DIGITAL MAPPING AND FACILITIES MANAGEMENT IN A UK WATER AUTHORITY

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ABSTRACT.

The Wessex Water Authority is responsible for all aspects of the 'water cycle' over an area of some 10000 km^2 in South-West England. Following an early entry into digital mapping (DM), the entire water supply network was digitised by mid-1985. At this point, a state of the art system was acquired, with the primary objective of applying the technology to further aspects of the Authority's operation, with access to the data becoming available to all levels and functions. This paper is in two parts. The first introduces Wessex Water and its approach to information technology; it then goes on to chart the history of digital mapping in Wessex and look ahead to its continuing expansion. The second part explores three specific topics in greater detail, based on experience acquired to date: specifying DM requirements, data capture and operational applications.

1. WESSEX WATER AUTHORITY AND MAPPING.

1.1 ABOUT WESSEX

Wessex is one of the ten Regional Water Authorities set up in England and Wales in 1974. It has responsibility for all aspects of the water cycle, including supply and distribution, land drainage, sewage treatment, pollution control, river management and recreation. The residential population served is over two million, but this increases during holiday periods. Other salient statistics: length of supply mains 17,200 km; average daily quantity supplied 378 ML; total length of sewers 11,300 km; length of main rivers 2355 km.

Since its establishment, Wessex has acquired a reputation for its strong commitment to the use of Information Technology where it can be shown to bring positive benefits. In addition to Digital Mapping, the main theme of this paper, extensive use is made of digital communications, telemetry and Computer Aided Design.

Following an extensive survey, a digital communications network for voice, computer and telemetry data has been established linking all major offices. This provides up to 2 Mbits/sec capacity using a ring configuration to maximise resilience. By means of this, all major locations can obtain access to the centrally-located mapping processor.

The telemetry system covers all significant operational sites with over 350 out-stations. All supply and most sewage treatment sites are unmanned and monitoring and control is carried out by control rooms. One of the main uses is the management of the network, for example in regulating pressure to minimise leakage. Network simulation is used extensively and this will be linked to mapping in the near future (see 1.3 below).

Although systems capable of both Digital Mapping and CAD were evaluated, it became apparent that the optimum solution for Wessex was to install the most effective systems available for each application while at the same time providing links between them for the transfer of data. The CAD system runs on the IBM 'look-alike' mainframe and is the basis of all major new works design carried out by the Authority.

1.2 THE FIRST PHASE, 1979-85.

With considerable foresight, Wessex first made the commitment to Digital Mapping in the late 1970s. Although it was not possible at that stage to achieve the full benefits of the inchoate technology, it was appreciated that rapid developments would soon bring these to fruition.

When Wessex was established in 1974, it assumed the responsibilities of numerous predecessor bodies such as river boards, water boards and rural district councils. As a consequence of this, the map-based records - which the Authority is under a statutory requirement to keep - were particularly heterogeneous, with a wide range of accuracy, symbology and coverage. One of the many benefits of the digital mapping data capture exercise was that it imposed a valuable discipline which ensured that all records met a common standard of accuracy and completeness. Indeed, the number of man-hours spent on digitisation roughly equalled that spent on site surveys and correction of records.

At the time of its inception, developing digital mapping meant exactly that; "off-the-shelf" hardware was acquired and it was then linked up by Wessex staff. Concentrating solely on the water supply function the emphasis was placed on data capture. The necessary software was also written in-house, for example, allowing for the stretch and skew of maps and enabling records based on the old 'County Series' maps to be digitised according to the Ordnance Survey National Grid. At a later stage, software for data extraction - for example, according to street name, or summing lengths of main by their properties - was developed.

By 1984, digitisation of the supply network on the in-house system was largely complete. Increasingly, however, a sense of frustration was being felt that this substantial database was not realising its full potential. In particular:

(i) direct user access to the system was limited;

(ii) map boundaries were present, as with paper maps, and these constituted a major limitation;

(iii) there were no facilities for map backgrounds;

(iv) the handling of attribute or non-graphic data was limited;

(v) the extension of the software to cater for sewers, rivers and other aspects would require several man-years of development and even this would fall short of what had become commercially available;

(vi) interchange of data with other systems was difficult - this included not only Wessex' mainframe applications (CAD, network analysis etc) but also plant data from other utilities.

The intermediate stage involving the acquisition of a replacement for the in-house system was lengthy and detailed, as befits such a major capital investment. It is the subject of a separate section (2.1) of this paper.

1.3 1985 ONWARDS.

In spring 1985 a DM/FM system was selected by the Authority which it was believed came closest to meeting the multiplicity of requirements in both the short and longer terms. The chosen configuration was a VAX 11/750 processor, centrally located adjacent to the mainframe, with initially two workstations, one for development and one for operational trials. A further two workstations were acquired in spring 1986. In addition, there are a number of 'enquiry stations' based around the IBM-PC. All hardware is linked via the communications network (see 1.1). The option exists to upgrade the system in a number of ways.

In addition to the central system, an essential part of the overall contract was several items of custom-built software. Firstly, this provided the ability to transfer from the old system the digital supply network data which represented a substantial investment in man-years of effort. Secondly, it made possible the two-way exchange of maps between DM and the Authority's CAD system; for example so that background maps could be shared between systems. Thirdly, it provided direct links between the mapping and mainframe computers, for a number of reasons, some of which are discussed below.

The clear intention when Wessex made its investment in Digital Mapping was to realise the benefits as rapidly as possible. To this end, a number of developments are now taking place in parallel, each of them selected to maximise cost-effectiveness.

Water Supply. The database inherited from the in-house system is beginning to be used as the definitive plant record. Operational staff have been given the software 'tools' to update this record as changes are made to the network. Time series data, which was previously recorded manually, relating to bursts and similar incidents will shortly be added. In this way management will be able to quickly review the 'burst history' of the network and the replacement programme can be more accurately tuned to the condition of the assets. In the longer term, the considerable attribute database - including diameters, materials, C-values etc - is expected to provide the static network data for network analysis, thus giving the usual benefits in terms of reduced redundancy and inconsistency of data.

Recovery (Sewerage). Digitisation of the sewers in one of the major urban areas of Wessex is expected to be complete during the third quarter of 1986. In addition, a number of methods of inputting sewer and manhole data 'on site' are in use - these are discussed in section 2.2. Sewers represent a major asset, much of which is now in a state of disrepair. Wessex, like other UK Water Authorities, is drawing up a sewer rehabilitation programme and information on sewer condition is a vital input to this. Digital mapping provides a means for recording this information logically and consistently and also collating and presenting it in a format appropriate to management's requirements.

River Management. The relationship between abstractions, discharges (including pollution) and river flow is fundamental to the achievement of the Authority's objectives. River data will show the numerous sampling and extraction points and the upstream/downstream relationship of the network. Using the links to the mainframe computer, where an extensive archive of water quality data is kept, it will be possible to explore the temporal and spatial distribution of water quality.

2. EXPERIENCE TO DATE

2.1 SPECIFYING DIGITAL MAPPING REQUIREMENTS.

The acquisition process for the replacement mapping system in Wessex was both lengthy and rigorous, involving two distinct stages. In the first stage, all likely suppliers - a total of fifteen - were asked to respond to an outline specification of Wessex' requirements. The responses to this provided sufficient indication of which suppliers came closest to meeting the complex specification, and a shortlist of three was drawn up for closer examination. The requirements for true facilities management - rather than drafting capabilities alone - and for links to other systems proved to be most exacting.

The three suppliers remaining from the first stage were subjected to a three-part evaluation exercise: mapping benchmark, computing benchmark and site visits. The first of these called for the display of maps from both Ordnance Survey and the Wessex in-house system; graphical data capture, editing and display; and the use of attribute data. The second looked at aspects such as remote operation; operating system and security; data exchange between systems; and the effect of multiple usage on timing and performance. Finally, suppliers were asked to arrange visits to existing installations which they believed would closely parallel the proposed operation in Wessex 2-3 years after installation.

An essential input to the initial specification and the content of the second-stage evaluation was a knowledge of the Authority's requirements wherever mapping is likely to be applied. As always in such situations, a middle course has to be sought which stimulates the interest of potential users without "promising the earth". In this respect the in-house system in Wessex - or a similar pilot exercise - is invaluable, providing exposure to the concepts at all levels of the organisation, without the need for heavy capital investment.

A low-budget pilot has the advantage that lessons can be learnt or mistakes made without unduly serious consequences. Indeed, the shortcomings of Wessex' in-house system made a major contribution to the specification of requirements for its replacement. Potential applications were clear but could not be realised, and this could be demonstrated to users. At the higher level, senior management were able to come to terms with the concepts and implications of digital mapping and their commitment was the greater because of this.

2.2 DATA CAPTURE.

A major dilemma facing those wishing to invest in Digital Mapping relates to the capture of data. This usually involves a lengthy and expensive commitment of resources, whilst at the same time the true benefits cannot be realised until a substantial database is built up.

One way to break this 'vicious circle' is by means of a low cost combined pilot and data capture exercise as discussed above. The data can thus be loaded on to the system without a major capital investment beforehand. At the same time, the discipline imposed by the need for accurate and consistent data provides a validated database which represents a considerable improvement in the quality of data available to the user; this regardless of the outcome of the pilot.

Equally, many organisations will already have geographically-based data - perhaps on mainframe - which is suitable for display on a mapping system. Links between systems, of the type already discussed, can be utilised. For example, in the case of public utilities, the billing system may include a location reference (in the UK, the postcode). In this way the geographical database can be enriched rapidly and effectively.

At the other end of the spectrum, many organisations find that their records of plant are in a very poor condition or cannot be relied upon for their accuracy. In the UK, records of the sewer network - some of which may be over 100 years old - sometimes fall into this category. Wessex now has a well-proven suite of programs for the capture of sewer and manhole data, based on the 'Husky' hand-held computer. The operator is able to visit the site and is led through a series of questions which ensure that the data is input direct to digital storage in the computer. This can later be transferrred direct to a floppy disk on a desk-top computer, and thence to either the mapping or mainframe computers. The Ordnance Survey National Grid - which provides a unique reference for any point in the UK - provides the 'key' which enables plant to be shown in its correct geographical location on the mapping system using the grid reference input on-site.

2.3 OPERATIONAL APPLICATIONS.

Because of the existence of an established database, Wessex Water was able to move relatively quickly to a situation where digital mapping could be applied operationally. This section aims to highlight some of the experience gained from that.

Firstly, background maps should be made available wherever possible. Although street-name look-up facilities can act as a substitute in some circumstances, a high proportion of applications call for a knowledge of the location of plant relative to distinct geographical features. This is particularly true in the case of public utilities, much of whose plant is at or below ground level. Many potential users of mapping have had years of experience of paper maps based on backgrounds, and a similar product on screen also has psychological benefits. Unfortunately, to date less than 15% of the UK has been covered digitally by the national mapping body, Ordnance Survey. Many users therefore find themselves in a dilemma, with the choice of either waiting for O.S. or having digitisation carried out in-house or externally.

Secondly, training potential users needs to take into account their intended use of the system. Only those involved in system development need to have an overview of the entire system and its capabilities; specific users must be shown how their particular requirements can be met and how this brings an improvement in current practice.

Finally, digital mapping can offer a wide range of capabilities and hence applications. These must be prioritised so that the greatest benefits can be achieved first: specific users should be 'targetted' and their commitment assured.

CONCLUSIONS

DM/FM is a powerful tool which Wessex believes will be applicable to all geographically related functions.

A low-cost data capture exercise makes it easier to justify investment in DM/FM.

The bulk of Wessex' requirements were based on experience of the pilot system and its limitations.

Geographical data is available from a number of sources.

The lack of digital map backgrounds in the U.K. is an impediment to developement.

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