Mapping Ireland – The End and Yet the Beginning

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SUMMARY

Ordnance Survey Ireland (OSi), the national mapping agency of Ireland, will in early 2005 complete the creation of large-scales vector mapping coverage for the State. This process, begun in 1824 and moving to digital mapping in the 1970s, has included resurvey by photogrammetric methods of the suburban and rural areas of the country, providing an accurate and high-specification spatial dataset. The work has been completed by OSi staff and by contractors on two continents. The paper:
- Describes the programme and its results
- Analyses the lessons learned in implementing the work in technical, financial and organisational terms, including the issues of
    - In-house versus contract
    - Setting priorities
    - The balance between quality, cost and timeliness
    - Educating and yet being guided by customers
    - Preparing for the next chapter whilst not losing focus on the current one
- Reviews the importance of the vector data in the development of an Irish SDI. (The ISDI project is currently at a formative stage, with a Government decision that it should be implemented, and an inter-Departmental Group currently developing a draft policy)
- Overviews the next stages in developing the topographic data to meeting ongoing national and customer requirements, not least in building an SDI, including
    - Ongoing specification/ quality development
    - Developing data models
    - Implementing systems which enable the developments
    - Continuing to meet developing customer needs

In completing the work described, linked to the implementation of a new coordinate reference system compatible with GPS along with the related physical infrastructure, Ireland has created a high quality topographic base and is able to draw conclusions that will be great relevance to other countries in both the developed and the developing world.

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1. IRELAND

Before talking about the mapping of Ireland, it is appropriate to spend a little time describing the country of Ireland, enabling the experiencing in the mapping programme to be put more easily into context. Ireland covers 70,000 square kilometres. It is still predominantly a rural country. A measure of this is to consider the approximately 50,000 townlands into which the country was historically divided (these are the smallest areal division of the State, ranging in size from 0.5 to 3,000 hectares, with each covering a little more than 1 square kilometre on average). In the 2002 census, 52.5% of these Townlands contained 5 households or fewer. More recently, Dublin has become a very significant urban centre, with the population of the Greater Dublin areas accounting for nearly 50% of the national population of approximately 3.5 million.

For clarity, readers' attention is drawn to the fact that this paper is considering the 26 counties which formed the Irish Free State in 1922, and which in latter times have been called the Republic of Ireland, Eire etc. The term Ireland is the preferred usage within the State. This paper is therefore not considering the full extent of the island of Ireland, which also includes the six counties of Northern Ireland, part of the United Kingdom.

2. ORDNANCE SURVEY IRELAND (OSi)

2.1 History

OSi was founded in 1824. It was a military organisation, with the staff tasked with completing a national survey at 6" to the mile (1:10,560 scale). Over the previous decades, records had not been fully maintained and the valuation of land, and therefore the taxation determined from this, was not accurately recorded. Before the authorities could reliably exact appropriate taxation, a survey was required to rectify this situation. The survey was completed in 1842, making Ireland the first country fully mapped at 6" to the mile. A 25" to the mile (1:2,500 scale) survey followed in the second half of the nineteenth century.

In 1922, the then Ordnance Survey was split into three organisations, Ordnance Survey of Great Britain, Ordnance Survey of Northern Ireland, and Ordnance Survey Ireland. The three organisations have retained close ties, for instance on geodetic matters, but are separate organisations operating within different jurisdictions and therefore within differing governmental frameworks.

2.2 Technical Issues

OSi introduced digital mapping in the late 1970s and has continued to be at the leading edge of technological developments amongst its peers. Digital photogrammetry was introduced in 1992, with the organisation having the largest civilian installation of DPWs in the world. More recent developments have included the implementation of a national Real Time Kinematic (RTK) GPS Network, the development of a new coordinate reference system compatible with GPS, and the purchase of LIDAR equipment.

A key decision for OSi was approved by Government in the mid-1990s. This was to commence the resurvey of rural areas of the country (as stated in section 1 of this paper, the vast majority of the land area) rather than considering a revision or overhaul process. The case for the expenditure was made on the accuracy and completeness attainable with the new technology (DPWs etc), and there being no need to compromise this with continuing reference to the old mapping, the framework of which dated back to the mid-nineteenth century. The resurvey programme was completed at the end of 2004 and is the main focus of this paper.

The urban areas of the country (approximately 850 square kilometres of mapping covering towns and cities with a population of greater than 1,500) had been resurveyed in a programme beginning in the late 1950s and subsequently revised. Any accuracy issues arising from the nineteenth-century mapping had therefore been removed at that time and a further resurvey was therefore in the mid-1990s not considered necessary.

2.3 Organisational issues

Organisationally, OSi changed fundamentally on 4 March 2002 when, following primary legislation, OSi was set up as a State Body. This changed the status of staff from civil servants to public servants and allowed the organisation further freedoms to make business-based decisions, for instance on developing products and services in joint ventures with other organisations. This form of status is widely-used in the Irish public sector for stand-alone business-based activities, whether fully commercial or partially state-funded. The primary legislation underpinning the change of status (Ireland, 2001) also allowed a restatement of OSi's mandate, which runs as follows:

'The general function of OSi is to provide a national mapping service in the State. In this regard it shall operate in the public interest by creating and maintaining the definitive national mapping and related geographic records of the State.

OSi's functions shall include all tasks as are necessary to fulfil its general function including, but without prejudice to the foregoing, the following:

－ To maintain and develop the underlying physical infrastructure which is needed to support mapping applications, including to maintain a national grid and the national geodetic and height frameworks and to link these to international systems

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– To create and maintain for the entire State mapping and related geographic databases which have national consistency of content, currency, style and manner including for those areas which do not provide a commercial return on the activity

– To provide mapping and related geographic information to the public and private sectors in support of social, economic, legislative, educational, security, business and administrative functions and requirements

– To encourage and promote the benefits of the use of the national mapping and related databases and the development of products, services and markets to meet national and user needs

– To advise the Government, a Minister of the Government, a body established by or under statute and other public sector organisations on matters relating to the policy and practice of survey, mapping and geographic information and on the development of national spatial database infrastructures

– To represent the State at international level on matters relating to mapping and geographic information

– To provide the necessary technical support to the Chief Boundary Surveyor in the performance of his or her duties in delimiting statutory boundaries and the delineation of such boundaries on maps

– To depict place-names and ancient features in the national mapping and related records and databases in the Irish language or in the English and Irish languages

– To protect Government copyright on OSi records, databases, products and published material including copyright on OSi records, databases, products and published material made prior to establishment day.'

OSi believes that this statement, in primary legislation, is one of a limited number of such explicit statements for national mapping agencies.

In recent years, OSi has made further strides in completing and updating the national mapping, in developing new systems and databases, and in the crucial area of staff development to provide the skills and resourcing need to complete the challenging programmes (for further information, see Kirwan and Greenway, 2002). OSi currently employs approximately 300 people, and has a turnover of approximately €28 million and market revenues of approximately €18 million, the balance being comprised of a Service Agreement from Government to support the non-commercial activities of OSi.

It should be noted that OSi is not responsible for recording the ownership of land, or the position of ownership boundaries. OSi completes topographic surveys recording the features

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as they exist on the ground. Land Registry, using OSi mapping, is responsible for the registering of land ownership, using a general boundaries system.

3. THE MAPPING PROGRAMME TO DATE

3.1 Plans and Progress

The Government decision in the mid-1990s approved a resurvey of the rural areas of the country. Detailed planning of this programme led OSi to develop two specifications of mapping to complete this: a 1:2,500 series covering suburban and peri-urban areas, and a 1:5,000 series covering rural areas. The division into different categories of landscape was made on the following, published criteria (OSi, 2003):

–   All existing 1:1,000 mapping of urban areas will be retained (0.1 million ha);
–   1:2,500 suburban mapping will be created and maintained to the geographic limits of all settlements with a population of 1,000 or more in the most recent census (0.4 million ha);
–   1:2,500 peri-urban mapping will be created and maintained for all settlements with 50 or more dwelling houses in the latest census (1.5 million ha);
–   All other areas of the country will be mapped at 1:5,000 scale (5.0 million ha);
–   All areas of the country will continue to be mapped at 1:50,000 scale (derived from a 1:10,000 scale database).

As will be apparent, this categorisation will require a certain of upgrading of the mapping of areas as development spreads. Intended revision cycles for areas have also been published, as follows:

–   Urban and suburban areas – annual cycle;
–   Peri-urban mapping – three-yearly cycle;
–   Rural mapping – five-yearly cycle.

OSi recognises that these cycles will need to be continuously improved into the future, but set these figures as a manageable achievement in the short-term.

From the outset, it was planned that the resurvey would be completed by predominantly photogrammetric means. The availability of the old mapping, however, was not ignored. To make best use of the various sources of information, therefore, a new photogrammetric survey of the areas was completed, but with the old mapping imported into the digital photogrammetric process as an image. This image was used to extract a variety of textual information such as townland names, the position and detailed alignment of boundaries, and information on areas of land which were not visible from the new photography. Generally, such areas are unclear due to tree and vegetation cover. In such areas, a local fit was made of the old map to the photography, and the old features were' traced off' (and coded as such). These techniques have been used for both scales of mapping, using low-flown photography for 1:2,500 mapping and 1:40,000 scale photography for 1:5,000 mapping.

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To complete the mapping programme in a timescale acceptable to customers, OSi used a mix of in-house and outsourced work. This included the recruitment of 40 additional technical staff in early 2001 to provide additional in-house capacity. In practice, however, the bulk of the 1:5,000 mapping was completed by five contractors using six production facilities in Northern Ireland, Scotland, the Czech Republic and India.

At the date of writing (late January 2005), the databasing of all 1:5,000 mapping is within two weeks of completion, and fewer than 10 maps at 1:2,500 scale remain for databasing. The completion timetable has been considerably shorter than that predicted in the mid-1990s, due to the use of additional in-house staff and outsourcing.

The 1:1,000 mapping of urban areas has not been reviewed at this stage, although annual revision cycles have been put in place and maintained. The accuracy of the mapping has met customer requirements until recently, when the wider use of GPS has led to some users querying the absolute positional accuracy of some areas of the mapping. OSi's response to this is described later in this paper.

3.2 Operational Lessons

The last 10 years have seen approximately 100 OSi staff working on the new mapping programme, and up to 250 contractor staff in the outsourced production sites over the last three years. This has been a very considerable exercise. Its early completion is witness to excellent progress being made, and the resulting data is of a good quality. In this regard, OSi has been able to make full use of its existing Sysdeco databases, allowing the 'multicoding' of features, for instance recording that a feature is a hedge, the edge of a land parcel, the edge of a road, and a townland boundary. This multicoding will later enable the full attribution of the feature as OSi's databases develop.

One key strength of the tracing-off of features from the old mapping has been the ability to provide detail in obscured areas. In 1:2,500 mapping, field revisers have visited such areas and confirmed or amended the detail of the features. Having a set of features to revise has, however, allowed very significantly better productivity and accuracy to be delivered than a reviser starting from scratch in an area where, by dint of tree coverage etc, GPS could probably not be used reliably. In 1:5,000 areas, no ground verification process is in place, with the data retaining the relevant trace off code as information to customers. The lengthy experience of OSi photogrammetric staff, however, has allowed a high level of interpretation from the photograph. The trace-off method has also allowed mapping to be made available to customers (with suitable coding on the traced off detail) despite limitations on ground visits, either because of lack of permission to enter land, or a more general prohibition in the summer of 2001 when the outbreak of Foot and Mouth Disease in Northern Ireland led to OSi withdrawing all field staff from agricultural areas of the State for some months.

The 1:5,000 mapping programme was OSi's first use of outsourcing for mapping programmes, and its largest single outsourcing. Prior to this, OSi has outsourced specialist operations such as high-altitude flying and, more recently, map printing. Relevant OSi

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managers took a good deal of advice from other national mapping agencies which had used outsourcing, particularly OSGB, and in light of that advice developed a tendering and quality assurance process. Inevitably, however, OSi has learned a number of lessons from such an extensive outsourcing exercise. In summary, the main lessons have been as follows:

– It is vital to take sufficient time at the start of the contract, after the awarding of tenders, to ensure that all parties are fully clear on all aspects of the requirements and the specification. There is a natural desire to start producing and databasing mapping, but a pre-production phase allowing the proving of methodology and understanding is essential to ensure that reliably high quality mapping is produced;

– Close, collaborative working between client and contractor is also vital, with the links being necessary at commercial, senior technical and operator level. This requires regular face-to-face interaction at all levels, to augment telephone, email and formal reporting channels. In OSi's opinion, the operator interaction is vital to ensure that there is client confidence in the processes and operators used by the contractor, and to ensure that nuances of the specification are flagged and clarified at an early stage, rather than waiting for submission and testing of a block of work some weeks after its initiation. OSi believes that such interaction requires OSi operators on the ground in the production centres for extended periods (some weeks and more) at the early stages of the project;

– The methods used for acceptance testing completed mapping need to be developed and adapted in light of circumstances and quality being achieved. OSi began with a sample acceptance testing system based on blocks of mapping. It became clear that a more thorough testing was required, both to provide OSi (and its customers) with assurance of the quality of the mapping, and to provide detailed feedback to contractors on the quality issues needing to be addressed in future work. A 100% sampling method, involving both photogrammetric and graphic tests, was therefore implemented and proved successful in addressing issues and delivering mapping to the required quality.

3.3 Market Lessons

Perhaps the overriding lesson from the market is that customers 'write off' past developments almost immediately. OSi's customers have for many years been awaiting the completion of vector mapping coverage of the State. Now that this is within sight of being completed, they are focusing on the range of developments needed to the mapping and spatial databases to meet their ongoing needs. This is, of course, inevitable, but nonetheless frustrating to the supplier on occasions.

One early issue with the 1:5,000 mapping programme was to agree the specification of the data. In the very early days of the programme, in light of customer input, a simple specification focusing on land parcel boundaries and roads was developed and was implemented for some areas. This met the needs of some particular customers. One of the key marketing issues for a national mapping agency, however, is the requirement to meet the need of a wide range of customers, with varying needs (and budgets). It therefore soon became clear that a richer specification was required for 1:5,000 mapping, and this was put in place prior to the commencement of outsourcing. In fact, the specification is very similar to that for

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1:2,500 mapping, with the key difference being the amount of ground change expected and therefore the revision cycle.

Another key requirement of customers was for OSi not to focus solely on new mapping, although to give this a very high priority. This required careful balancing of OSi's resources, and constant responsiveness to the requirements of customers, to ensure that the balancing of constrained resources was at the very least acceptable to key customer groups. Some amount of planning for the future, for instance to develop a flowline for the first revision of the newly created 1:5,000 mapping, was necessary alongside the completion of the new mapping programme. There was also the need to continue to reduce revision cycles on vector mapping, to develop a wider range of medium-scale products to meet the needs of the route navigation market and others, and a need for ongoing specification enhancement. Ongoing planning was needed by OSi to meet the needs of customers, including a crucial element of rapid-response to key customers to meet particular demands.

OSi has, as set out in its remit earlier in this paper, a requirement to educate current and potential users of spatial data as to its benefits and possibility. This can at times conflict with the old adage that the customer is always right. Again, a balance has been required, with key OSi technical staff supporting marketing and sales staff to allow customer feedback as to priorities, to provide customers with clear statements of OSi's plans, but also to ensure that customers are aware of what can and cannot be achieved with various scales and specifications of digital data.

In all of this, OSi has, as all organisations do, had to face the inevitable trade-offs between time, cost and quality. Time was to a large extent tackled through the use of outsourcing, but debates have of course continued as to the specification required for a mapping dataset, the cost of producing it, the customer demands (and budget) for it, and the timescale in which is required. This has been rationalised by OSi as seeing the end of the new mapping programme as a very important watershed for OSi, and for the spatial industry in Ireland, but also as the opening of a new chapter which might appropriately be titled 'ongoing data enhancement'. OSi's plans for this chapter are described in the next section of this paper. In this way, OSi has ensured that it has delivered on the key need of its main customers – vector mapping – in an acceptable time-frame and within available budgets, whilst committing in advance to a structured programme addressing all aspects of quality.

4. THE NEXT CHAPTER

4.1 Market Developments

As in the case around the world, the requirements of the market for spatial data continue to develop. Particular issues in Ireland at present include:
–   A requirement that data becomes more and intelligent, allowing its automated use in a wider and wider range of activities, and more interoperable with a range of spatially-related data supplied by other organisations;

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– The wider range of industries using spatial data, with for instance insurance companies and delivery companies now seeing the benefits of spatial data in their operations, but not seeing it as sufficiently core to the business to pay significant amounts of money. In this regard, OSi considers there to be two categories of business users of its data: corporate and commercial. In the former case, the breadth of requirements for spatial data is sufficiently wide for the data to be seen as a corporate resource, with significant IT investments needed; in the latter case, a business case for the purchase of spatial data for a particular set of operations needs to be made;

– A continuing downward pressure on prices for spatial data, coupled with European initiatives such as INSPIRE which raise again the question of 'data for free'.

These issues are not unique to Ireland: see Lawrence, 2004, for a GB perspective on the issues.

4.2 Irish Spatial Data Infrastructure

The development of an Irish Spatial Data Infrastructure (ISDI) is underway, with elements such as OSi's vector data now being in place. Another key element is the move of the Land Registry to a digital mapping environment, something which will commence this year. A range of digital spatially-related data is in place in various organisations and industries; the challenge is to make it seamlessly interoperable, and to deal with the related legal, technical and commercial issues.

This work is being progressed through an Inter-Departmental Working Group chaired by the Department of the Environment, Heritage and Local Government. This Group includes representatives from key bodies including OSi and the Central Statistics Office, and appropriate academics. A consultation document on ISDI issues was circulated in 2004 and elicited a good level of high quality responses. The Group is now in the process of developing a draft policy on ISDI for presentation to Government. The Government has already formally mandated the development of an ISDI on two occasions: as part of an action plan on the Information Society (Ireland, 2002); and to underpin the Government's National Spatial Strategy. It is anticipated that a draft policy will be presented to Government for approval in the middle of 2005.

In parallel with the work on developing a formal policy, and on representing Ireland's viewpoint to wider initiatives such as INSPIRE, a number of operational proofs of concept are being developed. These include the development by OSi of a GeoPortal, the creation of a GIS Test Bed covering 7,000 hectares of mixed areas in County Clare, and the enhancement of OSi's Boundaries dataset to include a wide range of boundaries (for further information, see OSi, 2002).

4.3 Data Assessment and Enhancement

At the heart of the next chapter, to run from 2005 to 2007, in OSi's activity is the enhancement of the large-scales vector database. This programme of work incorporates the bringing of all large-scales mapping fully to current specifications (which have inevitably

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developed during the 10 years within which the new mapping has been created), and the bringing of all mapping fully within the target revision cycles.

A programme of work to deliver this has commenced. In parallel, the options for reducing the revision cycles still further are being investigated, including systems for allowing customers to provide information on where ground change that is key to them, has taken place. This will, in essence, be a digital equivalent of a plastic trace showing ground change. Options being considered include that, in return for providing the information, the customer will be provided by OSi with a commitment that the change will be included in the database within a certain time period.

The enhancement of the large-scales data will be undertaken in a systematic manner, and will work on a geographical basis so that the first county will be completed by the middle of 2005. This will be a vital component in an ongoing customer education and interaction process. OSi recognises that full use of the benefits of the richer data by customers will require significant developments in customer processes and systems, and the availability of a full county to the enhanced specification will allow the testing of these implementations. Linked to this is a move from the old coordinate reference system, to a GPS-compatible system, which can be effected by customers in the same time-frame (Cory et al, 2003/04).

Another key piece in the data enhancement programme is the collection of statistics on the quality of OSi's data. With recent work in ISO/TC211 (ISO, 2001), the dimensions of quality have been defined, and OSi commenced in 2004 a systematic quality assessment programme to measure OSi's performance against these measures, as a first step in improving, and the putting in place of targets for these improvements. The results in terms of positional accuracy for urban areas of mapping will also allow OSi to make evidence-based decisions on any necessary resurvey of urban mapping.

All of this will be linked with the development of new products and services to meet developing market needs. In the short-to-medium term these will include the creation of very accurate height models using LIDAR, and the creation of a wide range of products and services based on historic mapping, the scanning of which OSi will complete during 2005. Resources freed from the new mapping programme are now being channelled into this work.

4.4 Systems Developments

The rate of development of technical systems continues to gather in pace. OSi's supply systems are in the final stages of being replaced by a web-based system that will cater for OSi's own supply operations, and our mapping Agents. It also has the capability of being expanded to allow for Internet-based purchase of mapping.

OSi has also recently completed the development of a new master spatial database, based on Oracle systems, which will allow the development of a richer data structure (including moving multicoding into full-blown data attribution). This database is currently being populated and some of the richness can be realised immediately. Other elements require the

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completion of the data enhancement programme, meaning that a national version of enhanced data structures will not be available until the end of the data enhancement programme. In this work, OSi will continue to work closely with customers, to enable them to understand the data structures and schemas proposed, and therefore to make informed comment on these crucial medium-and long-term developments.

Future developments will include the ability to create medium- and small-scales data automatically from large-scales data, something which OSi is fully allowing for in its data structures, and additional imagery information available through digital aerial cameras. OSi will continue to push forward in the implementation of new technology, allowing the organisation and its customers to benefit from the new possibilities that they bring.

5. CONCLUSIONS

Perhaps the overarching conclusion of this paper is that a central competency required of a national mapping agency is the ability to balance:
– As a public body, it must balance a business and a social focus;
– With a range of customers, it must balance their varying needs whilst never producing a compromise solution that satisfies no-one;
– With a range of linkages to other organisations in the public and private sector, nationally and internationally, it must balance the inevitable tensions between them, with these likely to increase as SDI initiatives pull increasing amounts of spatially-related data together;
– It must balance the work that the national mapping agency will undertake itself, and that which will be undertaken by the private sector organisations that exist

With expectations continuing to rise, for instance for data of a higher specification and increasingly more rapid revision cycles, coupled with ongoing developments in technology requiring careful and timely investment decisions, the need for this ability will continue to grow.

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BIOGRAPHICAL NOTES

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