

THE FOUNDATION OF A GEOGRAPHICAL INFORMATION SYSTEM FOR NORTHERN IRELAND

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Northern Ireland, small and compact, geographically well defined with a relatively simple administrative structure, has a unique opportunity to reap the advantages from the establishment of Geographic Information System. This paper describes the beginnings of the formation of the topographical part of the database, which will form the basis of such a system and the first part of this sophisticated spatial database. It identifies the benefits including financial ones that are to be gained within the Public Sector from the introduction of information technology including computer graphics. Here much of the information (in parts 80%), required for the proper management of municipal and utility functions or facilities and for the efficient provision of service to customers, is common. It will describe how in Northern Ireland user needs have been identified, and the organisational structure necessary to continue to do so has been constructed. This will assist in the acquisition and development of compatible systems to achieve maximum advantage. It also outlines the method of extension from a solely topographic database into an integrated system for the storage, exchange and use of spatially related data within the Northern Ireland Public Sector. This extends even to Remote Sensed data from the Northern Ireland Regional Remote Sensing Processing Centre, which is to be established in 1986 at the Ordnance Survey of Northern Ireland and ultimately interfaced into the topographical database.

CONCEPT

In common with many other organisations, the rapid growth in both the requirements for and techniques of information technology during the past decade, the Ordnance Survey of Northern Ireland began to look at the possibility of replacing its conventional map production (using largely manual techniques) with a computerised system. The concept involved the conversion of geographical data into digital form, their storage in computer systems and their subsequent manipulation and display. In late 1981 a feasibility study on the provision of a digital mapping and topographical database and its implications was begun. This concluded that the current topographic archive should be digitised over a ten-year period using a commercially available 'turnkey' system. This would provide a complete topographical database for Northern Ireland in digital form and establish the basis of a single integrated geographical information system.

Geographical information may be defined as all information that can be spatially referenced using a common system of geographic co-ordinates. All information, whether it be about a water stand pipe, a traffic incident or an unemployment record has one thing in common - a location. It is this positional location, often indicating causal relationships that is the common factor. All Ordnance Survey of Northern Ireland mapping is based on the Irish Grid (as is the modern mapping for the whole of Ireland), using a Universal Transverse Mercator Projection. The geographic position (co-ordinates) of any feature of the map is therefore the unique 'hook' to which all other data sets can be tied and so provides the common link between them. Thus the Geographical Information System would hold digital geographic data for, say, housing in any chosen areas, and a whole plethora of information - population, age structure, valuation, services networks, etc - would be related to the positional data. Many organisations already require positional data in digital form and as the system develops demand for this will grow. The possibilities that are provided by a properly constructed and managed Geographical Information System are almost limitless.

INTEGRATED APPROACH

The single most important feature in our thinking is that the system should produce a DATABASE - not simply a cartographic databank. Such cartographic databanks are fine for producing cartographic maps or digital 'backdrops' but are quite unsuitable for manipulation for other purposes. Our ultimate goal is a true Geographic Information System. Herein lies the essential difference in our approach from that taken by many organisations in other parts of the world.

To assist in achieving this goal Liaison Committees were set up bringing together the many public services concentrated in Northern Ireland government departments as well as other major organisations in the public sector. These included those bodies responsible for land registration, water and sewage, roads, planning and electricity services as well as police, housing, telecommunications, agriculture, forestry, economic development, health and social security. The function of these committees was and still is to advise on the structure and form of the

topographical database and on the programmed population of it. They also carry out a vital role in the spread of information amongst members regarding the requirements of data exchange and the progress of computerisation within each organisation, and they have an increasing co-ordinating function.

This establishment of user needs was and is fundamental to our approach. From the beginning, the objective was the systematic introduction of an information system - and perhaps Northern Ireland is in a unique position to benefit from computer-based spatial data: It is a geographically compact area of some 14,000 square kilometres, with a population of approximately 1,500,000. Thus the database will be of a size that is relatively easy to manage. However, to put the size of the project into perspective, it is estimated that the topographical part of database alone will be about 20 gigabytes in volume. This emphasises the problems to be experienced elsewhere. Northern Ireland also has a comparatively simple administrative structure, where most of the local government and utility-type services are run directly and centrally by government departments. This leads to little or no geographical conflict in demand between requirements from different user sources. Thus we have a compact and simple environment within which to operate, to assist in the production of a single integrated system, with no duplication of effort in data capture and a ready sharing of data - providing an early start was made.

This latter point is vital because in Northern Ireland until recently most of the organisations concerned had not introduced computer technology except for financial and administrative purposes, eg, pay invoicing, customer records, etc. Therefore we have a clean page, so to speak, upon which to write without having the constraints of previous system procurement decisions and of data conversion. Large computer files of statistical information and cabinets and plan presses bulging with maps and written records are of limited use if accessing them is a clumsy business and they are difficult to relate to the real world. This especially so if they are prone to damage and costly to maintain.

Public utilities and other bodies base many of their administrative and service records on maps. The availability of suitably structured digital databases containing both graphic and non-graphic linked information will provide them with fast and flexible means of storing, retrieving and manipulating this information. Northern Ireland is determined that users of topographical information do not experience the incompatibility problems in utilising digital data now being encountered in many places elsewhere. For this reason it is important that all user organisations' systems are capable of linking into an integrated geographic information system. Compatibility is therefore the essential element.

Political support for this integrated approach has been forthcoming because the wisdom of avoiding duplication of the digitisation of topographic information by public sector bodies has been realised. This thinking extends even to other information used by public sector bodies where, in parts, 80% of that required for the proper

management of municipal and utility functions and for the efficient provision of services to their customers, is common to more than one organisation. Information should only be collected or converted to digital form once, by the appropriate authority and to the proper standards, so that it may be used by all. It is thought that in Northern Ireland the Ordnance Survey is the natural originator of standards for production for digital maps, such standards being essential.

BENEFITS

Availability of a digital topographical database provides many already well-known benefits: Gone are the constraints of map sheet lines and of conventional content and output specifications; and there is the luxury of scale-free data that can be extracted selectively or used in conjunction with data from other sources.

The financial benefits are much more difficult to quantify - particularly as many of them accrue to other organisations, and not in the immediate future. We are in essence making a necessary investment in the infrastructure of the nation for the future. However the fact that many organisations worldwide, and an ever increasing number of them, have both the requirement and the justification to computerise their own graphical records for some applications, which in turn need a topographic base for full utility, indicates that these benefits are real. The main stumbling block or constraint for many is the non-availability of the topographical data and the cost of its provision not only in financial terms but in other resources including time. In Northern Ireland the financial justification is soundly based on non-duplication of data conversion and on the realisation and acceptance that additional and larger benefits accrue when the information systems of the entire Public Sector is linked, thus allowing the free exchange of information between those that require it. It is interesting to note that it has been conservatively estimated that the savings on the topographical data only could amount to some ten times the investment within the Ordnance Survey.

SYSTEM PROCUREMENT

The Ordnance Survey of Northern Ireland sought a computer-based system with the following broad objectives:-

- Capture and maintenance of the map archive in scale-free digital form over an initial ten-year period;
- Use of this digital archive for all map production;
- Creation of a fully structured topographic database to allow flexible extraction and manipulation of archive information by the Ordnance Survey and various other public sector organisations;
- Integration of the topographic database with other organisations' databases at their sites for convenient exploitation by them;
- Provision and development of all these services into the indefinite future.

Following evaluation of the output from a comprehensive series of Bench Mark Tests designed to identify suitable 'turnkey' systems, equipment was bought. The system configuration operates within a VAX environment, and as the database grows additional data storage will be acquired as necessary to hold the estimated 20 gigabytes of topographic information for Northern Ireland.

DATABASE

The design of the topographical part of the database is crucial. From the outset it was realised that ultimately a fully relational-type database would be required. Although there are a number of these presently available the full development of this type of database is still in its infancy. As a result it was decided initially to simulate a relational one to facilitate the eventual translation of data.

The major element of any investment into any such project is not the capital hardware or software part of the system but in the data itself. With a data capture period of up to ten years (a workload well in excess of 400 man years), the database structure must be very carefully designed to allow for portability and currency. In essence we are planning for a year 2000 system in the year 2000. Thus the design must be flexible enough to allow for the as yet unknown requirements of the future.

It is only on a project like this, when one dissects a map with its mass of information both specific and implied, that its value as a vehicle for the storage and transmission of information is fully appreciated. The topographical part of the data will have in excess of 140 main families of data, but it is intended that much of this structuring and its further breakdown will be done automatically by using computer files held by other organisations. For example, buildings could be classified by their usage or other attributes from information held in valuation records, eg private or government: dwelling or commercial; retail outlet or office etc.

THE WAY AHEAD

The basic task is to capture the map archive in digital form by 1995 or before, as it is intended, because of user demand, to accelerate this programme using a number of methods including automatic data conversion by raster scanning.

The first phase involved digitising the urban areas which are mapped at 1:1250 scale, these being the areas of greatest ground development and therefore the areas where public utility network information, etc, is most densely concentrated. The Greater Belfast Area will be available in digital form in 2 years time and by late 1989 the topographical information of all urban areas will have been converted. Rural areas will follow and throughout the ten-year data-capture period the stored digital information will be maintained up-to-date by direct input of automatically recorded field data. As well as the large-scale database, a small-scale database derived from the 1:50 000 series maps will be established in parallel within the first 3 years.

In addition, with the establishment of the Northern Ireland Regional Remote Sensing Processing Centre at the Ordnance Survey, remote sensed data from both satellite and aircraft will be available in digital form to assist in such studies as soil classification, agricultural crop and disease identification, pollution control, etc. Ultimately the Regional Centre will be interfaced directly with the topographical database system, thus providing a very powerful information tool. Airborne campaigns this year to capture data at five metre resolution of selected parts of the Province as well as data from Spot Image and the Thematic Mapper are underway, leading to a series of project orientated investigations.

Users, including the Ordnance Survey, will be able to access the system as soon as it contains data of interest to them. By then they will have developed their own compatible computer systems running a databases containing their own specialised data and it will be possible for users to manipulate the topographical data and their own as required for their unique purposes. A number of pilot schemes to be conducted in conjunction with our colleagues in the Water Industry, Land Registry, etc, will start this year as a beginning of the extension of the use of the system.

In addition, a project bringing together the Ordnance Survey, Water Service and the Institute of Hydrology is progressing. This contains topographic information, which includes relief, in the form of a DTM and river systems with the output of river telemetry stations. This will enable not only a series of graphical outputs of water quality, flows etc and all their derivatives, to be produced but also the opportunity to undertake computer modelling exercises. Other plans include a soil survey of Northern Ireland which will be 'digital', and studies to include the incorporation of Geological information in the system.

When several users are connected to the system, each of them will be able to extract data not only from the Ordnance Survey system but also from each other systems (subject to access privileges) and to manipulate the total data as necessary. As the number of users sharing information in this way increases, the system will constitute a continually improving Geographic Information System for the benefit of all.