DIGITAL MAPPING - AN INFORMATION CENTRE

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ABSTRACT

British Gas South Eastern has used the experience gained in its Digital Mapping trial to study the end users data access requirements and the use of information in geographic and alpha numeric form. The paper studies the historical use of maps, map based records, conventional mapping and existing alpha numeric data systems. The developments that have given the planning and operational engineer access to geographically based information through low cost workstations, "the Engineers Information Centre" are also examined. Many of the non-engineering departments within the organisation also hold map based records and the advantages of linking these to a single map base to form the "Corporate Information Centre" are discussed.

INTRODUCTION

Digital Records

Digital Records are referred to as AM/FM in North America, an abbreviation of Automated Mapping and Facilities Management. This North American jargon sounds impressive, but its meaning is not clear in the United Kingdom. AM/FM broadly is defined as computer aided cartography (AM) and the management of the business or information that can be made from records that are associated with the map (FM). To explore the potential benefits offered by Digital Records within the Gas Industry, we need to understand why the Industry maintains map based records, what these records are and what other existing records systems are used to store information.

The largest map user in British Gas is the Distribution Department which is responsible for 210,000 Km of underground plant held as records on some 90,000 large scale map sheets. These map records are the key to an Information Centre. The other map based records maintained by the Engineering Department, together with existing alpha numeric computer files, form the basis for creating a fully integrated Digital Records System.

HISTORICAL USE OF MAPS

Early Recording

Towards the end of the Nineteenth Century, the small Gas Companies had information requirements similar to today's organisation, though naturally, this information was much smaller in volume. As gas mains were laid, their position and depth were recorded relative to existing geographic features often in "Book Form" as sketches and not to scale. Annotating the sketch were details of the pipe, its diameter,

material, its length and other information, who laid it and, sometimes, the cost of labour and materials. These records were ideally suited to their purpose as the same person was often responsible for the planning, construction, maintenance of the gas supply system and service connections to customers. Under these circumstances, these books could almost be considered to be personal information systems.

Early Planning

The need to plan the gas supply to a town and the expansion in terms of the number of staff involved meant that the book records became inadequate as a planning tool because it was impossible to maintain an overall perspective of the network or see any geographical relationship between one street and another. Some form of map base had to be used. Map sheets at 1:2500 scale were chosen and the main's position drawn from the book records.

Due to the limitation of scale, not all the information from the books could be recorded on the map. Consequently, the line of the main, diameter, depth and some principal locations were all that could be transferred to the map to retain legibility.

Two Early Record Systems. These two record systems, book and map, had to be maintained in parallel. A straightforward task, though subject to error even if under the control of one person. The introduction of more than one person maintaining the records became the source of accumulated potential error.

Towards Today. During this century, the Industry's needs and expectation of its map based records have changed and developed. Today, many map based systems of recording are maintained, often with record transposition from one system to another, in order to meet the demands for information that a modern utility imposes from its record systems.

CONVENTIONAL MAP BASE

Large Scale Maps

The master records of the Gas Network are held on paper or polyester film 1:1250 and 1:2500 scale Ordnance Survey. The maps show the route of buried plant and use line styles to differentiate between mains of differing pressures. They also indicate a limited range of other features. The Ordnance Survey National Grid at these large scales also provides a convenient, though not ideal, referencing system. To disseminate and communicate using the information, several mapping systems are maintained, each type containing the line of the main as a common entity and added details appropriate to its user needs. To achieve the aforementioned, there is a fundamental need to record the plant's relative geographical position to the surrounding geography and to maintain that record to ensure the plant's relocation at some time in the future.

As-Laid Drawings

The use of multiple line widths and styles at 1:2500 scale to represent mains means that it is impossible to draw them in their true geographical position when one or more are laid adjacent in the same street. To overcome this congestion, as-laid records at 1:500 scale or larger are produced by photographically enlarging the large scale Ordnance Survey maps and scaling the mains position from on-site measurements.

Detailed Sketches

Adding dimensions to large scale maps can cause congestion of information. Placing sufficient detail at complex junctions and mains connections can lead to confusion when trying to interpret the map on site. Detailed sketches, often freehand, are made and referenced from the map for these complex areas.

Other Large Scale Map Records

The Transmission System is recorded in addition to the master map on large scale maps, normally covering rural areas and contains precise locational information. Smaller scaled maps are used and maintained for Pipeline Act details and wayleave plans.

Planning

A separate system exists to enable expansion of the Gas Network to be made into areas of new housing or expand within established areas. This is achieved by using the developer's plan and adding the proposed gas mains. New building developments are photographically reduced and incorporated into the existing record at the appropriate scale when the developments are completed. In some cases, when the supply of the hitherto unpublished survey information (SUSI) is made available by the local Ordnance Survey Office, this is also incorporated into the map. If this updating system is used, the Gas Industry's mains and plant will need to be repositioned on the map to fit the new geography. This ensures that the relative position of the mains, plant and geography is retained.

Out-of-Hours Cover

To provide copies of the mains records to staff outside normal office hours, the large scale map sheets are microfilmed. The resulting fiche are distributed to appropriate personnel. A regular updating programme ensures that the sheets on which changes or additions are made (which represent approximately ten percent every six months) are refilmed and exchanged in the field.

Network Analysis

The analysis of pressure, consumer load, flows and their behaviour under various climatic conditions is used today in the operation and planning of gas supply networks. Large scale based records of plant are maintained for this purpose as separate drawings from the master record which, for operational reasons, are normally kept in various offices.

Conventional Map Base Summary

The volume of information that can be held on a map is limited by scale and the need for clarity. To overcome these difficulties the Industry maintains several map based systems at various scales, each containing detail appropriate to the user's needs. Transposition from one system to another causes progressive loss of accuracy and is labour intensive. The need to amalgamate records and maintain one map based system is clear.

ALPHA NUMERIC COMPUTER SYSTEM

Management Information in Engineering

In the late 1970s details of all mains that were maintained by the Distribution Department were transferred onto an alpha numeric computer system known as M.I.N.E. (Management Information in Engineering). This transfer required all mains to be defined as administrative units within a street. Each mains unit consisted of a section of main of the same material, joint type, age and approximate position, subject to a maximum length. A unique number identifies each street and each unit number within the street, together with a description of where the unit starts and finishes. A total of fifty items of information are held against every street and mains unit. This system enables management statistics to be automatically generated. To achieve this, job instructions are issued through the computer and information about completed work captured in alpha numeric form.

Planned Mains Units. As new mains are planned, they are described as planned mains units then added to the alpha numeric record. When the main is laid, its status is changed. This system is adopted for various operational reasons, changes to the proposal are sometimes made on site which may result in new units being created or destroyed and proposed mains are more easily altered if held at a different status.

The system has been very successful. The information being used is, by its very nature, geographically based and the system will be enhanced by the provision of direct access through a computer map.

Network Analysis

The large scale maps are used to show the position of nodes to define network analysis units. These contain data on the pipes: length; material; size and potential load. The unit definitions are held in alpha numeric form, which is subject to continuous revision as the network changes.

Details of gas demand are generated from Customer Account files and the flow and pressure between nodes is calculated across the system, taking into consideration the major factors that affect the gas network. Alterations can be made to establish the predicted change that will occur when one or more of the basic network design criteria are altered.

The output is normally in alpha numeric form. This is not ideal and often requires relating to a map or schematic network diagram for clarity.

Other Computer Systems

The Industry maintains other computer systems in non-engineering departments, such as Customer Service, Sales, Customer Billing. Many of these often contain a geographic association, which will be discussed towards the end of this paper.

The two major engineering systems, M.I.N.E. and Network Analysis, are naturally geographically based and form the basis of discussion here.

DIGITAL MAPPING TRIAL IN BRITISH GAS SOUTH EASTERN

British Gas South Eastern commenced a Digital Mapping Trial in July 1983. A multi-disciplined Project Team was formed and digital mapping equipment purchased. The aims of this project were to:

1) Substantiate the benefits of digital mapping.
2) Measure the impact on Engineering Standards.
3) Establish computer guidelines for digital mapping.
4) Research the secondary capabilities of digital mapping.
5) Investigate the effect of digital mapping on the organisation.

The Horsham District in the Sussex Area was chosen for the trial. This was selected for several reasons - the District's proximity to Gatwick Airport meant that major residential and commercial developments were taking place; the mains network was expanding; the District was an example, in miniature, of the Region's Engineering activities; total coverage of the District by the Ordnance Survey of maps in digital format.

Statistics of the Trial District

The Horsham District consisted of:

46,000 consumers, 600 Km of main, 7,600 M.I.N.E. mains units and 240 large scale digital map sheets in a gas supply area of 135 Km^2.

Prototype Design

An extensive and detailed analysis of organisation procedures and use and maintenance of the existing conventional maps. Following this analysis, a prototype digital mapping system was designed and demonstrated to all levels of staff and management. It was this prototype that formed the basis of our subsequent developments.

Procedures and programs were written to assist the take-on or conversion exercise to bring the digital Ordnance Survey maps up to date and transfer the mains and plant record.

Fundamental System Design

Colour. Underlying our whole design was the fact that colour was a fundamental requirement. The rapid identification of different categories of gas mains, other utilities plant and various geographic features can be made by the operator due to the ease with which feature recognition can be achieved through colour differentiation. The scope of design offered by colour also adds significantly to the arguments in its favour.

Geography and Mains Files. It was found necessary to aid and increase data flexibility to ensure that mains could be easily identified for inter-utility exchange and network analysis. To achieve this, geography and mains needed to be separated in the computer system. Maps are held as conventional map sheets. Mains are stored as logical networks geographically related but not stopping at map sheet edges.

Base Map. The digital map had to be capable of displaying, in a readily identifiable form, data relating to Existing, Proposed and Historic geographic features in any combination. These may be referred to as "time" structures; each must contain details of kerbs, street names, buildings, fences, house names and numbers, all of which must be capable of being turned on or off in the display.

Mains and Plant. As with geography, the mains and plant had to be capable of displaying existing, proposed and historic information, in any combination. Within each mains "time" structure, mains of various operating pressures must also be displayable.

Data Base Attachment. By drawing the mains onto the computer file as mains units and forming a link between them and the associated alpha numeric record, the first major step was taken to establish the "intelligent map". In addition to the graphic information normally held on a conventional map, it was now possible to use this to gain access to all the information held in the system.

DIGITAL RECORDS UPDATING

The processes and procedures used to control and validate the take-on exercise are well documented (Cross, Branch 1984) (Mahoney 1985). These basic conversion techniques form the core of the system used to maintain the digital maps and associated plant records. The updating of one record which will automatically adjust all associated data is a long term objective. The immediate task is to use digital records updating as the key system that can ensure all geographic data and associated alpha numerics are in unison. To achieve this, it is necessary to install software and introduce administrative procedures.

Under the manual recording systems, when new mains are laid dimensions are taken that locate the main relative to geographic features. These dimensions are recorded on "freehand" sketches from which the 1:2500 or 1:1250 records are updated. Copies of the updated record are used by M.I.N.E. and Network Analysis to update the appropriate records.

Four separate systems, often in separate locations, are thereby maintained. Digital Records form the link to ensure that the records are now related and validated. This is achieved through the use of customised facilities.

Site Recording

Dimensions between plant and geographic features are recorded on site onto a 1:500 scale screen dump which has been taken from the screen printer prior to the site visit. This saves the time taken to make an on-site "freehand" sketch and confirms that the features being measured from are on the map.

Input of Dimensions. The dimensions are drawn onto the dimension levels of the plant file using specifically designed user commands that emulate the measurement methods. The completion of all dimensions for a defined area is automatically notified and logged by the system. As with all information, it can be selectively turned on or off when using the system and is accessible to all users.

Local System Management

All work on the system is logged and work allocated to individual operations by a Local System Manager (the Senior Draughtsman). The log is flagged to indicate new sketch information and, when M.I.N.E. is updated, the data base change will also be logged to enable the amendments to the associated mains and plant graphic to be made.

Network Analysis Updates

Developments are being undertaken to create a dual noded mains network on the digital record system. The mains will be drawn only once, and any updating of the M.I.N.E. data base must also adjust the related Network Analysis records.

Common Update

When Network Analysis updates are incorporated, a total records update process will be in operation. A fully automatic update system is now being worked towards.

THE ENGINEERS INFORMATION CENTRE

The first stage in developing an Information Centre has been achieved by linking the geographic information to its associated alpha numeric. If developments cease at this stage, the records could be made available to appropriate personnel; it could have all the advantages of being one centrally held and maintained record. Digital Records, having collected the data, give the opportunity to present map based information in a form more readily understandable by the user through simplified and structured system enquiry methods.

A re-assessment of the need for hardcopy output often shows that the task which the output is requested for can be performed on the graphic VDU. This is particularly relevant to the Planning and Network Analysis user.

Rapid Access and Terminal Use

The geographic based information needs of the user must be fully understood to enable rapid (within 30 seconds) VDU response to enquiries. Conventionally small scale paper maps covering large geographic areas are often used to identify the large scale map, which is then used to find a particular street or property (which may be drawn on more than one map sheet).

The automated system provides direct access to the geography for a street by asking the user to enter the street name. The system returns the appropriate geography (even if it appears as more than one conventional map sheet). Access is then given to the relevant graphic and alpha numeric information available for that street.

User Operations

Presenting the user with geography on the screen poses several questions: What is it used for? What is the end product? Will other information be displayed against it? When will another enquiry be made?

Answers to these questions enable three user categories to be identified. In turn, this allows the type of terminal to be identified for the particular user.

The Limited User. Many enquiries take place to identify items, such as mains associated with properties, planning proposals, site dimension recording and Public Utilities Street Works (PUSWA) enquiries. This user requires data for a short amount of time; the task is performed and another request is made. Low resolution graphic terminals are adequate for these tasks. Witnin Utilities, these will represent a high percentage of the terminals attached to a graphic network.

Professional User. Access to geography, associated M.I.N.E. and Network Analysis information allows the engineer to use the system for detailed data base enquiries; the results being displayed against the appropriate geography or graphic. This is particularly applicable to the planner and operational engineers.

This system use will require a high resolution graphics screen, full graphic manipulation facilities and access to all alpha numeric data.

Record Maintenance User. The maintenance of the map base requires access to the geography as map sheets (which form a convenient method of filing geographic data in the computer). Access is required to mains and plant records, with the appropriate software to manipulate and amend the graphic and associated records. The need to digitise geographic information from Developers, Utilities and Local Authorities requires a full size digitising capability. The accuracy of the digitising surface must allow accuracy to an order of magnitude greater than required for the geographic base. This terminal is the "standard" graphic workstation of the past few years, which deals with large volumes of data for full detailed manipulation and amendment.

They will represent a small percentage of the overall workstations on graphics network required within the Gas Industry.

Engineers Data Base Enquiries

To facilitate the need of the engineer for operational, planning and managerial information, extensive use of the data base and customised graphic commands will be made. Tutorial menus must be developed that will automatically build data base search programs from selected criteria without the requirement of the engineer to master complex enquiry languages. When the appropriate geographic features have been selected, and the data base report criteria defined, the geographic area is identified against which the program will be run. The results of the enquiry displayed against the graphic must be clear and unambiguous. To achieve this, customised display features would be provided. Specified features may be highlighted if they have met a search criteria; for others, reports with completed data boxes on the graphics may be required.

The areas where these techniques are appropriate show the diversity of such enquiries. Examples of these areas are:

Mains Planning	Plant Maintenance
Service Planning	Plant & Mains Location
Network Analysis	Historic Information
Wayleaves	Archaeological Sites
Structure Plans	Hazard Categorization
Boundary Data	Activity Monitoring and Analysis

Engineers Information Centre Summary

Information is easily assimilated when presented in graphic or pictorial form. Allowing the engineer to use simplified rapid access methods, can make information available in the most readily understandable form, using highlighting, colour, linestyle and reporting features. To achieve these results conventionally, alpha numeric reports would be generated and subsequently interpreted by cartographic staff using manual drawing presentation techniques.

The type of terminal on which these enquiries are made is dependent on the principal user requirements, which range from general enquiries to the planner and operational engineer. The advantages and benefits of data base enquiries are only attained by advanced software customisation. These capitalise on holding and maintaining one record and making it available to all users.

CORPORATE INFORMATION CENTRE

The Engineering Department is recognised as the major user of geographic based information. Consequently, developments to date have naturally concentrated on the engineers' use of mains, plant and other associated alpha numeric records. Once this has been completed, the opportunity will exist to incorporate the geographically associated alpha numeric system currently used and maintained by other non-engineering departments. Maintaining only one map base for the organisation and providing customised updating processes for

departments' own overlaid data, will provide wide ranging benefits to the organisation.

Customer Service, Sales, Marketing, Accounts, Transport and Market Research Departments all use maps for various purposes. Information in "picture" form is more easily and accurately assimilated and analysis will show that beneficial facilities can include the areas of gas availability to potential customers, vehicle route planning, meter positioning, planning sales campaigns, potential sales area relating to Local Authority structure plans, land ownership and wayleaves, demographic and strategic studies. This list is by no means exhaustive but provides an insight into the way that Digital Records can be used to interface and make available data for the whole organisation.

To maximise the advantages provided by integrating the whole organisation's geographic and alpha numeric data, direct access to the geography encompassing an individual property must be made available, and eventually the analysis of large areas will require a change in the type of display available.

CONCLUSIONS

Digital Mapping for the Utilities should not be viewed as an end product but as an avenue into the technology of the next century, not only in the way it records its underground investment but by manipulating and questioning that record to make better and more cost effective management decisions. To gain the maximum benefits of introducing Digital Mapping, a long term view must be taken of an Organisation's geographic based information. The initial design should be flexible enough to allow for future usage of the system. Digital Records are more than automated cartography; there are benefits in using the computer to draw mains records on maps, the break-through comes by linking the records to other alpha numeric data systems within the Organisation. Digital Records can be customised to provide rapid access to geographical information and present enquiry results in an easily understandable form on terminals appropriate to the users needs.

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