DIGITAL MAPPING - THE CHESHIRE EXPERIENCE

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ABSTRACT

Cheshire County Planning Department has ten years practical experience with digital mapping. The approach adopted is problem-solving rather than research-based. Progress has been made a step at a time by involving partners with similar needs. At each stage lessons have been learnt, clients increased and the work consolidated both technically and politically. The standards achieved do not represent the highest state of the art but the paper shows what can be achieved within limited budgets by co-operation and by the right balance of organisational and technical issues. The paper outlines some of the more spectacular successes and highlights the problems encountered. It concludes by looking forward at the County's total mapping requirement and speculates on what will be achieved in the next ten years.

THE ORGANISATION

Cheshire County Council is a democratically elected Local Authority which is responsible for providing services for about 940,000 people. Cheshire is situated in North West England just to the south of Greater Manchester and Merseyside. It covers a geographical area of 900 square miles and has road network of 5000 kilometres. To operate its services the County Council employs some 39,000 staff in about 2,000 County-owned properties. The County's budget for 1986/87 is £519 million. By far the major share goes to providing Education (£316m) followed by Social Services (£56m), Highways and Transportation (£53m), Police (£46m) and Fire Services (£13m). By comparison the money spent on Planning and Environment Services is small (£3m). Cheshire is divided into eight District Councils who have different functions including housing, the control of development and environmental health.

Local Authorities are statutory bodies funded mainly by rates and taxes. They aim to provide their services to the community in the most efficient and effective manner. All this activity has an important geographical dimension. A vast and diverse amount of data relating to people, places and networks is gathered and stored in manual and

computer systems at many locations around the County. Maps play a vital role in presenting and linking together this information.

THE INTRODUCTION OF DIGITAL MAPPING

Digital mapping was introduced into the County Councils' Planning Department in 1976 for two reasons. First, as a means to speed up cartographic services and second, to search large computerised data sets to extract spatially encoded information.

Cartographic Services.
The department had the task to supply District Councils, other County Council departments and the public with details, including mapped boundary definitions, of land parcels which were available for residential and industrial development. The Cartographic Services had difficulty in providing these maps with the parcel boundaries on time because of the large number of sites which required frequent updating. The problem was solved by digitising the boundaries and producing map overlays at the specified scales from a graph plotter. There was a bonus in that the areas of the land parcels were automatically computed.

Searching of Data Sets.
The department held large Ordnance Survey (OS) grid referenced data sets on several topics - planning applications, industrial premises, development sites, archaeology etc. Often these sets needed to be searched to extract information by 'areas of interest' (eg) a list of planning permissions for industrial use in the Green Belt in the last five years. This information could now be extracted by digitising the 'area of interest' and interrogating the file using point-in-polygon searching techniques.

Initial Hardware and Software.
The department operated an AO digitiser which output to a card punch. The software was written in the department in Fortran for an IBM 370 mainframe. This machine was connected by line to a PDP 11/34 which serviced an AO graph plotter in our Highways department some 4 miles away. The Planning Department was off line. This primitive arrangement was to serve us for seven years but the two problems were solved. It was no toy.

DEVELOPMENT

Zonal Model.
It quickly became apparent that the 'ad hoc' manner of digitising 'areas of interest' was inefficient and where areas enjoyed a common boundary for part of their

perimeter it could lead to errors whereby data could be found in both zones (or neither) because of boundary overlap problems. The concept of a zonal model was decided upon. Essentially zones would be formed from segments. Segments would only be digitised once and cut and joined to make larger or smaller segments to form other zones. Segments were stored as grid referenced points in a Line File or as elemental segment references in a Line Definition File. Similarly zones were stored on a Zone File or a Zonal Definition File. Each segment has a unique reference number consisting of a feature reference and a spatial reference. The spatial reference uses the 'Left/Right' rule whereby the zone to the left of the segment being digitised forms the first part of the spatial reference whilst the zone on the right forms the second part.

The ability to produce zones meant that thematic mapping could now be undertaken. For example, social statistics from the Population Census could be allocated to the 202 ward zones of Cheshire to produce a shaded ward map by each statistic.

System Development.
Fortunately the IBM mainframe resources were 'free' in the sense that the Planning department did not directly pay for them. However, no professional programming resources were provided by the County's central computing services and only off-peak time processing was allowed. The planning department produced the bulk of the software single handedly over five years at the same time as carrying out its routine tasks.

The data structure has not changed but the plotting and data base system has been improved extensively to increase performance and quality of output. It would seem to be a feature of this type of system that it needs to be continuously developed as data volumes grow and experience with users' requirements dictate the need for enhanced facilities. Perhaps this is inevitable if one considers geographic information systems to be a major extension of Information Technology. However, it does not accord with the Data Processing manager's modus operandi as he likes to finalise the development of systems before handing them over.

Management Considerations.
In a non-profit making organisation like a local authority there are no easily defined guidelines to apply when investing resources in a new activity like digital mapping. In addition, with users' requirements and information technology developing rapidly, it is virtually impossible to balance carefully the likely benefits against extra costs.

The approach we chose was to produce a regular stream of usable output in response to the increasing demands of users. The early history of digital mapping in Cheshire was one of pioneering development by a few people with a joint interest. Critical to the credibility of our service was the timescale of our response. We recognised that is not easy to maintain the enthusiasm and commitment of either managers or users if they have to wait long periods of time prior to obtaining results. Positively responding to our clients and the good-will that this generates has been politically important to the project's survival.

The range and nature of requests have been extensive. Organisations like the Ministry of Agriculture, the North West Water Authority, British Telecom, and County departments such as Architects, Emergency Planning, Fire, Highways, Police, Trading Standards, etc, have all experimented with the facility. Triumphs have been important to our progress, and three of our most prestiguous products have been

1981 Census of Population. The statistics were mapped for the 202 Census Wards of Cheshire resulting in a more easily digestible display of the data. This was a factor in increasing the range of users and analysis of the statistics over previous Censuses.

Areas of Family Stress. Sixteen parameters of family stress such as the number of free school meals, probation orders, youth unemployed etc, were collected for the wards of Cheshire. A map shaded by ward was plotted for each parameter and a summary map showing the ten most heavily stressed wards was produced. This improved our knowledge of the varying social conditions of communities throughout the County and was positively received by both politicians and Chief Officers.

Ecological Data Base. A voluntary organisation, the Cheshire Conservation Trust, surveyed the County area for sites of ecological value. They then approached us to provide a system for their display and up-dating. As a result they digitised some 10,000 sites classified into 20 categories. The maps plotted from this data base have been used in Public Inquiries and pie charts showing the total area of each classification drawn.

This last initiative is an example of another of our management principles - that of co-operation between organisations and departments. Fortunately, within the County Council there has been a high degree of co-operation between departments. The 'free' use of the central mainframe and the Highways equipment and software to plot maps has been paramount. Without it the project

would have failed. In return, departments are encouraged to digitise their own data using our facilities. We have also exchanged information with external organisations such as the Water Authority, and the District Councils.

Finally, shortage of personnel with the necessary background and experience required to design and implement the digital mapping system meant that we had to train and develop our own staff. Initially it was not easy to gain their co-operation because the field was new to them and few of the operators had any real technical ability. Understandably they were nervous and the fact that the software was initially primitive and not fool proof did not help matters. By responding immediately to staff problems - technical or physiological - confidence was built up and standards and productivity rose. In short, technical leadership is vital when establishing new practises.

EXISTING SITUATION

The number of segments now on file is around 30,000 and the total number of zones is about 16,000. It continues to grow as users become aware of the facilities and start to put their own data on the system or set up grid reference data files to use with the system.

The whole exercise can be regarded as a development project to gain experience in a new field of information technology and make the County Council aware of the potential whilst at the same time solving problems and bearing some useful products. In this it has succeeded.

A feasibility study has been set in motion to identify the corporate uses of digital mapping and to establish the resources and skills required. This study was recommended by the District Auditor, the Government's watchdog on public sector efficiency, and has the backing of senior management.

Lessons learnt.
A number of simple lessons have been learnt and the most notable of them are as follows

Spatial Data Base. Our most important lesson was the realisation that digital mapping was merely a form of output. We had constructed a simple spatial data base whose data structure allowed us to build a zonal model and an elementary cartographic model. Other models especially a network type, would eventually be needed in the County Council.

Visual acceptance. Our early cartographic attempts were of a primitive standard and generally disliked by the user. Great strides were made subsequently in presenting a good and clean visual product as it was found that users could be more attracted to the blemishes on a map than the message it contained. Colour, various line formats and thickened lines have all helped to de-fuse this initial rejection.

Inconsistent data accuracies. It is necessary to understand the surveyed accuracies of the various topics in the data base to avoid spurious accuracy. Caution is required when producing maps where the plot scale is larger than survey scale. Similar problems occur when creating point-in-polygon searches on zones without making allowance for the survey accuracy of the zones especially at the boundaries. For example, it is not reasonable to search the Agricultural Land Classification data which has been digitised as 1:63360 scale and has a survey accuracy of ± 100 hectares, to see whether a proposed housing development of 20 units lies within a certain class of land. There is a temptation for this type of error to occur because of the ease with which the data bases can be accessed, combined and searched.

Updating. As the number of segments has grown and the frequency that a segment (or part of a segment) helps form a zone increases, then the problem of updating magnifies whenever a segment is changed. By breaking down a segment into two or three elemental line types this problem can be minimised. So whenever these elemental lines are updated, all the relevant segments and zones are automatically updated. Without this facility the data base would eventually become inconsistent.

Data capture. The whole operation of data capture is too slow at present. The cost of reorganising and inputing data from several differently structured paper files can be prohibitive. The use of automated techniques for capturing graphic data is a particularly important issue for us, especially as we currently have virtually no OS digital map data. The data volumes generated are considerable compared to traditional data sets.

Management Techniques. The ability to search, combine and 'layer' zones gives new opportunities to analyse and present spatially located data. Techniques such as 'sieve' analysis have been programmed together with simple searching routines. However, users have not grasped these tools and this lack of experimentation is disappointing. There is a great tendency to

concentrate on graphics and to neglect the potential of the digital data base. A great deal of new education is required to increase user awareness. Even then it may be only the enthusiastic who have the motivation to pioneer.

Demand. The demand for our digital mapping service grows steadily as more managers appreciate its role in helping them make speedy decisions about property management, road maintenance programmes, service delivery, route planning, policy planning etc. However the market for our products is at an early stage of development and therefore likely to have a large element of latent demand because users are currently unaware of the possibilities offered by geographic information. The appetite for this information could be insatiable, so a balance needs to be struck between the need to know and the cost of finding out.

A DIGITAL FUTURE

Digital bases in Cheshire have reached a plateau. This plateau has been reached after a ten year ascent and we are now in a good position to realise the full corporate potential of digital systems. We can now see some things very clearly but there are a number of obstacles to overcome on the way ahead.

Geographic information underpins much of the work of the County Council; the analysed data providing a powerful mechanism for informed decision making. We therefore need to develop our spatial digital systems.

It is clear that our immediate technical requirement is to improve our current models - zonal and cartographic - by enhancing our local computing facilities. This can all be achieved for a modest cost and will be valuable in increasing our productivity. By reducing the learning threshold with user friendly software, it will also increase the interest and participation in digital activities by a wider range of users.

It is clear that high volumes of data in digital mapping technology gives rise to problems of cost of storage and speed of retrieval of data.

Finally, it is clear that improved speeds of data capture are a vital requirement for both ourselves and the Ordnance Survey. Our most difficult task will be to acquire the basic digital topographic coverage of the County. Ideally this should be provided by Ordance Survey in a data structure that will allow us to construct several models. The only realistic way this can be achieved over the next 5 years is through technological

development. Raster technology is moving in the right direction, but there are still problems to overcome, and further work is required on pattern recognition.

One way forward is for us to join with our partners such as the Statutory Undertakers and the District Councils, and commission a project to digitise a limited number of topographic features fully structured at a lower standard of accuracy than OS. Alternatively we may resort to raster cover with limited vectoring. This would allow us to produce thematic maps on a topographic background and, most importantly, to produce models to allow us to tackle operational work such as police and fire fighting activities, emergency planning and road maintenance. It is these basic 'life or death' uses of digital data which may help to trigger the necessary financial investment at a time of severe financial restraint.

When we reach this point the summit will be in sight.

CONCLUSION

We must now launch our second initiative. This is to mount an ambitious development project on a corporate basis. This 'demonstrator' project will tackle operational type problems and increase the range of users, the areas and intensity of use. The project will need to find partners amongst the District Councils, the Statutory Undertakers, the Universities, the private sector, the software houses and the Ordnance Survey to fund, implement and demonstrate that the digital world has arrived at the work bench.

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Footnote: Any opinions expressed are those of the authors and not Cheshire County Council.