Hardware, Data Capture and Management Techniques : Volume Overview

Volume 1 is oriented mainly towards developments in techniques, technology and philosophy. It is set at a time when considerable re-evaluation is being undertaken of past approaches, and national and international moves are underway to coordinate future developments. Also, it is a time when the whole field of Auto Carto is being affected not only by the normal academic developments so traditionally communicated in the past, but by commercial, military and political pressures all of which are dominating the way in which the field is progressing. Commercial pressures exist to a large extent because the cost of good software and hardware systems are beyond the purchasing capability of most academic departments, and fewer GIS innovations now emanate from those areas. Military influences are seen crucially in the areas of Digital Terrain Modelling, also exist importantly in the whole area of national digital databases, and more subtly in the dissemination of hardware systems. Certain U.S. hardware manufacturers may not sell to many other countries because their machinery is deemed to have strategic significance. For this reason, even though India may have some increasingly able digital cartographers, they are unable to use the supercomputing power of a Cray which is a proscribed machine under U.S. law. This links into the political factors. By now many Governments are fully convinced of the value of Auto Carto, not only for strategic reasons, but also in the wider cost-benefit terms of improved management of utilities, general topographic mapping, education, land-use, and social planning. By rights this then involves wider political involvement in the field, and the academic stereotype of a person researching in isolation for the sake of so doing, is now increasingly rare as the papers in these proceedings bear witness.

This volume starts with the discipline set in present and future context in a keynote paper by Joel Morrison, followed by overviews of selected National Topographic Mapping Programmes. The current status of Japanese digital mapping is outlined by Miyazaki, Tsukahara and Hoshino, who note in particular a dynamic land use data base project at a resolution of 10 metres. In Italy Surace presents the first 1:25000 digital map produced, and importantly evaluates management strategies for the introduction of new technology in an organisation. Surace proposes a gradual transition from 'old' to 'new' both to avoid alienation of staff, and also to make them part of the technological changes taking place. For the British Ordnance Survey MacMaster, Haywood and Sowton note the piecemeal development of past digital mapping

policy, and stress that considerable effort has gone into identifying user requirements as a means of ensuring success in the future. The only potential problem here is discussed later by Proctor who admits that the OS estimated completion date for digital coverage is 2015, too far distant for most user requirements. More advanced in its program is the U.S. Geological Survey. Here Nystrom's study involves an evaluation of GIS technology (ARC/INFO) in four applications areas in Connecticut. Crucial here is the integration of a wide range of data sources.

Sessions on data capture focus on Field methods, Photogrammetry, and remote sensing. The use of electronic 'total' stations features in papers by Kidd and Lovatt, and Wild, the latter being a comparative study of equipment available. Proctor gives a cost-benefit appraisal of all forms of data capture considered by the Ordnance Survey, while Potter concentrates on the data utilised in the electricity utilities. Dowman and Muller give not only cost-benefit but accuracy assessments in a discussion of the relative merits of original photogrammetric interpretation and derived digitising, while orbital photography is used in the detection and dynamics of power station thermal discharges (Rodgers) and land use assessment in difficult areas of Himalayan terrain (Sharma and Garg). The newly launched SPOT satellite features in Denegre Deschamps and Geltier's comparative study between its imagery and those of Landsat.

Once captured digital data need to be coded, structured, and communicated. The encoding of features traditionally is a manual exercise, though Simone shows how automated feature recognition can be used in the identification of railways, roads, and land parcels. More pragmatically Hoshino and Inaba aim to standardise the geocoding practices in Japan. Christ examines topographic data models, particularly in the context of the 'scale-free' ideal. He argues that a scale free database should have cartographic models for particularly important scales, in his case examples are provided for 1:500000 and 1:2 million. Regarding generalisation, Buttenfield stresses that line generalisation is much more than a process of culling points. She notes that certain features at certain scales have scale-dependent 'structural signatures' which may enable generalisation to take place in the context both of scale and nearby features.

Lastly, Quinn stresses that better maps can only come from better spatial data models. He derives one such, based on roads which allows more complex interrogation of the data sets while Essinger argues that effective digital map design must be based on a philosophy which allows symbols to be assessed in their true visual context and not just regarded as numerical calculations for plotting purposes.

The standardisation, and associated descriptions, of data types, formats, and transfer standards has been a major task undertaken by the U.S. National Committee for Digital Cartographic Data Standards (NCDCDS). Headed by Harold Moellering this has had a significant international effect. Moellering and Teselle introduce the development of standards in the U.S.A., Southard comments on the experience of standards developments in the U.S.A., Australia, Canada, and the U.K. stressing that development must be seen as an evolutionary process. Key components of the standards forum follow. Chrisman argues that quality control information not only is fundamentally important to others using a data set, but is cost-effective, and provides case-studies to underpin those arguments. Beck and Olsen set quality control within the context of USGS activities, while Rugg and Schmidt develop feature coding standards. The latter have strongly influenced both the British Ordnance Survey (Sowton and Haywood) and the U.K. Military Survey (Kennedy-Smith). In Canada Maher provides case studies of data transfer between proprietary geographic information systems - notably ARC/INFO, DIPIX, STRINGS, and CANSIS.

Interagency transfer is the concern of Simpson and Moore while Allam sets into context the Canadian situation on data standards. Where data are transmitted via existing telecommunications networks then standards again feature prominently (Jiwani), and Vahala views standards as vital in GIS coordination in Finland where there is a policy of disturbed spatial data processing between many agencies. As an example of one agency's efforts Keisteri introduces the Finnish Information System, a system of in-house software developed over the last decade. At a pragmatic level Waugh and Healey identify the problems that exist if an application requires the use of more than one software system. They have different user interfaces, require data input in a variety of ways, are documented and maintained to different levels. Their GEOLINK system is one Pascal-based answer to this situation.

The considerable volumes of data now captured necessitate careful attention of data structures, and compression techniques. Fundamental aims here are to maximise efficiency of manipulation, reduce storage overheads, and increasingly to maintain as much contextual information as possible. The vector topological data structure is substantially enhanced in the U.S. Bureau of the Census TIGER System (Trainor) where census units are integrated with features such as roads, railroads, and rivers. Broome elucidates this by illustrating the mapping potential that such integration allows - distant indeed from the British Census Agency's lack of involvement with mapping.

Approaches to data structuring include the increasingly influential quadtrees. Kleiner and Brassel evaluate these for

the mass storage of very large static data bases, and Mark investigates the wider utility of quadtrees, while Chen and Tobler concentrate on their use of digital terrain modelling. Links between raster and vector structures are addressed by Devereux, who proposes that for a particular study area vector 'templates' of such things as field or ownership structures could be used to provide 'context' when vectorising raster data. Degani introduces a mapping system that utilises both vector and raster techniques. The compression of raster files is examined by Wang, with Mennim indicating usage in geological map production. Data structures which optimise spatial searching are studied by Davis. He identifies problems of using standard vector topology and quadtrees, proposing hashing techniques which minimise overheads in searching. Palmer also is concerned with searching, specifically in the context of very large data volumes. More specific studies are a discussion of map overlay techniques (Doytsher and Schmutter), and models for the efficient manipulation of Ordnance Survey 1:625,000 digital data (Visvalingam, Wade and Kirby). Case studies of data base development are undertaken by Faintich for the Defense Mapping Agency, Chen for the Chinese National Land Information System, and Salge and Piquet-Pellorce for the I.G.N. small scale (1:10000 to 1:50000) database of France, and Carstensen assesses relational interrogation of databases.

Three dimensional imagery is increasingly the province of military applications. For weapons systems accuracy of digital terrain models becomes an important issue. Ley investigates these in the context of the U.K. Military Survey. Multi-disciplinary applications of DTM^s are described by Catlow, while on the civilian front Turnbull, Maver and Gourlay discuss visibility calculations in the context of visual impact analysis in the electricity supply industry. Digital terrain models are used with land use data, and 'frame grabbers' enable photographic imagery to be captured so that the DTM^s can be superimposed. Kraak asks whether there could be wider use of three-dimensional techniques beyond DTM^s. He proposes route-finding, planning and point symbol mapping as three other areas for evaluation. Lastly Ostman suggests the use of IBM Personal Computers for the editing stage in the creation of DTM^s.

The display of spatial data is fast becoming an area for the attention of expert systems, or artificial intelligence techniques. While some agencies prefer to develop hardware specially customised to local requirements (for example at I.G.N., France; Bernard and Piquet-Pellorce), others are attempting to define rules and structures (such as the study of Mackaness, Fisher and Wilkinson) which will enhance the decision-making power of software systems. In essence the task for display is how best to integrate the professional, behavioural and often idiosyncratic design decisions of traditional cartography (on the assumption, of course that these

are the ideal design criteria). Grelot criticises the previous generations of spatial data models, which like any specialist approach will constrain people into problem-solving along particularly narrow lines. Chen seeks to develop rules for modelling spatial features, while Bouille extends this hypergraph-based data structure (a data structure used by Domaratz and Moellering in their study) into the area of artificial intelligence. The recent International Conference on Spatial Data Handling in Seattle saw much debate about expert systems, with one criticism being that in many existing design systems there already is the ability to define 'rules' in the form of user-specified macros. In many of the Auto Carto papers is becomes apparent that knowledge-based systems necessitate re-evaluation of every component of digital mapping, from the data models, through structuring, and on to analysis and display.