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"Bringing the past into the digital age"

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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.

Bringing the past into the digital age – the historical Ordnance Survey map scanning project at the Bodleian Library, Oxford

***Richard Harper*[1]**

Introduction

With the last issue of *Sheetlines*, members received a stunning reproduction Ordnance Survey map of the Crystal Palace. The copy of this map was produced thanks to an exciting project being undertaken at the Bodleian Library, Oxford. This article describes the origins and aims of this venture and how in the future it could benefit all map aficionados.

Through donations, and its status as a national deposit library, the Bodleian has acquired over time a wide range of rarities; historically important and beautiful documents. Among the vast number of collections is an almost complete collection of Ordnance Survey County Series maps. Included in the collection are maps dating from the mid-nineteenth century to the end of the Second World War, at scales of 1:500, 1:528, 1:1056, 1:1250, 1:2500, 1:10,560 and 1:63,360. These maps provide extensive and detailed information on how the country was shaped during the past in magnificent detail. The sheer size of the collection means that most of these maps have been seen only by a privileged few. A project currently being undertaken at the Library aims to change this.

Project beginnings

After successfully digitally capturing the Library's fourteenth century Gough Map, staff from Protinus Holdings remarked to Nick Millea, head map librarian, how useful it would be to scan the historical Ordnance Survey map collection kept in the Library's book stacks. No one present on that day realised how a passing comment would lead to the biggest single project the company and the library's map department had ever undertaken.

In January 2005 Protinus embarked on this ambitious enterprise to digitally capture the entire Bodleian Library collection of historical Ordnance Survey maps. The company felt that, commercially, there was a real need for high quality digital images of historic OS maps that could be used in various Geographical Information Systems (GIS). With a wealth of experience in digitising historical maps Protinus had the knowledge and expertise to undertake such an ambitious project. The aim of the venture was to scan every out-of-copyright large-scale historical Ordnance Survey map the Library held. This would provide the Library with a digital copy of each map that could be viewed by readers at the Library without the need to retrieve the original map. The company would in turn be able to use the maps for various commercial ventures.

At the beginning the project was housed in the depths of the basement at the New Bodleian Library. Equipped with only a single sheet-feed A1 sized

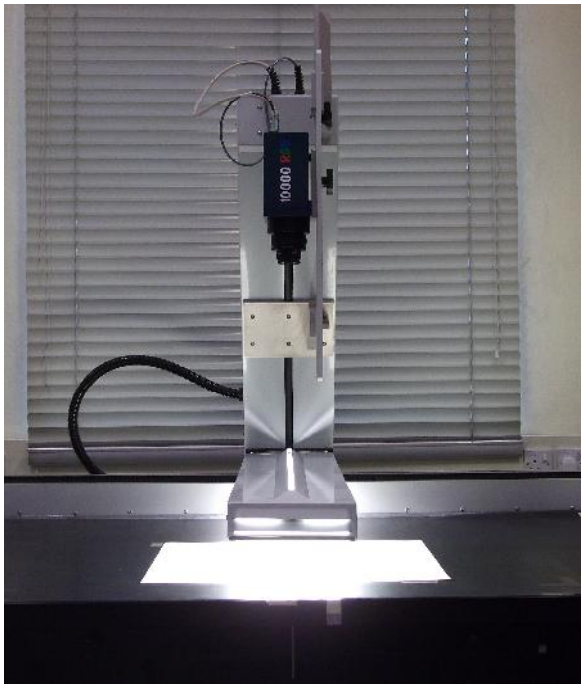
[1] The author is Prontius' project manager for the project.

scanner and a computer, no one had any idea how long the project would take. As the Library had received maps from the OS they had never been individually catalogued. The map librarians only had a rough idea of how many OS maps were in the collection. The enormity of the project still invokes a sense of awe within the office and at the time of writing Protinus is still based at the Library. The location may have changed, (the project is, ironically, now located in the old map reading room), personnel and equipment may have changed but we are still scanning!

Map cataloguing

With such a vast collection it soon became apparent that Protinus would need a dedicated map librarian to assist with cataloguing and retrieval of the maps from their storage location. To this end Alex Zambellas was employed and over time he has painstakingly listed the OS County Series maps. This has proved hugely useful not only to the company but to the Library as well. The Bodleian's collection has been checked against other collections at the British Library and the National Library of Scotland, (NLS), as well as consulting OS catalogues, indexes and Richard Oliver's Concise guide.[2] Maps missing from the collection have been identified and where possible replaced by donations from the recent dispersal of the OS's collection at Southampton and by purchases of scans from the NLS. A better estimate on map numbers has been established. Without yet being in a position to count individual maps it is still not possible to know how many the Library holds, but Alex's records have helped ascertain an estimate figure for the County series, including reprints, of approximately 300,000.

Map capture



Each map is individually scanned in full 24-bit colour using a French built I2S A0 scanner, (*figure 1*, *left*). The camera scans in a sweeping motion digitally capturing one pixel wide by a specified number high, depending on map size. Sophisticated software stitches all the individual one-pixel images together to produce a final image of the entire map. Depending on the map scale the images are captured at 300 or 400 pixels per inch (ppi) as a TIFF image. This gives an accurate reproduction of the original material that can be viewed, used and reproduced in a number of ways, simply not possible with the initial paper map. The sweeping motion of the camera

[2] R Oliver, *Ordnance Survey maps, a concise guide for historians,* Charles Close Society, 2005

means that nothing comes into direct contact with the map itself. Cold lights positioned on the moving camera arm ensure that the maps are only exposed to the increased light for the shortest possible time.

As each map is examined before scanning, any damaged sheets are quickly identified and listed for attention of the Library's Conservation and collection care department. This makes further damage less likely and they are repaired to exacting standards. These delicate maps are then preserved for the future.

The scanning process takes about forty seconds to capture one map and the TIFF file is saved to an external hard drive. The data is uploaded to the company's substantial server facilities in Hampshire. With each map taking up to 550,000 megabytes of storage space, terabytes are quickly consumed.

Maps are then checked for errors and catalogued. Backing up of the data is essential to ensure that any corruption of files doesn't result in map images being lost. Lists of maps held on Protinus's servers are double checked against the catalogue of the Library's holdings. This guarantees that all maps have been captured.

Obtaining more from the maps

Having a digital archive of the Bodleian's OS maps is one thing, but advances in computer mapping software have allowed Protinus to use these maps in a wider range of contexts than just viewing. The company saw a real need to provide users with online maps of Great Britain for every available date range and scale. The maps need to be displayed at a high resolution, fully searchable and with a zoom function to see detail.

Working copies of the original TIFF image are made, enabling digital cartographers to work on the processing of maps without fear of damaging the original master image file. To facilitate in the joining of the individual map sheets, mapping software is used to remove the marginalia from around the edge of each map leaving just the surveyed map area remaining. The important information contained in the border of each map, including, but not limited to, map title, survey date and publication date, is transferred to a database.

The database is a vital component of the project. Having the maps available to view is all very well but without this accompanying metadata they can mean very little. The database is fully searchable and linked to each corresponding map. By selecting an area of interest the date range of maps in that area is displayed. Selecting a specific map scale or date range will then present all other information associated with that particular map.

Every map printed by the OS for each scale was produced to an exact size. However, paper size would vary. By digitally 'cutting away' the marginalia the remaining map image is squared and straightened allowing it to be joined to the adjacent map seamlessly.

Figure 2 shows an example of four individual 1:2500 maps that have been joined. The original paper map colour has been retained to highlight the four individual sheets. However, a procedure can be applied to the maps that enables each map to be colour matched. This removes discolouration incurred

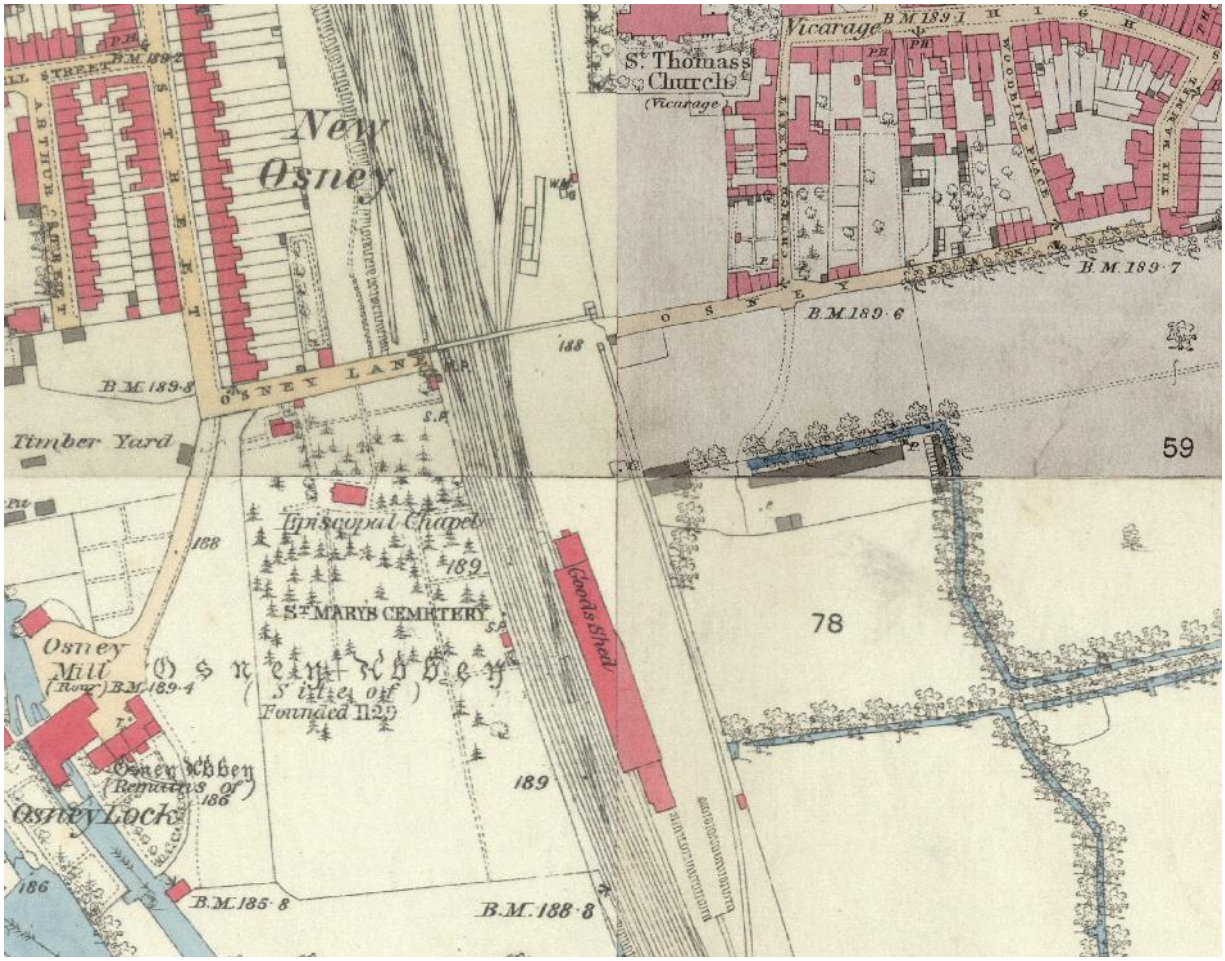


Figure 2. Four 1:2500 maps joined to create one new map

through exposure to light and dirt and gives the background a uniform appearance.

Once a series of maps has had the marginalia digitally removed, straightened and squared, a mosaic of the individual maps is constructed. This creates an area until eventually the whole county is compiled. Protinus assembles these mosaics a county at a time just as the OS originally surveyed.

The mosaic of an area is compared to modern day mapping using specialist software. A process of geo-rectification is then performed so the historical map is assigned a known coordinate position. Ground control points (GCPs) are placed on the projected map and the identical point placed on the historical map. As more GCPs are placed, the software uses algorithms and trigonometry to predict where other GCPs should be located. The cartographic technician will then correct the software assumptions. The more GCPs that are placed the more accurate the geo-rectification of an area becomes.

When geo-rectifying, the technician is looking for map objects that are unlikely to have changed over time. Among the most useful features are churches as they are prominent historical features that often remain on the modern day mapping. Bisecting field boundaries can be used in rural areas but care must be taken when selecting dynamic objects as they could have been altered with the passing of time. The technician will also be looking to spread

the GCPs evenly over an area so that bias will not distort the map. It can be very easy to position many GCPs on an urban area but in rural locations definitive points are harder to find. It is the skill of the cartographic technician that ensures that no distortion of the map image occurs.

This process is performed for each map sheet in a grid. Once all the maps for a county have had GCPs placed they are then grouped to form a large, single GCP file. This is then positioned on the whole county map mosaic. The geo-rectification process is run which effectively transfers the known positions from the projected map to the unprojected historical map. When the whole procedure is complete the county borders are painstakingly cut and joined to the neighbouring county to eventually develop one map of England, Wales and Scotland in its entirety. With over 300,000 maps to process this is an extremely time consuming exercise.

To aid file manageability, the newly formed map is cut into individual 1 km tiles. The coordinate information is stored in a file format called a GeoTiff. This allows mapping software to open each GeoTiff map tile in its correct geo-position. A map of Great Britain for each date range at each map scale is produced. These can then be layered to allow comparisons to be made.

Map viewing software is under development which will in future allow users to view maps online. Two or more maps can be compared altering the transparency of the display so that landscape change is highlighted. For commercial purposes, geo-referenced site diagrams can be uploaded to the website to assist in historical site evaluation. This software, due to be available in 2012, is also linked with the map data database so all the important OS information contained in the map marginalia can be retrieved and added.

The market for high quality digital images of historical maps is ever increasing. Uses for these maps is broad with requirements ranging from new site development, commercial insurance, historical land use surveys, archaeological interest to personal curiosity. Having access to these maps online allows users to view them from anywhere with internet reception rather than having to visit the Library themselves.

Further future development

Uses for the historical maps other than online viewing are being developed. With the OS making a number of its products freely available through the OpenData initiative has opened up a whole new range of possible applications that would not have been possible without further funding.

One such area that is being explored is applying OS height data to the historical maps. The OS OpenData package Land-Form PANORAMA® contains height data originally generated from stereo aerial photography produced in the 1970s. The date of the data is perfect for the historical maps as the latest date for the scanned maps is the 1960s. This height data is input into mapping software to create a digital terrain model, (DTM). The historical map tile image can be layered over the top of the DTM to produce a 3D image. The generated 3D image brings the maps to life as the surface elevation is clearly represented.

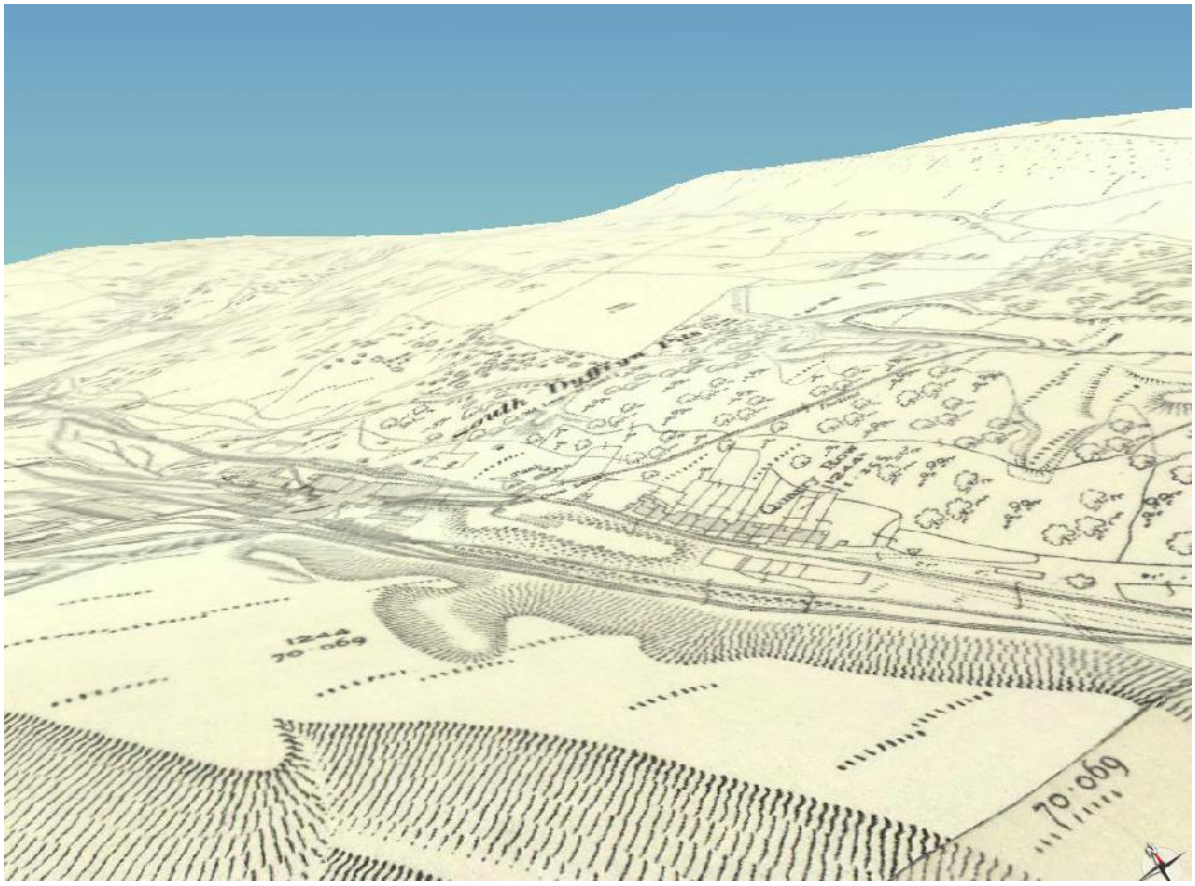


Figure 3: A 3D view of an area near Merthyr Tydfil, Wales

Figure 3 shows how combining the surveyed map image with the 1970s height data enlivens the 2D historical map

Protinus is also developing a method of extracting contour line data displayed on some of the 1:10,560 maps. Due to the difference in the colour of the contour displayed on the map, software can identify the contour line, separate it from other details on the map and produce a separate vector map of the contours. The various height values can be assigned to the relevant contour. The newly produced contour maps can also be used to develop historic DTMs and a historic height database.

Conclusion

This project benefits the Library by providing a digital image of every map that lets them be more widely viewed while helping to preserve the originals. A better understanding of the collection has been achieved and missing or damaged maps have been identified. Users will be able to search the maps themselves, freeing up the map librarians.

Outside of the Library the maps will be used in a variety of applications. It is hoped that companies and individuals will be able to purchase full colour, site-centred areas of the historical maps where once it would have involved cutting and pasting black and white photocopies. With the recent introduction of OpenData from the OS more ideas are being put forward on how to combine historical map imagery with other geographical information to produce more innovative products.