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DIGITAL MAPPING AT THE ORDNANCE SURVEY

D W PROCTOR

1. BACKGROUND

It is probably fair to say that at the start of this century Great Britain was better mapped than most countries are today, even many developed countries. Over 80% was covered with 1:2500 uncontoured mapping, whilst at the scale of 6 inches to the mile (1:10 560) there was full cover of either basic (surveyed at that scale) or derived (from larger scale) mapping, all of it contoured though in many areas the vertical interval was large. At that time the Ordnance Survey was also responsible for Ireland but this is no longer the case so this paper deals with Great Britain.

Between the wars, in a period of depression and stringent economy, the revision of the mapping was either neglected or carried out in an inadequate manner on unstable materials. It became necessary for a Departmental Committee to study OS in some depth; their report (Davidson 1938) made some wide ranging and far seeing proposals for fundamental changes in outlook and procedures. These are basically summarised in two topics, though there were many more not relevant to this paper. Firstly was the need for a retriangulation and the adoption of a single metric National Grid. Until then mapping was by counties or by groups of counties (referred to as County Series) using Cassini Projections with separate meridians; even the triangulation was by counties and though a retrospective computation of a principal national network was carried out (Clarke 1858) the lower order work was in most cases not readjusted to it. Secondly a major upgrade of the large scale topographic mapping was recommended. The acceptance in principle of the Davidson Report, as it became known, with some modifications as needs changed, has been the basis of most of the work of OS ever since.

2. RECONSTRUCTION

The new mapping was to be on the National Grid (NG) and therefore had to follow the observation and computation of the retriangulation which was used to provide NG coordinates. Observations had commenced in 1935, were suspended during hostilities and were completed in 1962 (OS 1967). Before the availability of electronic computers adjustment as a single figure would have been impracticable, in fact it was a major effort to adjust the Primary Network in eight blocks (Clarke had used 23); secondary and tertiary triangulations were subsequently adjusted within the primary.

This network, known as OSGB36, provided the mapping coordinates and still does so today even though the advent of electromagnetic distance measurement indicated detectable and variable scale error. When it became feasible to adjust as a single figure, both with and without the addition of numerous EDM observations, it became apparent that the old angle observations were sound but the division into separate figures, then held fixed at common edges with subsequent blocks, had caused the various distortions (Ashkenazi et al 1972). There have now been two scientific adjustments, the latter also including NNSS Doppler observations but restructuring of the mapping is not justified at present.

The new NG mapping could start where the triangulation had been computed, and it was commenced in 1947. The Davidson Report had specifically recommended the recasting of the County Series 1:2500 to NG and updating it but proposed further consideration of a suitable scale for urban areas. In the light of this it was decided to remap the whole of Great Britain at three basic scales of mapping, sheetlines being defined by NG. In major urban areas the scale of 1:1250 was selected, sheets being 0.5 x 0.5 km, and the series was to be a 'resurvey', a term used in OS for an 'ab initio' survey with no detail derived from previous mapping.

For rural areas, ie minor towns, villages, all inhabited areas, farmland and parkland, the Davidson proposals were adopted. A system which became known as the Overhaul, recast and restructured the County Series 1:2500 into NG terms, dividing them into 1 x 1 km sheets (many were actually printed as 2 x 1 km but the unit of survey always was, and still is, the single km square) and revising them, the revision sometimes involving as much as 60 years of change.

Finally the third basic scale was six inches to one mile, for mountain and moorland areas in 5 x 5 km sheets. This 6 inch scale was to cover the whole country, being derived from larger scales wherever available and a photogrammetric resurvey in 'basic areas'; this resurvey included contours at 25 ft vertical interval (VI), which were also to be added to the derived sheets.

During the course of the work the scale was changed to 1:10 000 and the contouring to either 5 m or 10 m VI. The whole basic scales programme comprised some 224 000 new maps and was known as the '1980 Plan' based on the scheduled completion date. It was completed more or less on time, except for some contouring of derived sheets, but today there are still some sheets at 1:10 560 and some with 25 ft contours, awaiting conversion.

3. CONTINUOUS REVISION

One further very important recommendation of the Davidson Report was that, as the new maps were complete, they should immediately enter a continuous revision (CR) process, and that this process should be as important as, or even more so than, the work of extending the cover. This was a lesson learned the hard way. Two decades of barely adequate revision effort at the start of the century followed by two more of neglect resulted in the topographic mapping of GB becoming inadequate for its purpose and falling into disrepute. Over 40 years of unremitting effort were needed to remedy the situation and the Davidson Committee were anxious that this should not be repeated.

The system adopted was to set up CR Sections in areas where NG mapping became available and to issue such sections with copies of the published maps on stable plastics, to be updated as change occurred. This surveyor's document is thus the most up to date record of the topography and is referred to as the master survey drawing (MSD); when enough change has been surveyed the MSD is used for the preparation of a new edition and, in due course, a new MSD is issued to the section. The system continues today, the main changes being in the method of supplying the data. Sales of printed paper editions are low because they rapidly get out of date and frequent new editions are impracticable. Customers needing a current map, and willing to settle for legibility rather than excellence, can have a copy of the MSD, as 'supply of unpublished survey information' (SUSI) or, as a compromise between update and cost, they can have copies from a microfilm of the MSD held by the local OS agent; these are renewed more frequently than new editions but not every time new detail is surveyed.

Thus, in conventional graphical terms, the OS holds and maintains an archive of over 224 000 large scale maps and the map user can be supplied with various products according to whether his priority is for high cartographic quality or for currency. The level of update has to vary according to priorities because CR is an expensive way of surveying change but there is a determination never again to allow the revision process to collapse.

4. ADOPTION OF DIGITAL MAPPING

The foregoing paragraphs are history but they serve to set the scene at the time OS started to look at digital techniques. During the 1960s quite a number of organisations started to collect digits as the output from stereoplotters so that when, in 1969, OS fitted shaft encoders to a Wild A8 such devices were already commonplace and linear encoders had become available. A Calcomp drum plotter enabled the photogrammetric data to be plotted and further graphical detail could be digitised and amalgamated, using a D-Mac digitising table.

The equipment allowed experimentation and software development (Sowton 1971) but was really only able to produce a plot adequate for sending out to the field for completion and verification. The trial period eventually led to the decision, in 1972, to include digital capture in the map production flowline for a proportion of sheets. Ferranti Freescan Digitisers were used to capture data from photographic enlargements of the MSD and, after processing, the bulk of the final cartographic drawing was produced on a Ferranti Master Plotter, a flat-bed plotter with a light-spot projection head.

To understand this decision we should look at the state of the 1980 programme which was then in full swing. The initial 1:1250 task was complete; about 45 000 sheets of cities and major towns surveyed and published. Such areas tend to expand and smaller towns, previously not considered to justify the largest scale, grow in size or importance and so join the programme. There was thus a requirement for about 400 sheets per year to be added to the 1:1250 cover and slightly less than half of these were suitable for photogrammetry as aerial photography of small extensions was not economic; the remainder were surveyed by graphical methods using an open skeleton of detail fixed with optical tacheometers. A similar number of sheets of 1:10 560, or rather 1:10 000 which had by then been adopted, were all surveyed photogrammetrically but these were of the most remote and undeveloped areas. The preponderance of new work was the overhaul of the 1:2500 leading then to more than 10 000 new maps per year. The process here was, as stated above, to recast the County Series to the National Grid and revise them using graphical photogrammetric methods such as the Grant Projector or radial line intersections. There were also, of course, new editions being published as a result of the continuous revision surveys.

A very large map production turnover was in progress and, for more than 98% of them the methods were entirely graphical giving no scope for digital data collection except by digitising the completed MSD on a cartographic digitising table instead of using it as a key for scribing a fair drawing. Anyway the decision in 1972 to commence digitising production work was a momentous one even if it now appears that it was taken for the wrong reasons. The original objective had been to enable the production of a facsimile of the conventional map by automated drafting which was expected to be cheaper.

The outcome was a map more or less indistinguishable from the conventional product, in which all the linework, all the text and some symbols were plotted on the Master Plotter with the subsequent manual addition of such ornamentation as building stipple, vegetation, embankment and a few other symbols. The printed edition was called a 'Digital Map' (Gardiner Hill 1972) which, in the terminology of 1987 is a bit of a misnomer, and was not cheaper to produce than the conventional product it so closely resembled. However production continued in the hope that the ease of editing digital data would make revised editions cheaper to produce and that the same data could be used for plotting derived smaller scale maps economically. Neither of these hopes were to be realised but fortunately, by the time this was established, there was a demand for the real digital map; topographic data supplied in computer-readable digital format so, once more, production was allowed to continue.

Thus a databank of digital data had been established, the nucleus of a major undertaking, stored on magnetic tape; and all the data was acquired by manual cartographic digitising. With hindsight one can say now it is a pity that the contours then being plotted on both basic and derived 1:10 000 sheets were not also captured digitally but at that time this would not have produced an economy over direct scribing at the stereoplotter so this was not introduced.

5. DATA STRUCTURE

It has been made clear that throughout the development period leading to the introduction of digital mapping the purpose had been solely that of producing automated cartographic drawings requiring a minimum of manual enhancement prior to printing. This was the case whether the objective was an initial digitisation, an update of an existing dataset or the production of a derived map at a smaller scale. Maps at 1:1250 and 1:2500 were being digitised and, apart from the resolution or least count (approximately 0.05 m and 0.1 m respectively) an identical specification was used for each. Being aimed at the production of a graphic the various lines were digitised and stored in a convenient sequence, each line feature being given a serial number, a feature code and a string of coordinate pairs to drive the plotter; there were also point features similarly structured but with only one coordinate pair of course, and text features having a start point coordinate, an orientation, the text itself and indicators to define letter font and point-size.

The result was a reasonably efficient data set for the production of an at-scale plot but it has been described as totally unstructured by some users. This was because, for instance, the features comprising the hedge or fence either side of a roadway, the kerbs or edges defining the actual metalled surface, the centre line and the name would be 6 separate non-consecutive features with no pointers or cross-references to each other. A more complex object or entity such as a school with several buildings, internal roadways and paths, car park, playground etc would be even more difficult to collect within the digital data though, as soon as it is all plotted or displayed on a screen, the various relationships become obvious. There were also difficulties over the closure of polygons or establishment of nodes since the acceptability of the data was based on visual inspection of plots rather than mathematical conditions of intersection or linearity.

Conversely there were users who considered that OS digital data contained too much structure by which they meant there were too many feature codes. These codes were really attributes to the lines, various classes of building, hedge, wall or fence, roadway, stream, riverbank, assorted boundaries or point features such as triangulation point, benchmark, telephone box, electricity pylon etc. New codes were added as they appeared to be desirable, some also represented two types of feature, which happened to be coincident, rather than risk double plotting. By early 1987 there were 163 feature codes in use, some of them extremely rare, and there is no denying that the list had become ponderous. It is a fairly simple matter for the user to compress the feature coding by amalgamating several OS codes into one of his own, but if this is the general approach then it is correct to reconsider whether a reduction in codes could simplify the data capture resulting in lower production cost and in an acceleration of the digital conversion programme within the constraints of the resources available for it.

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6. PROGRESS

As at mid 1987 some 35 000 sheets have been digitised and databanked, about 15% of the total task after 15 years! Things are not as bad as that sounds because the programme started low key and has gradually accelerated. Equipment has been expanded to 38 assorted digitising tables for basic data capture and 15 interactive edit stations, each including a further table for making corrections. Present estimation is that all the urban areas should be available by 1995 and the rest of the justified area 10 years later. Even that represents a significant timespan but resources are limited and there are a lot of sheets of mapping. The digital mapping programme of OS was a major topic considered by a House of Lords Select Committee (Shackleton 1982) who certainly recommended considerably more effort going into the programme in order to accelerate production but the issue was clouded with demands for more structure and a great deal more academic refinement of the product.

One rapid result of this report was that additional funds were made available which allowed the OS to increase production by awarding digitising contracts to commercial companies with suitable equipment. There were early misunderstandings concerning the high quality of the graphic that had to be obtainable from the digital data, and about interpretation of the somewhat complex feature code list. Some companies did not achieve adequate results but there are still 23 firms involved, at least a proportion of whom thoroughly understand OS requirements and have no problems in achieving them. Currently about half the production of new digital sheets comes from external contract work, but the penalty for this is that internal work has suffered; a number of key experienced staff have had to be taken off production work for the checking and acceptance of contract work and staff limitations mean it is no longer possible to keep all the internal digitising tables fully productive. Production has expanded but even the completion dates above will not be achieved at the present rate of progress. Whilst resources are limited and competition for them is fierce a good case has to be established for the expansion of any particular area.

Undoubtedly there is a demand for digital mapping; OS are under considerable pressure, from local authorities and utilities in particular, to increase output. Most of those bodies, anxious though they may be to introduce computer handling systems for topographic and other spatially related data, are responsible for sizeable areas comprising hundreds and frequently thousands of map sheets. Considerable capital investment is required to install the hardware, the software, the digital data and the training; an outlay unjustified if only random patches of their area are available. It is logical that they wait until map coverage is complete or within a year or two of being so. The result is that sales of digital data are currently low and do not serve to convince financiers that it is worth investing further resources in capturing the data. It is a recursive loop from which the exit has to be to increase output without significantly increasing the resources allocated. This highly desirable outcome is always to be sought anyway but there is reason to hope that some advance can be made.

7. EXPANSION OF DATA CAPTURE

The cartographic digitising described above captures data from the MSD on which it has already been plotted. If some data can be captured during the survey process then it should not need to be digitised from the graphic and various trials were described last year (Proctor 1986) in which this was the objective. Some of the digital cartography resources are allocated to updates. It has been stated that new microfilm copies of the MSD are made periodically, rather more frequently than new editions, and it is policy that when this happens for a sheet which is available digitally then a digital update should also take place. This is an inefficient use of the cartographic resources and deprives the field section of the MSD for an inconvenient period.

Development commenced in 1982 of a digital field update system (DFUS) comprising a digitising tablet, a microprocessor with OS developed software and a plotter. The concept is that if digital data is available in addition to the MSD, the CR Section can have a DFUS workstation and do their own digital updates. New detail is graphically surveyed, in pencil, as normal but then instead of the surveyor inking up his work on the MSD it can be digitised directly from the pencil plotting, edited into the digital data and then as a check the MSD is transferred to the plotter where the new work is plotted on the reverse where it should appear superimposed on the original pencil work. There are various benefits from this system. The automated plotting should be of a higher standard than the penmanship of the surveyor (including text) thus improving the appearance of the MSD and of the SUSI copies made therefrom. The digital customer can obtain up to date survey data of the same currency as the graphic SUSI. The field section is not deprived of the MSD for long periods, and the cartographic digitising division at HQ is absolved from the need to carry out updates whilst the extra effort in the field section is small because the digitising process replaces the manual penning. After software development during 1983, experimentation in 1984, production trials in 1985 and assessments

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in 1986 it was decided to expand the system beyond Birmingham and Dudley where the initial work had taken place. By the end of 1987 ten offices should be equipped and the real test can then involve a much broader spectrum of users from whose reaction a realistic assessment will come.

One obvious candidate for digital capture is the photogrammetric stereoplotter even though this is a very small proportion of the overall effort. Digital capture facilities were acquired in 1984 and now consist of Kern DSR1 and DSR11 analytical plotters, and digitisers fitted to two Wild A10, two Wild A8 and two Kern PG2 stereoplotters, data capture is effected by use of Kern Maps 200 software, with Kern Maps 300 software for editing. The equipment was initially purchased to give added flexibility in the photogrammetric area and to enable automated plots to be produced for field completion instead of inking up conventional pencil plots. Software to convert this to the digital mapping format was far from straightforward but was developed. It then became necessary to manually digitise the field completion, to merge the two sets of data and to attach feature coding to the photogrammetric data; this gave problems especially where part features were involved, for instance it is often only possible to plot the ground line of two sides of a building. field completion providing the other two. Techniques had to be developed both for the field survey and for the cartographic digitising but a small trial block was completed to demonstrate that the process can get photogrammetric data into the cartographic databank without redigitising. It was not economic. However processes and specifications have been reviewed and a further, much larger, trial should be in progress before the end of 1987.

Digital data is also available from instrumental detail survey (IDS) using various electronic instruments which have replaced optical tacheometers. The observations and the MSD are sent to HQ for computation and plotting; the MSD is then returned to the section for field completion and retention. At some later date that sheet is taken up for digital conversion or, if already digital, is returned for update and the IDS work is digitised with the graphic survey. A system has been developed for sections equipped with DFUS to retain the MSD whilst computations take place and the data is sent to them in digital map format for plotting on the section plotter. After field completion the digital update combines digitising the graphic survey and merging this with the existing digital map and the new IDS work so that effectively three data sets form one new homogeneous digital map. Development has also permitted updates to take place on a 'user defined map' which is a map of conventional dimensions but shifted from normal sheet lines to permit a single update of a patch of revision which crosses a sheet edge, which seems invariably to be the case.

Finally, though this is not strictly a further expansion, a logical progression from DFUS is to look at the all digital section of the (near) future in what has been named Project 88. Here the concept is to get away from the idea that the MSD, with its problems of age, legibility and distortion, is the topographic archive with, in some cases, a digital data set as back up. Instead the digital map becomes the archive and the MSD is superfluous. Such a section will hold their maps in digital form; when an update is required a temporary survey drawing (TSD) is prepared for the area on arbitrary sheet lines as convenient, revised in the normal way and returned to the office for digitising. After digital update of the archive the TSD can be discarded, digital customers can be supplied with current data and the customer who would normally have a conventional SUSI copy of the MSD can, within reason, specify the scale, the sheet edges, the selection of features and colour coding to best suit his purpose for a customer plot of current data (CPCD). It is essential for this approach that an inexpensive fast drum plotter can be used, which is the case. The normal DFUS station has the constraint that an existing MSD has to be placed on the plotter so the pen holder must take a microscope for registration and the plotter must also act as a coordinatograph. Project 88 escapes this constraint. A trial section is being set up in Milton Keynes during the latter half of 1987, the digital data will all have to be brought up to the same currency as the MSD and then, in early 1988, the section should be able to start live operations in a non-MSD situation. Essentially this involves a modified DFUS workstation with a different plotter and with some enhancement to the software to permit the production of customer defined plots. It is hoped during the trial to have both IDS and photogrammetric data to incorporate and the analysis of the results is likely to take as long as the trial itself owing to the complexity of the trial and the many issues involved.

There is more that can be done in this direction or is at least worth looking at. Graphical field survey is used to complete all instrumental surveys (photogrammetry provides perhaps 60-70%, total stations about 45%) and for small revision patches the work is all graphical. Measurements, alignments and intersections all have to be precisely plotted on the MSD, but a technique which allowed digital capture, followed by computation would save plotting and manually digitising. Also it will be a long while before even the majority of field offices have DFUS, meanwhile a great deal of IDS work continues to be calculated, archived and plotted. All these points need to get into the cartographic databank one day. If we consider an MSD arriving at HQ to be digitised for the first time, perhaps 15 or more years old with patches of IDS at, say, 2 yearly intervals, the problem of isolating and transferring all the IDS work and not redigitising it with the bulk of the detail is no easy one and surely the process is likely to be more costly. However the directly computed coordinates of IDS work are more accurate than the redigitising process and it is eminently desirable that these should be retained in the cartographic databank and that there should be a source coding indication with them that they do possess this extra precision. These issues remain for action in the future.

8. ACCELERATION OF DIGITAL PROGRAMME

Another option for increasing output without increasing resources devoted is to speed up the work itself and one way of doing this may be automation of the digital conversion task. Another is to reconsider the specification if, as has been suggested, production is retarded by an unnecessarily demanding standard. Some work to examine these issues (Proctor 1987) has already commenced.

The first serious investigation of automation came with the purchase of an early version of Fastrak from LaserScan Laboratories in 1980. This is a line following approach and was found suitable for curved and irregular lines which do not intersect, such as contours. However at that time there were no resources available for that task. OS large scale maps contain a high proportion of straight lines where the benefit is minimal since manual digitisation of the two ends is quick and easy; the maps also contain many intersections each of which means an operator decision, to the extent that it becomes a full time operation. As a result of this Fastrak was sold in 1985 since there was no economic work for it to do. The matter does not end there because LaserScan have developed Lasertrak which works on the same principle but is said to be more versatile and they are participating in further trials on OS behalf.

The more obvious automation is by raster scanning and subsequent vectorisation. After some basic assessment of the options it was decided to test the SysScan approach. OS have purchased one CADIG digitising workstation and one GINIS edit station, with supporting microprocessor and software, meanwhile SysScan provide their standard ScanMap product from their bureau service which is raster scanned and vectorised data in links and nodes form but, of course, with neither feature nor text recognition. It has been found impracticable to scan the MSD because of varying quality of the linework both as regards the surveyor's penmanship and fading of the MSD itself if it is old. Therefore the previous new-edition is scanned, and the workstations above are used sequentially for digitising new data from the MSD, coding the scanned vectors, replacing all the vectorised text with textual data and, in a large proportion of cases, tidying the vectors because of small kinks in straight lines and wriggles in what should be smooth curves. On completion the data should be identical to the standard product but a significant amount of editing is required to make this so. The small sample of sheets that went right through the process to the current OS specification showed a marginal economy but this is of little import. It is expected that a sheet with little or no change since the last edition can economically be scanned, one where there is a great deal of change to be manually digitised from the MSD should all be digitised this way because the scanned data would largely have to be erased anyway. The sample has not been adequate to determine where the break even point comes but now it is no longer relevant to seek this criterion because the specification is about to be changed.

Whilst the SysScan trial was in progress a consortium of users of OS large scale digital maps representing the various utilities (National Joint Utilities Group - NJUG), local government at various levels (Local Authorities Management Services Advisory Committee - LAMSAC) and cadastral use (Her Majesty's Land Registry - HMLR) got together and produced a joint specification (NJUG 1986) which would satisfy their basic requirements and use only 15 feature codes. This specification is known as 'NJUG 12' getting its name from the publication number 12 of NJUG and not related to the number of features; the idea was to use this specification in privately contracted work where OS data was not available and the specification was also put to OS as a request for simplified data obtainable more rapidly. A significant portion of the SysScan trial effort was devoted to testing this but it was found that the specification would not satisfy OS needs and there would be extra costs involved in having, and maintaining, work to two different specifications and, more particularly, two very different quality standards.

However as the NJUG 12 proposals came from a group representing the great majority of potential OS digital sales a detailed look at the OS specification was taken and a new proposal (Haywood et al 1987) with 34 feature codes resulted. Discussions with the NJUG users are in hand and only trivial matters remain to be resolved; it is almost certain that this specification, described as OS 1987, will be implemented during July 1987. This will not modify the appearance of the graphic product in any way; all the previous features will be retained, and depicted in the same way, it is just that they will be grouped together into fewer, but more general, feature codes. At present there is no relaxation in cartographic standard and this is an

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important point; the NJUG 12 specification adopted the OS standard that all digital detail should be accurate to within half a line width of the original on the graphic (ie 0.1mm) but interpreted this such that irregularities in appearance are permitted within this tolerance whereas in addition to a conventional accuracy and content specification, OS also demand an appearance standard which many digital users consider pedantic and unnecessary.

There is scope here for further investigation. The amount of editing required of vectorised raster scanned data is at least trebled by the OS appearance standard and this could be the turning point on whether to expand the system and obtain a Kartoscan Digitiser. There is little doubt that adopting the OS 1987 specification will significantly increase the output of the cartographic sections involved in manual digitising because though the number of features remain the same the edit and checking effort will be reduced; however the change in specification will largely negate the automation trial which will have to be repeated using the new specification. The recent report (Chorley 1987) of a Government Enquiry into GIS/LIS has clearly expressed a need to accelerate the digitising programme and to collaborate with the proponents of NJUG 12 and as has been shown various investigations are in hand to find ways of doing this; they may not all succeed but surely some will and it remains to be seen exactly how effective the combination of these initiatives will be.

9. TOPOGRAPHIC DATABASE

Care has been taken not to describe the current OS digital mapping data as a database, and the word databank has been used for the collection of 35 000 digital maps held on magnetic tape; a disc based databank is being developed and applications of optical disc are being studied. However the issue is not so much 'how is it held?' but 'what is held?'.

The structure, or lack of it, of OS digital maps gives, as it was designed to, a set of data from which a graphic can be produced. Purchasers are, in fact, holding their own data digitally and superimposing it on the OS data both on screen and plot. However if the objective is to use OS data as a backdrop on which to display the users own data, then the OS element could be on video disc or stored as simple raster. The application which requires to interact with the NG coordinates of topographic data, recognising distances or sizes, or assembling complex objects from a multiplicity of features, needs rather more structure in the data. Since 1985 a team have been studying the requirements of a relational topographic database in which link and node data structure is probably to be used, superimposed on this could be various levels of topology, building polygons and more complex entities with provision for the attachment of a more or less unlimited number of attributes, some topographic supplied by OS and others added by the user.

Undoubtedly the true digital map user who wants to make use of the digital data contained will find the topographic database a great deal more useful; in fact he probably finds the current data almost useless. At present, perhaps because the absence of suitable data keeps him away, this type of user is very rare. The great majority of digital users do so because their management and information services are greatly enhanced by the speed of data presentation available through automation. It enables decision making and information exchange to be greatly accelerated. At present they do not think they have a use for a database; perhaps a decade or two ago they did not think they had a use for digital electronic computers. The database study team are due to make their report and recommendations by the end of 1987 and then a decision must be made about implementation. It is almost certain that the database structure will occupy more storage space and may be more expensive to capture, so implementation will not be an automatic outcome; strong justification will be required. Human nature being what it is there seems to be an excellent chance that the current users of unstructured data, who are quite happy with it, will look for and find ways of enhancing their systems when given highly structured data, but this is conjecture. The immediate effect of a sudden price rise could be counter productive so great care will have to be exercised.

10. SMALL SCALES DATABASES

Even the three year study leading to a large scale topographic database was not undertaken without some experience of handling structured data. A suitable arena for the initial introduction was at 1:625 000 scale, at which Great Britain is mapped in two sheets. The main source of data was the Route Planning Map at that scale, but other sources were also used, eg for contours. The data is in three sets, within each of which link and node structure is used; the principal set is the road network with the towns served by them. This has been used as a learning process, a demonstration package was produced, a query language written and various tasks such as route finding and distances can be carried out. The data has also served useful purposes, the annual editions of the Route Planning Map have been produced from it since 1986 and experimental non-standard tasks such as in-car navigation systems have been developed. Initially the data was considered experimental but it created a certain amount of interest. Just two datasets, excluding the contours, have now been made available commercially in addition to having been supplied for research applications, one of which (Jones 1986) for instance was to compress it for use on a BBC Microcomputer, though a number of floppy discs are required this is still an effective use.

It has been stated that when contours were being captured the need for digital versions was not recognised, and even when Fastrak was available and it was realised that contour digitising was feasible and desirable the resources were just not available to take on this task without serious detriment to the other parts of the mapping programme. Since then a collaborative arrangement with the Directorate of Military Survey has resulted in a compromise solution, the capture of the contours on the 1:50 000 series, these are of course at a wider VI than on the 1:10 000 and are smoothed. The digital contours are also being used to construct a digital terrain model (DTM) on a 50m grid. Where the data is available customers have the choice between the two versions; about one third of the series is available at the time of writing and hopefully the task will be completed in 1988.

There have also been various enquiries about digital data from the 1:50 000 series. This comprises 204 sheets in all but they contain much detailed data and digitising presents a formidable task. Eventually it was decided, after considerable consultation with potential users, to digitise one trial sheet and make it available at a nominal price to get user reaction. Sheet 111 covering the Doncaster and Sheffield area of Yorkshire was selected, a specification was prepared for digitising most, though not all, the topographic detail and the work was put out to contract. Once again the data is in link and node structure with relationships and attributes included; after considerable editing the data was made available in May 1987 for the interested customers prepared to give OS any feedback on potential future sales. Users have been asked to comment by October 1987. There is no current commitment to add any further sheets unless there is going to be the demand to make it a commercially viable operation. From the results it may be clear whether all or any further sheets should be added and if so which ones and over what timeframe. A decision on this should be made by the end of the year.

All this discussion about data or databases at different scales contradicts one of the theoretical concepts of digital mapping, that of the 'scale-free database'. Data is held by coordinates of the National Grid and should not, therefore, be scale dependent. In point of fact it is much more than the resolution or precision of the coordinates that varies with the source from which digitising may have taken place. After all the styles of printed map at 1:625 000 and 1:1250 are so different as to have no obvious similarity and digital data has been found to behave similarly. In the same way that it has not been found practicable to take the digital data from the largest scales and edit, filter and generalise it to produce much smaller scales (limited derivation is possible but uneconomic), it is also impracticable to form small scale databases from it. The current state of the art and speed of retrieval systems suggest that the large scale database, in total comprising perhaps 200 Gbyte, would be unwieldy for selecting, say, a non-motorway route from Exeter to Aberdeen. At present it is seen that there is a need not only for three separate databases at least but also that they will be separately captured from graphical maps at appropriate scales and not derived one from another. The all purpose single scale-free database sounds the ideal concept and one day it may come to pass but at the moment it is seen neither as a practibility nor as the solution to today's problems.

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ABSTRACT

Since 1972 Ordnance Survey have been producing digital maps based on manual digitising from graphical records and about 35 000 have been databanked. Progress does not satisfy demand and this paper describes investigations to extend data capture to field revision sections, to photogrammetric plotters and total station tacheometry. Other steps to accelerate the programme might be automation either by line-following or raster scanning or else by a reconsideration and possibly simplification of a demanding specification. A three year study is nearing completion to investigate the requirements for more structured data and possibly to propose and define a topographic database to replace the current format. As a prelude to handling structured data a 1:625 000 database has been created, and one sheet of 1:50 000 has been digitised on a strictly experimental basis. Also about one third of the 1:50 000 contours have been digitised and for those areas a 50m grid DTM is available. A large digital programme is underway but a lot remains to do and various research projects which are discussed in this paper seek both to improve both the products and to accelerate the acquisition programme.

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