THE ROLE OF MODERN CARTOGRAPHY IN ORDNANCE SURVEY (GB)

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ABSTRACT

Ordnance Survey (GB) has been Britain’s national mapping agency for over 200 years and our principal role of being map makers has shifted to being the providers of the nation’s geographic referencing framework. The paper map is no longer the store for geographic information, instead the database and database interconnectivity are the basic building blocks to our business, driving technological advances in the way we store, maintain and deliver geospatial information. The cartographers immediate response was to withdraw into the world of derived paper mapping where the traditional cartographic skills were still prevalent but it was a move which gradually sidelined them from the mainstream business. However, a cartographic renaissance is now under way following the realisation of the key role cartographers need to play in the design of database population and data visualisation issues concerning the new and emerging technologies.

BACKGROUND TO ORDNANCE SURVEY OF GREAT BRITAIN

In 1791 the British Government instructed the military to map the south of England at a scale of one inch to the mile (1:63 360) in preparation for an expected invasion attempt from Napoleon-led French forces. Kent, in the extreme South-East of the country, was considered the most vulnerable area for attack and that was the subject area for the first map completed in 1801. Thus was born Ordnance Survey and within a few years the practical value of appropriate maps had become more widely appreciated for the transfer and management of land, civil engineering projects and scientific applications such as the mapping of geological and archaeological information. By the mid-nineteenth century Ordnance Survey had assumed its modern role of providing the national mapping needs for the whole of Great Britain (i.e. England, Scotland and Wales)\(^1\).

![Figure 1. Extract from 1801 Map of Kent](image)
Now a wholly civilian organisation, we have remained the nation’s mapping agency and are now an independent government department that became a public sector Trading Fund in 1999. Becoming a Trading Fund gave us more commercial flexibility and the ability to invest but also greater responsibility for our finances and a commitment to making a financial surplus. However, profit is not our primary driver and some of our work that would not be commercially viable is undertaken at cost under contract from the Government where it is considered to be in the national interest. In this way we can ensure that every square metre of the country is mapped in great detail and is regularly updated and available for customers when needed.

Our world has changed considerably and digital technology has fundamentally altered our operations. The paper map is no longer the store for geographic information; in this information age the database and database interconnectivity are the basic building blocks to our business and Ordnance Survey has shifted from being map makers to being providers of the nation’s geographic referencing framework. Since 2001 we have been driven by our corporate vision, *Ordnance Survey and its partners will be the content provider of choice for location based information in the new information economy.* Three current key investment areas are:

- Data capture and maintenance systems to deliver a world leading, seamless data capture and data management environment;
- Enhancing the database content and quality to deliver products and services that are robust yet technologically advanced and meet the needs of customers, now and in the future;
- A service and delivery model that delivers products and services through a range of channels (including via the internet), which give our customers the choice of how they receive our data.

**NATIONAL GEOSPATIAL DATABASE**

Ultimately, all our products and services rely on a network of around 300 surveyors employing ground and air survey techniques to maintain the ‘master map’ of the country at nominal capture scales of 1:1250 for urban areas, 1:2500 for rural areas, and 1:10 000 for mountain and moorland areas, comprising in total some 230 000 maps. We began digitising these maps in the early 1970s in a fairly small way, the initial objective being to improve map production efficiencies and to produce electronic versions of the existing paper maps. No one could foresee then the enormous explosion in the demand for, and use of, geographic information (GI) that we see around us today. The programme accelerated through the 1980s and was completed in 1995, to make Britain the first country in the world to compile such a detailed national vector database.

![Figure 2. Plot from point and line data.](image)  
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The relatively unstructured (point and line) topographic geometry of the original database couldn’t possibly meet the needs of today’s technological advances and increasing customer needs. Consequently, we have completed a major re-engineering programme to develop the detailed topographic information, creating polygons to represent actual features and with inferred links to create some 440 million real-world objects. Every day around 5 000 changes are made to the database directly by surveyors employing the latest technologies from wherever they are working in the country and which are made available to our customers the following day. This database maintenance regime is directed by change intelligence or cyclic revision sweeps and ensures that any major changes to roads, building development, etc are recorded within 6 months of its ground completion.

The underlying update and storage mechanisms for the database, however, remains in tile format (the original map format) that arbitrarily divides up objects into separate, unrelated pieces and is inconsistent with our aim to sustain a seamless and integrated database. We are therefore currently developing a new maintenance infrastructure that will deliver a truly seamless database through an entirely new set of tools for the capture, storage, update, and management of the data. It is a major investment with which we will take a major step away from being a ‘product-based’ organisation toward a ‘database-centric’ operation and from which we expect to achieve cost savings in data capture and management processes and benefits to products that include improved data quality and integration.

**DERIVED DATA STRATEGY**

Our cartographers are working with databases to maintain our series mapping, but none are linked directly with our master database and require interactive cartographic effort at editing stations. These production databases comprise a vector database digitised from 1:250 000 scale, which is continuously maintained, and individual 1:25 000 and 1:50 000 scale raster datasets produced by scanning reprographic material used during previous manual production processes. Each of these datasets are used to maintain the paper series mapping; in fact it is the publication of the paper mapping that drives the revision of the 1:25 000 and 1:50 000 scale data and reinforces the view that cartographers are employed to just make paper maps that helped undermine their position within Ordnance Survey for a decade. Establishing these production databases and the subsequent digital editing techniques introduced in the mid-1990s did produce very significant savings in cartographic production but with independent product maintenance processes and without an underpinning cohesive data strategy the result has tended to be a lack of consistency across the product portfolio.

We are aiming to progress from our current position through the implementation of a derived data strategy that is based on our vision that all Ordnance Survey products will be generated and delivered from the one National Geospatial Database (NGD). Products at smaller scales will be derived from the source data without the need for separate capture and maintenance processes for different products at different scales, i.e. capture once, use many times, and employing as much automated generalisation as we can. Earlier attempts to produce derived products directly from the NGD were encouraging but we concluded that the data and technology were not robust enough at that time to sustain economic production. Following that conclusion we have focussed on development of the data and software infrastructure to support the strategy while the previously described investment in a new database infrastructure will prove fundamental to the necessary data enrichment and improvement.

Historically, cartographers at Ordnance Survey have been fairly quiet on database issues, but to achieve the greatest benefit from our derived data strategy it is imperative that they are heavily involved in the content design and continued review of the NGD to ensure that the quality, completeness and attribution of the data best serves the needs of current and future derived products and services. This will be a fundamental role for our cartographers as we gain more understanding of data visualisation issues affecting customers and emerging technologies.

**CARTOGRAPHIC PRODUCTS**

Information on all of our products and services can be found on our website www.ordnancesurvey.co.uk, but a sample of our key products are outlined here.

**Paper Maps**

Contribution from our paper map sales represents less than 20% of our annual trading revenue of circa £100 million (2004/05) and yet it is in the paper map series that our public image and brand remains embedded. The maps we publish have become an institution in themselves and, despite being a commercial organisation, we betide us if the general public disapprove of any move on our part to change specifications. We consult widely prior to implementing specification changes to the national series mapping and some of the lobbying and debate in the past has been
surprisingly passionate, some achieving widespread attention in the national press and even reaching Government circles.

The principal published national map series are:

The **OS Travel Map - Road** published at 1:250 000 scale and totalling 8 in the series. Targeted at motorists navigating specific regions of the country, the map features the latest road information, distances between towns, selected tourist information and a comprehensive place names index.

![Figure 3. Extract from OS Road Map 8 (South-East England)](image)

The **OS Landranger Map** published at 1:50 000 scale and totalling 204 in the series. Targeted at people planning a holiday or day trip to the town or the countryside and includes visitor attractions such as camping and caravan sites, tourist information, picnic sites, selected places of interest, etc. National trails and recreational paths are also shown. It is probably still the best known of Ordnance Survey publications and a perfect example of how national consistency is a key commitment and how, although we do ensure that we at least cover our costs for each of our national series of paper mapping, they are produced primarily to meet the nation’s needs for accurate, definitive and current maps. Of the OS Landranger Map series only 40% of them would be commercially viable in their own right.

![Figure 4. Extract from OS Landranger Map 196 (The Solent & Isle of Wight)](image)

The **OS Explorer Map** published at 1:25 000 scale and totalling 403 in the series. The most detailed of our published paper mapping series is positioned as the essential accessory for outdoor activities such as walking, horse riding or off-
road cycling. It has won various accolades, including Product of the Year at the Go Outdoor Awards and favourite accessory in magazines for outdoor pursuits. Key to the success of this map is that it is the only national series in Great Britain that depicts the entire Rights of Way (RoW) network, tracing routes that the public have a right to walk. We are currently in a 2½-year programme that will deliver a revision of the whole of England and Wales to include the depiction of open access land under the provisions of the Countryside Rights of Way (CRoW) Act 2000. Further information on CRoW 2000 can be found at [www.countryside.gov.uk](http://www.countryside.gov.uk).

Although limited by the nature of raster databases, we do extend choice to customers by providing our OS Select™ service, available online and through high-street partners, enabling the purchase of personalised 1:25 000 or 1:50 000 scale mapping. The information contained on the maps is exactly as on the published maps but allows the customer to choose the centre of the map, the cover image, title and whether it is supplied flat or folded.

It was to this area of ‘traditional’ cartography that Ordnance Survey cartographers withdrew during the last decade as they watched from a distance what they perceived as the threatening march of databases and new technologies. By doing so they were sidelined and failed to play what should have been a key role in the emerging technologies, leaving the software developers themselves to deal with key visualisation and communication issues. Whether or not it was due to short sightedness or a lack of confidence in tackling complex issues emanating from the new technologies, it is currently being corrected through the implementation of a strategy to ensure the cartographic renaissance necessary to fully realise the benefits of the NGD.

**Data Products**

In collaboration with the geographic information community, Ordnance Survey has been developing the concept of the Digital National Framework™ (DNF®), which aims to provide a permanent, maintained and definitive geographic framework to which any information with a geospatial content can be referenced. It incorporates a set of enabling principles and operational rules that underpin and facilitate the integration of georeferenced information from multiple sources.

It is through developing the DNF that much of the investment in our master database is driven and realised today in our flagship product OS MasterMap®, which will eventually supersede all existing detailed datasets made available to date. It is a seamless and intelligent map designed specifically for use with geographic information systems (GIS) and databases with each feature or real-world object labelled by its own unique Topographic Identifier or TOID®. This 16-digit number provides a common real-world referencing system that ensures users a reliable and accurate exchange of their own or 3rd party information.

OS MasterMap is structured by layers and themes that allows customers to specify and order online only the data they need and yet be confident that full consistency and interoperability between the data is retained. Ongoing support through change-only update saves them further time and effort.

Four layers are currently available. The **OS MasterMap Topography Layer** contains the detailed surface of the landscape, mapped to minute detail to include every building, field or pillar box in the country, and broken down into nine themes: roads, tracks and paths; land; buildings; water; rail; height; heritage; structures; and administrative boundaries. The **OS MasterMap Address Layer** provides precise coordinates for 26 million residential and commercial properties, creating a fixed link between the property and the address whilst the **OS MasterMap Imagery Layer** provides a detailed overview of the country’s transport infrastructure for which the first
two themes released are the Roads Network and Road Routing Information such as height restrictions and one-way roads.

![Figure 8. The current layers of OS MasterMap](image)

**CARTOGRAPHIC SERVICE**

An independent report in 1999 estimated that £100 billion of economic activity, approximately 10% of Gross Domestic Product (GDP), was underpinned by Ordnance Survey data. In the vast majority of usage the data is viewed in some way and the potential for high cost wastage by misleading or confusing users through poor data visualisation is clear. Good cartography has a massive role to play and yet a reluctance to be integral to the developing technologies was not restricted to Ordnance Survey cartographers in Great Britain.

Ordnance Survey cartographers are now embracing the new and emerging technologies, accepting them as the next stage in cartography’s evolution offering new opportunities rather than as a threat to their vocation. However, after many years of self-imposed exile in the shadow of innovation in the handling and use of geospatial information, it is no wonder that they are now having to be very proactive in selling their skills and knowledge to some areas of the organisation.

An early success for our cartographers has been in supporting the building of demonstrators for use in convincing prospective customers of the value of using our data. Until recently demonstrators were built for specific customers solely by experts in the use of GIS but who have had no cartographic training. By applying fairly simple cartographic rules to the display of background Ordnance Survey data and the customers’ own information, we have been able to improve the service enormously, increasing the likelihood that the customer quickly perceives the benefit of using our data.

![Figure 9. Before (left) and after (right) applying cartographic rules to a GIS demonstrator showing sites of fatal road accidents in the county of Oxfordshire](image)
Despite the flexibility OS MasterMap offers customers, a massive majority of them simply use the default values within the data for display purposes, whether it be on screen or plotted. The British Cartographic Society and Ordnance Survey are this year introducing a new competition open to anyone with access to a current OS MasterMap licence with a view to encouraging greater use of innovative and stimulating map design. The entry can be a paper map or in digital form, can include the user’s own information but must be predominately OS MasterMap data making greater use of alternative visualisation and have an intended purpose and targeted user. The final winner will be announced at the British Cartography Society symposium in Plymouth in early September 2005.

Another initiative about to be launched is to bring cartography to the customer. We are working with colleagues from our Sales and Marketing departments to identify a suitable customer with whom we can work to improve their visualisation of our data and provide significant benefit to their work. A possible early candidate would be a regional Ambulance Service, for which a representative at a recent seminar held by Ordnance Survey claimed that by trimming just a second off the average response time for an ambulance attending an incident would save lives. If by helping them improve their usage of Ordnance Survey data they could achieve that, what a powerful example of the benefits that applying good cartography to good geographic information can bring.

The final step in this element of our strategy for a cartographic renaissance is to move closer to those developing the emerging technologies. We operate a programme that allows partners, whether they be individual entrepreneurs or multinational companies, to add value to our core data to create tailored solutions to meet end-user needs. The programme gives us the opportunity for closer working to bring mutual benefits to both parties but have yet to introduce an element of cartographic support or advice to their technological innovations. Location-based services are an example of where our partners are developing new and exciting methods for bringing personalised data to customers but where, in the main, the cartographic visualisation doesn’t match the innovation of the technology being employed. It is here, and in future technologies, where today’s major challenges to cartography lie. It is lessons learned here that will provide cartographers the best experience and knowledge to influence the database attribution that will allow the most suitable automated outputs.

![Figure 10. Location based technologies](image)

**EMERGING TECHNOLOGIES**

The Research and Innovation (R&I) unit within Ordnance Survey has a key role to generate future benefit for the business, its partners, customers and the nation. They operate within a research horizon of 2 to 10 years and need to predict what scenarios may impact upon the business and how best to respond to those possibilities. Given the pace and diversity of change around us, their scope for research could be enormous, therefore it is important for them to drive effort by three customer-focussed questions:

1) What will users want in the future and when will they want it?
2) How will we deliver what users want when they want it?
3) How will we deliver what users want as cost effectively and efficiently as possible?
As well as projects that will fundamentally change the way cartographers will work in the future, such as the ‘capture once, use many’ concept and automated generalisation techniques, there are a number of research areas that ask questions of cartography. Some could be construed as a threat to our idea of cartography, so how should cartographers react? Retreat to the comfort zone and ignore these developments, focusing on the more traditional manifestations of GI where our skills are recognised and often admired? I personally have no doubt that should we take that route our current renaissance would slowly evaporate and we would find ourselves as we were in the 1990s, again sidelined from the mainstream business of Ordnance Survey and a future in serious doubt.

Instead, we have developed a very good relationship with the R&I team, who keep us abreast of developments and use our skills and expertise where it can aid their research. They clearly recognise that whatever the innovation, we have to deliver it to the user in the best way in which to meet their needs and that, although the user may not see a map, cartography remains a major component in the design. On that basis our cartographers are working with scientists in R&I on projects such as:

Improving **Data Capture** methodologies through ground or remote sensing techniques. Although this research is principally aimed at more automated change intelligence and data capture processes that will improve accuracy, precision and efficiency in populating the database there may be further benefits for the cartographer. For example, investigations into the use of LiDAR (Light or Laser Induced Detection And Ranging) which provides the 3D location of a surface from which a laser pulse has been reflected back to its source may also be able to identify the texture of objects. Airborne or ground-based LiDAR has the potential to provide a whole new range of possibilities in areas such as urban modelling or navigation, particularly if used in association with photogrammetric data.

**Augmented Reality** (AR) has been researched since the 1960s, but recent technological advances in computing capability and miniaturisation has aided real progress in this field. Superimposing computer generated graphics on to real-world images, AR has already been used in areas such as building aircraft and recreating archaeological sites, but Ordnance Survey research scientists are looking at outdoor usage where tracking becomes more problematical. Tracking hardware is encapsulated in a hand-held computer, such as a PDA, and the device’s own screen is used to display the augmented view while the user simply holds the screen up at eye level to view the content, representing an entirely new dimension for the use of our spatial data. Instead of 2-D maps or 3-D computer representations, the user can be immersed within a virtual 1:1 map where mountains, buildings, streets, etc are clearly labelled.

![Figure 12. Augmented reality – a virtual 1:1 map](image)

**SUMMARY**

Although the percentage contribution of our paper mapping series to total revenue will undoubtedly continue to decline as increasing use is made of our data in all sorts of ways, it will be many years before data supersedes paper maps as our public image and they will remain very important in our overall portfolio. Delivery of the derived data strategy will provide the next opportunity to refresh both the data and paper portfolios and cartographers will naturally play a vital part in designing the new products. However, they must not fall into the trap of taking the opportunity to focus on ‘traditional’ cartographic values through focusing on the development of new paper map series and ignoring other opportunities.

Time and technology move on, as do the opportunities afforded by DNF and emerging technologies, and it is imperative that cartographers become increasingly data centric and embrace the opportunities that these advances are bringing by influencing the database population and its data quality and by ensuring that all users of our data products are able to...
use the data in the most effective and efficient manner, whether it be for spatial analysis or for graphic visualisation on paper or other media.

It is only by recognising and embracing the key role they need to play in visualisation issues surrounding new and emerging technologies that Ordnance Survey cartographers will re-establish and cement themselves as a core competency within the National Mapping Agency.

REFERENCES


BIOGRAPHY

Bob Lilley is the senior manager responsible for cartography at Ordnance Survey (GB). Employed and trained as a cartographer by Ordnance Survey, Bob has undertaken a wide variety of other managerial responsibilities within the organisation including the investigation and procurement of digital cartographic systems, contracting in and out cartographic work, and customer supply of digital data within Sales & Marketing. In his current role he is responsible for all the cartographic work necessary to deliver Ordnance Survey’s paper and data products as well as the development and implementation of the strategy to revitalise and re-position cartography within the organisation.