ensure accuracy. I also deleted demolished features from the map data.

The Survey

Using GNSS I measured local points of existing survey detail around the site to both check that the existing data fell within the acceptable OS tolerance for 0.42m accuracy regions and that the GNSS equipment was correctly capturing position in sympathy with the exiting data and without major errors that may result from, for example, equipment malfunction or multipath. The urban extent of Bicester was re-surveyed in late 1990s and my experience from previous survey tasks in the town had always confirmed the accuracy in Bicester to be within that laid down in OS Guidelines for a 0.42m specification region.

The results from checking the points around the site proved the same, but if any had fallen outside tolerance I would have made further accuracy checks radiating out from the site picking up and comparing additional old detail points until I had confidence that the original survey was within tolerance. I would adjust as little old detail necessary to retain geometric, relative and if possible absolute accuracies as moving old detail could have an impact on customers holding that data. Examples of geometric fidelity and generalisation on site can be seen in the following two photographs with the position and direction taken indicated on *Screenshot 1* by red arrows.

Screenshot 1

Photo 1

Photo 2

Comparing *Photo 1* with *Screenshot 1* shows that parallel features have retained their shape and *Photo 2* shows the real world gap between the trolley-shelter and wall is centimetres and in *Screenshot 1* that I have generalised the mapping to show just the trolley-shelter. Despite modern survey methods allowing more accurate data I generalised features conforming to OS specification rules. The rules are based on cartographic reasons and producing a consistent supply of data for customers.

I commenced picking up REDM Stations positions as well as ground features such as road casement and path edges and the old points of detail, taking care to level the GNSS pole, checking GDOP and avoiding using GNSS near buildings to reduce the chance of multipath errors.

To capture survey features using a calibrated Leica T106 REDM (T106) I needed to know station setup coordinates and the bearing to which I was measuring the distance. To do this I set up the T106 ensuring it was level and vertically above the initial station and observed to a known point of old detail that I had checked for accuracy earlier with the GNSS receiver on my recce. To check that the instrument was functioning correctly and to alleviate any observer error I took measurements to old points of detail and checked that they fell in the correct position. This proved the setup was correct.

I picked up points on building outlines, fencing etc. and also measured to the other visible stations around the site. At the end of each round of station observations I repeated the check measurement to relevant independent points to ensure the setup had not moved.

When I had completed observations at all station set-ups I was left with a framework of controlled surveyed points and features that I then completed using graphic methods. I used a tape measure, Leica Disto and optical square to run short survey lines between known points checking that the measured distances are within tolerance to the distance as depicted in the data and equating any errors over the length of the line. I took check measurements when convenient to

old detail to confirm accuracy and geometric fidelity. I also saved my work regularly to avoid losing data.

Due of the complexity of the site I needed to confirm that captured detail conformed to OS Specification as laid down in the DCEG. One example was to look up the depiction of spiral access ramps to the higher levels of the multi-storey car park (*Photos 3 and 4*). I had surveyed line work associated with the ramps using the REDM (*Screenshot 2*) and graphically in-filled the area but needed clarification about how to show it to current specification. The rules suggested it should be shown as depicted in *Screenshot 3,* i.e. with the different colours and line styles representing different feature codes such as solid building outline and overhead building outline
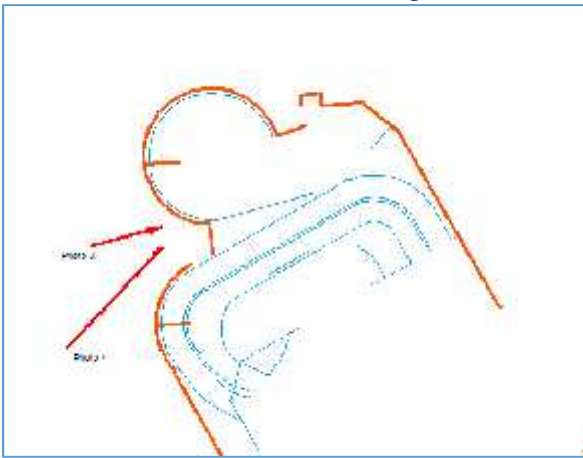
Screenshot 2
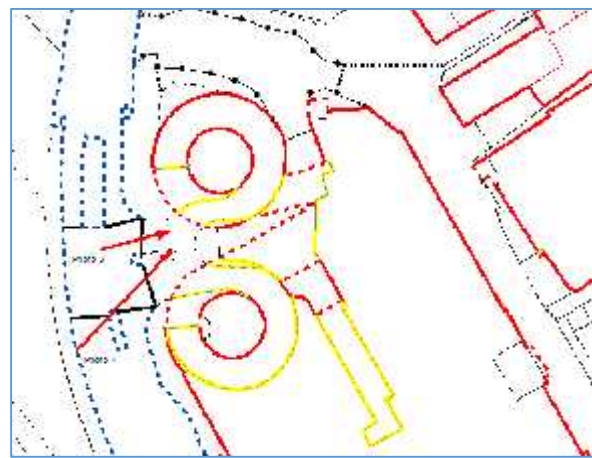
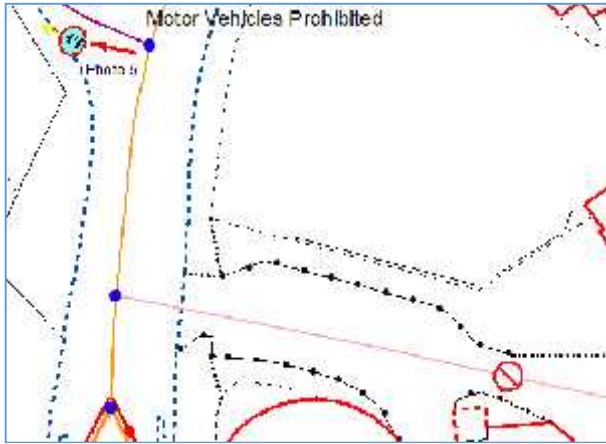*Screenshot 3*

Photo 3

Photo 4

It was at this stage I identified lines and areas that need to be obscured. These are features that fall under the roof line but are still shown in OS data. In Pioneer Square these included walls, paths and posts.

As well as capturing survey data I updated the Integrated Transport Network and Address layers that are part of the intelligent mapping product OS MasterMap. In the Integrated Transport Network layer, I added the alignment of roadways indicating by attribution that they had restricted access and were not publicly maintained. I collected the position of rising bollards, gates, turns and height width restrictions, one way systems, as well as classifying roads. Where
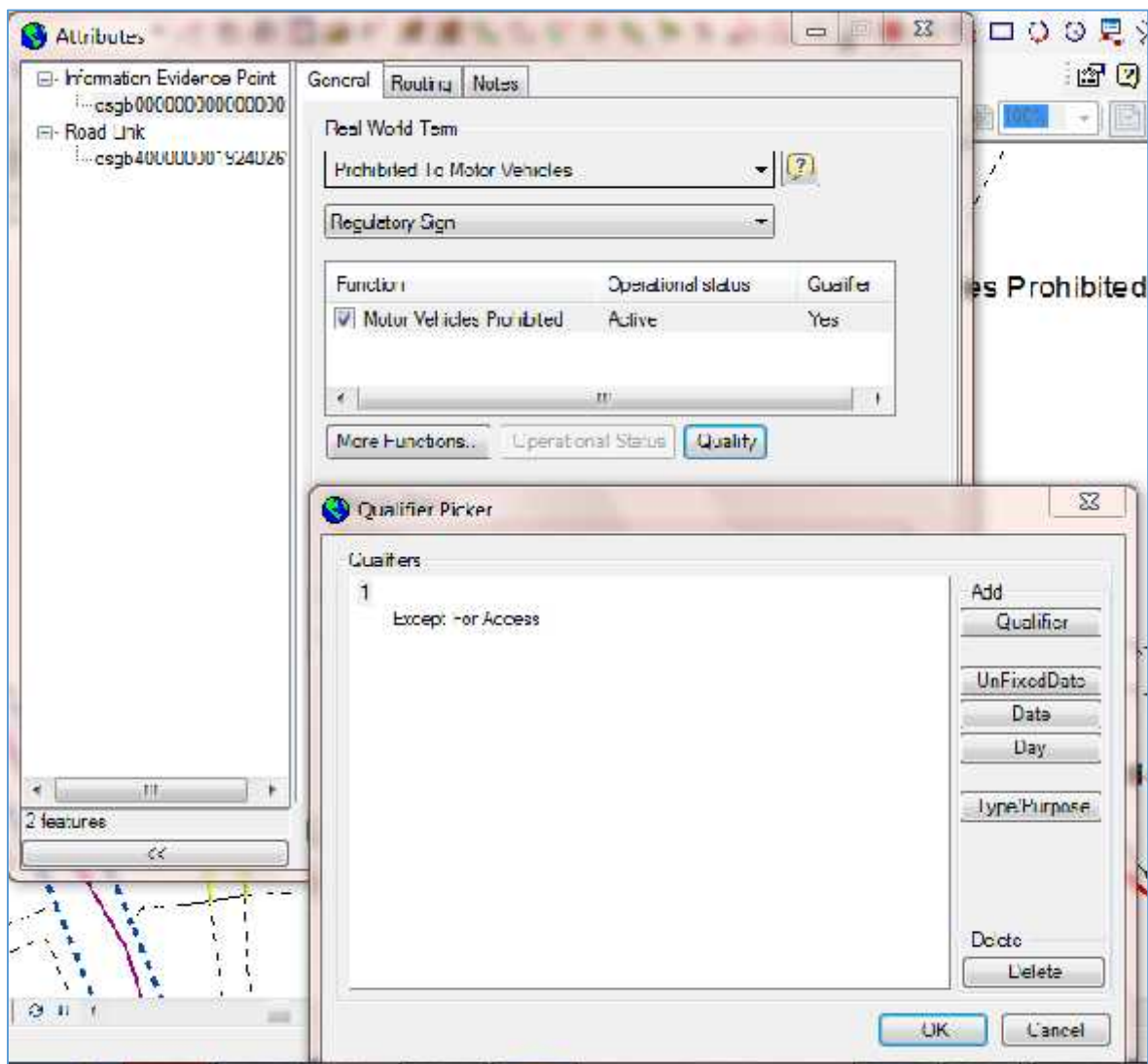
signage described restrictions and qualifiers such as time, type and purpose I collected those too. *Screenshots 4 and 5* show how I attributed a vehicle prohibition in OE and the resultant data of the sign in *Photo* 5.

Screenshot 4

Photo 5

Screenshot 5

Validation

Once satisfied that I had fully completed the survey and it was to specification, I ran the validation routine to structure lines and build polygons. This routine enabled closed polygons to be attributed and eliminated polygon bleeds polluting the data. Once this was completed and I had fixed all of the discrepancies indicated by the process I attributed the lines and polygons to reflect real world form and function such as edge of public roads and roofed structures made sealed surfaces and the like. I ran a final discrepancy check ensuring the appropriate attributed line work encloses each polygon and discrepancies had been resolved

I matched the outstanding addresses from the Postal Address File (PAF), to the appropriate Functional Site. A Functional Sites describes the main activity that occurs at a particular location and also holds proper name information including the evidence of how the name was collected.

I also updated Small Scales Tourist information for the car park which will be used on OS paper, digital and web based mapping products and services.

Before returning the data I ensured the routing layer was correct by toggling layers on OE to visually inspect the data and confirm road links and nodes had the correct attribution and that names were linked to the correct road link. I also confirmed that I had matched unmatched addresses and improved all the estimated positions possible in the editable area by checking the address file. It is important that all integrated products are updated and are compliant to OS Specification as customers depend on it for their requirements. Once satisfied I ran the job completion validation routine.

I submitted the job back onto the OS large-scale database, MAIA, through JE, where it went through further validation ensuring the job conforms to OS specification to supply to customers.

The result

Using change intelligence data in an off the shelf GIS Package I was able to plan and allocate my workload to complete the task. I was tasked to survey all new developments within six months of completion and I achieved this in Pioneer Square by updating the topographic mapping data to current agreed accuracies and specification. I also improved the address layer, drive restriction Information and small scales data making all data available to customers within agreed timescales and Service Level Agreements.