A04.1

A GI Triumvirate delivering Genesis

Berik Davies, Principal Consultant, Ordnance Survey, Brigitte Colombo, Oracle Corporation, David Hoy, ESRI (UK)

Abstract

Ordnance Survey is undertaking a programme of work that will provide new and much improved production processes for mid- and small-scale derived data. Using OS MasterMap® as the primary raw material, a semi-automated map generalisation flowline will be used to produce a number of mid-scale vector databases. This paper discusses the business benefits, technical architecture and key milestones, and demonstrates how a partnership of three has come together to successfully deliver this technically challenging project.

Introduction

Ordnance Survey supplies customers with a wide range of products, from large scale (for example, OS MasterMap) to small scale (for example, 1:250 000 Scale Colour Raster). The databases, system environment and delivery mechanisms that support these products have developed over a number of years, and whilst fit for purpose at the time, the current environment lacks flexibility, is complex, and is not suited to the requirements of a modern business in terms of agility or value for money.

The current flowlines employed in producing mid-scale products, such as the popular Landranger® and Explorer™ map series, rely on separate, product-specific databases to store information, and make significant use of manual cartographic processes in order to deliver the final product.

With the introduction of OS MasterMap, the geographic information (GI) industry in Great Britain has seen major changes. OS MasterMap has also resulted in the complete re-engineering of the back-end technology within Ordnance Survey. New hardware, database and applications software have enabled Ordnance Survey to deliver OS MasterMap, and that technology is now being put to use in other areas, such as the semi-automated derivation of mid-scale products from a core central database.

This paper explores the approach and key success factors of one particular project that makes use of the capture once, use many times methodology.

Business objectives

Ordnance Survey has a goal of supplying customers with easier and faster access to more current, accurate, consistent and useful GI. Its IT systems therefore need to be responsive to changing customer requirements.

Historically, IT systems at Ordnance Survey were largely based upon departmental, bespoke, project driven implementations resulting in many incompatible systems and databases. These systems were

difficult to integrate, costly to maintain and complex to adapt or extend, in part reflecting the immature state of the mapping software marketplace at the time.

The same situation is also evident within the cartographic arena, whereby separate teams, flowlines and processes exist to produce different map series, often resulting in a duplication of effort and a lack of agility in both systems and products.

Different products rely on different source databases to other products, and each database often has a separate capture and update regime, despite them all being based on the same real-world features. Ordnance Survey also has a desire to publish different products for different purposes; for example, the requirements of a hill walker for a mid-scale map are very different from those of a motorist with an in-car navigation system, but they will both be derived from the same large-scale data.

The key business drivers are summarised by the following points :

- improve currency of product;
- greater cross-product consistency;
- store and maintain once, use many times;
- facilitate new product opportunities;
- increase business agility; and
- production systems are standards and COTS based.

Capture once, use many times – the generalisation process

Now that Ordnance Survey is in the OS MasterMap era, with a single, seamless large-scale database, it begins to become feasible to derive all products from this single, central database. Some of these products, such as OS MasterMap itself, are published at the same scale as which the base data is held, namely 1:1250 in urban areas and 1:2500 in rural areas. However, the majority of the other products, both digital and graphic, are published at a smaller scale, and usually represent less detail than OS MasterMap. They are thus derived from the core dataset, and represent a generalised view of that dataset.

So what is generalisation? It can be defined by the following quote :

'To reduce the complexity of a compiled map product while maintaining the salient elements and characteristics subject to the purpose of the map.'

To many users it probably appears an easy task to summarise the real world onto a flat piece of paper to provide them with the maps they are familiar with today.

Cartographers and surveyors at Ordnance Survey have, through many years of experience, developed skills in the simplification and depiction of real-world features that produce map products at varying scales and for varying users.

Ordnance Survey has an ongoing programme investigating methods of automating the process of simplifying large-scale data to help in the production of smaller-scale products. The Landplan® product currently available is an example of mapping derived from large-scale base data (Land-Line®) using a semi-automated process. The topologically clean and consistent data that OS MasterMap provides offers new opportunities for further automating the process, but it also offers potential for creating a wide range of new graphic and digital products.

Although you can take OS MasterMap data and print it out at 1:50 000 scale without altering the data, it wouldn't be of much use to users. In practice we need to simplify the data by filtering features and making those that we keep easier to interpret. Frequently this requires features to be enlarged, combined or moved, or maybe all of these.

Some examples of what typical problems need to be resolved when data is generalised include:

A road in OS MasterMap will be shown at its real width, of say 6 m, but on the current Explorer (1:25 000 scale) map the same road is shown at a minimum width of 8.25 m, and other features such as buildings have to be moved so they don't overlap with it.

A town in OS MasterMap will be made up of a large number of buildings, gardens, man-made surfaces and many other features, but on a Landranger (1:50 000 scale) map this will be shown as a simplified built-up area.

Figures 1 and 2 indicate graphically the issues of feature simplification and conflict resolution that are typically encountered whilst generalising from a large-scale dataset such as OS MasterMap.

Figure 1. Feature simplification – lines

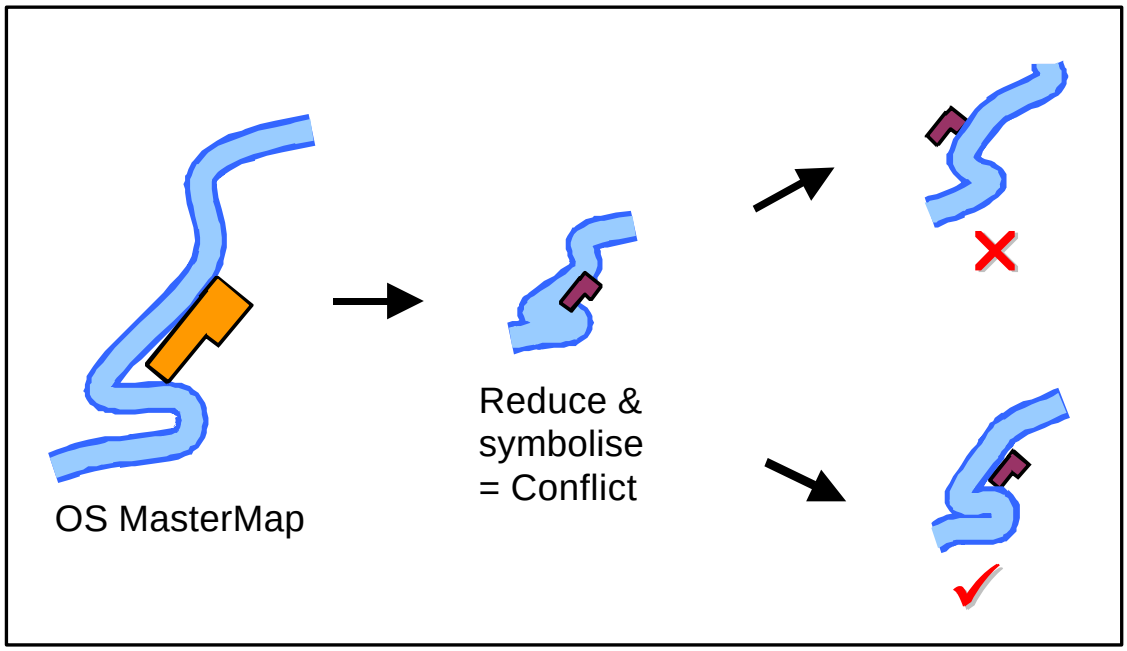
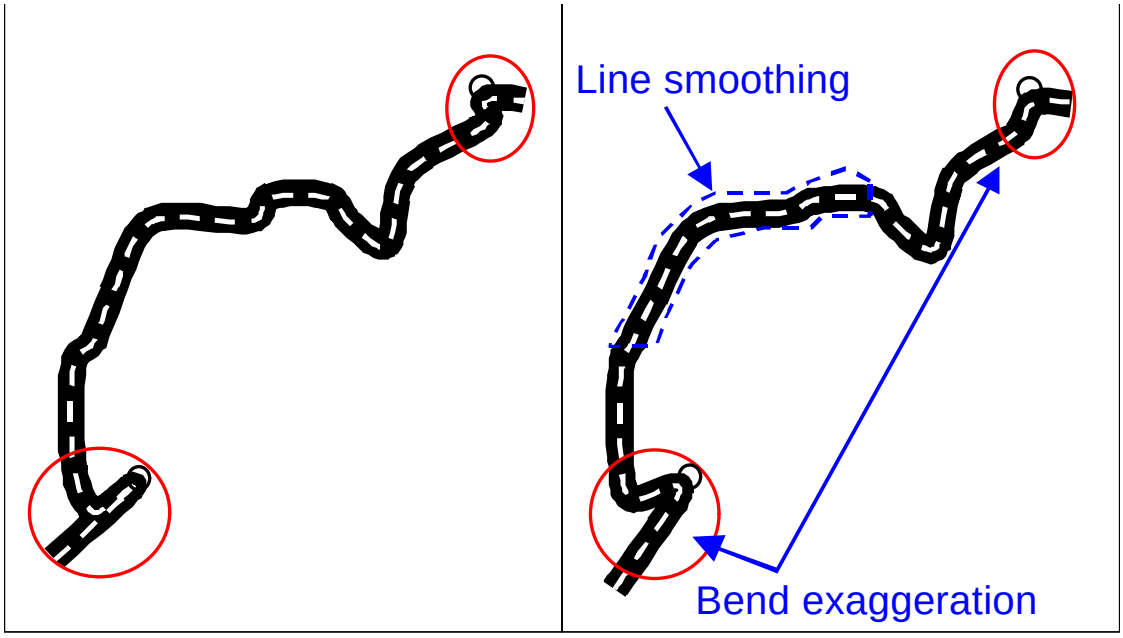


Figure 2. Conflict resolution – maintaining spatial relationships



A significant programme of work has been undertaken at Ordnance Survey in order to solve problems in two main areas:

- Working with third parties, including commercial software developers, universities and other national mapping agencies, to develop software algorithms and routines that simplify the data and fix the problems that occur with features conflicting with each other.
- Trying to establish a software environment that controls the generalisation process, using the best algorithms at the right time to ensure that the results meet the map specification as closely as possible.

Technical strategy

New IT projects at Ordnance Survey are no longer based on best of breed bespoke development environments, but exploit standards-based, commercial, off-the-shelf software (SCOTS). The use of a SCOTS-based system is known to reduce the long-term cost of ownership of new systems and increase the speed and flexibility of new system development.

This approach also supports the deployment of enterprise-wide solutions. An example of this architecture is a single spatial database providing data integration, with a suite of integrated capture, editing and product generation applications that implement business logic and fulfill operational requirements. The advantages include the technical and operational benefits of capture it once, use it many times and the replacement of the multitude of existing legacy systems with integrated, lower-cost, more maintainable and more flexible solutions.

The technical solution that Ordnance Survey have selected makes use of two key components. Oracle® Spatial is used as the central repository for all of the base scale data, whilst ESRI® ArcGIS® is used for the automated generalisation and subsequent manual cartographic editing work.

The Oracle database implemented at Ordnance Survey is at the core of the new data maintenance architecture, and is one of the largest spatial databases in the world. This is used to support Ordnance Survey's advanced storage, editing and product generation requirements. Four hundred and twenty million features are stored using native Oracle Spatial data types and indexes, resulting in physical disk storage of 1 terabyte.

The semi-automated generalisation process occurs within ESRI's ArcGIS environment, using a combination of both modified ESRI algorithms and bespoke software written by members of the research and production teams at Ordnance Survey. The generalised map is then edited by cartographers using ArcGIS software in a multi-user ArcSDE® environment. ESRI's Maplex label engine is being investigated as a tool to assist in the automatic placement of text.

It must be pointed out, however, that a substantial amount of manual editing by skilled cartographers is still required in order to produce graphical output that meets the high standards set by Ordnance Survey and customer expectations. We are a long way from the push-button generalisation that is perhaps the holy grail of many national mapping agencies, but work is continuing towards this goal. It is also not currently possible to derive all the required information from OS MasterMap, and other sources are used for data representing height, rights of way and points of interest.

Key success factors

As in any large programme of work involving complex processes and cutting-edge technologies, there are a number of factors that have contributed towards helping Genesis steer towards a successful conclusion. The close partnership between Ordnance Survey, Oracle and ESRI has been essential in establishing an environment in which ground-breaking work such as this can be undertaken. This is the triumvirate (a group of three in coalition or association) to which the title refers.

The central database, which forms the hub of the system, has been developed in close collaboration with Oracle, and Ordnance Survey, in turn, has been feeding enhancement requests and new requirements to Oracle for incorporation in future releases of the Spatial product. ESRI have been closely involved in the integration of a number of their tools in a complex and demanding flowline, and have provided significant input in helping to optimise the processes involved.

The involvement of a core Ordnance Survey team, formed of both product specialists, cartographers, research staff and those with high-level IT skills, has also been essential to ensure that the correct approach is undertaken in all areas of the business.

Business benefits

It is foreseen that production costs will reduce significantly, whilst providing the opportunity to produce better products. Test results obtained from the Genesis programme indicate that a time reduction of 25% can be achieved in the production of a single map sheet, and it is hoped that as the automatic generalisation algorithms improve, the amount of manual editing will reduce again, and thus this figure will drop still further.

The derived data will be more consistent with OS MasterMap, more current and more flexible to allow much easier specification changes. Genesis will also offer the opportunity for derived products to be tailored and created for more specific customer needs, helping Ordnance Survey produce what our customers want, when they want it.

Conclusion

This paper has described how Ordnance Survey are using the Genesis programme as an investigation into the use of new semi-automated generalisation tools, combined with OS MasterMap, to produce derived products from a single large-scale seamless database.

Close collaboration between Ordnance Survey, Oracle and ESRI is ensuring that technological hurdles are quickly overcome, and the enhancement requests that Ordnance Survey is feeding back to both of our technology partners will often be incorporated in future releases of their products, which will surely benefit the GI industry in both the UK and internationally.

The programme of work will eventually provide Ordnance Survey with a highly efficient method of producing a wide range of products from one single database, facilitating the objective of store and maintain once, use many times, and helping to provide customers with better, more current products.

It is recognised that there is still a long way to go to attain the holy grail of push-button generalisation, and it is hard to imagine a day when high-quality cartographic output will be able to be produced with no human intervention. However, continuing work with Ordnance Survey's technology and research partners is improving the tools currently available, and Ordnance Survey will continue to push the limits of technology to meet its business aims and customers' expectations.

Acknowledgements

The authors would like to thank Robert Sharpe of Ordnance Survey for his contribution to this paper.

References

Delivering a National Mapping Infrastructure: Case Study from the Ordnance Survey. Cambridge Conference, July 2003, Cambridge.

Colombo, B. and Parsons, E. The Maia project: The development of a very large geospatial database. AGI Conference, September 2002, London.

Trademarks