SECTION 4(a): OPERATIONAL APPLICATIONS

Introduction

THE EDITORS

Out in the real world of public and private commercial implementations the vast majority of today's large GIS are performing operational tasks. These include recording millions and, in some cases, billions of dollars of assets (utility outside plant, transportation infrastructure, and public and private land and property). This world is driven by the accounting metrics of actual benefits realised and costs saved. It is ironic that while almost every significant GIS acquisition requires formulation of a detailed cost–benefit case and many firms of consultants make a tidy living from selling the methodology repeatedly, so little of it is documented and publicly available (but see LGMB 1993; Obermeyer, Chapter 42).

The chapters in this Section describe the ways in which GIS are being used on a daily basis to record the location of features (e.g. land parcels, network devices, and highways signs), to perform update transactions (e.g. the acquisition and disposal of properties and changes to telecommunication devices), and to calculate the delivery routes for vehicles (e.g. for drinks vendors and long-distance haulage companies). Such prosaic applications are the everyday business of many GIS users.

In the first chapter Jeff Meyers (Chapter 57) reviews how GIS are being used in electric, gas, and water utilities to help them stay competitive in a rapidly changing marketplace. The combined external pressures of business re-engineering, privatisation, and open energy marketing are all profoundly affecting utilities. In this context, GIS can be seen as both a facilitator and a consequence of change. Meyers describes how GIS in utilities have evolved technically to become open systems, linked to a commercial database management system (DBMS) with a Windows interface. The combined demands of large databases, the need to model complex objects (e.g. transformers, pumping stations, and gas networks) and the very large numbers of concurrent users, means that in general utility systems push GIS technology more than any others. A modern utility GIS is likely to have been created using object-oriented modelling and programming techniques. It is also likely to have the capability to support multi-user transactional access on a continuous shared database. Data automation remains a major consideration for utilities, because of the time and cost involved. Collecting the basic data is now only the first part of the process of building an automated mapping/facilities management (AM/FM) GIS application. Many of the current applications require access to an intelligent network model, which is topologically correct and linked to other useful data, such as customer addresses and facilities data. Any assessment of the costs of data in an AM/FM/GIS should not underestimate the costs of maintenance which may exceed initial capture. Key utility GIS applications include: map production in support of many utility operations (e.g. inventories, gas pressure zones, rights-of-way); map (database) editing; facility queries; design/work order processing; trouble call/outage analysis; and utility executive information systems. Also of note in this chapter is Meyers' clear demonstration that the benefits of utility GIS far exceed the costs in many cases.

Although there are many similarities between the use of GIS in telecommunications and other utilities, there are also significant differences. It is generally accepted that telecommunication networks offer the most challenging environments for implementing

GIS. In part this is because of the very large size of telecommunication networks and therefore the tasks are often huge and substantial sums of money are at stake. It is also because telecommunication networks are very difficult to model in current GIS. The complexity of the networks (many links along a single fibre and many cables in a single duct) and the large number of devices also add to the difficulty. Carolyn Fry (Chapter 58) reviews a range of telecommunications applications and highlights the impact of deregulation, the availability of new technologies (such as fibre optic cables, more efficient terrestrial broadcasting, and satellites offering greatly increased bandwidth), and the rise in customer expectations as key drivers for change. Creating and maintaining up-to-date records on network infrastructures, engineering works, buildings, transport routes, and customers, has become vital for the survival of telecommunication networks. More recently, as the telecommunications market has become more competitive, GIS is also being used in marketing (e.g. to locate new customers), in cellular trouble call analysis (e.g. to map areas with poor signal), and in customer care (e.g. to determine the impact of planned maintenance programmes).

From the very start of GIS, transportation has been a fertile area for GIS applications. As Nigel Waters shows (Chapter 59), the overwhelming focus on networks presents many interesting problems for GIS. Among these is the need to manage transportation infrastructure and associated assets, and to provide efficient and effective solutions to network analysis problems. Most local and/or regional governments in the developed world have large departments devoted to managing and maintaining highways. They are concerned with the road and pedestrian pavements as well as associated street furniture (all the fixed features of roads, including rubbish bins, traffic lights, pavement markings, and even roadside verges). A specific purpose data structure, called 'dynamic segmentation' or linear referencing, has been developed to handle such information. The field of transportation logistics has the potential to make massive savings in the operating costs of public and private organisations. From routing pizza delivery vehicles, to rubbish and postal collections, the applications seem endless. Underlying this work are network analytical solutions such as shortest path, vehicle routing, spatial interaction modelling, and urban transport modelling. The characteristics of these models and their applications are described in this chapter.

In the next chapter Thomas Cova (Chapter 60) shows how GIS can be used in the field of emergency management. Many organisations have a mandate to prepare emergency response plans and to act quickly following an emergency event. Traditionally, plans have been developed manually and many are remarkably unsophisticated. Cova's review illustrates how GIS can be used to create comprehensive emergency management strategies focusing on mitigation, preparedness, response, and recovery. GIS have been used in emergency management because of the capabilities they offer for: integrating disparate data; modelling everything from the possible impact of hazards to the best evacuation routes under rapidly changing circumstances; recording the location of assets and resources (e.g. food and building supplies, emergency services, and specialist personnel such as doctors); and educating people about the possible hazards in an area and any necessary response plans. In spite of the great benefits of applying GIS to emergency management it seems surprising that they are not more widely used. This probably reflects a lack of awareness and, paradoxically, given the massive potential savings of lives and resources, the cost of setting them up.

Peter Dale and Robin McLaren (Chapter 61) take a look at the application of GIS in land administration. They examine the technical, institutional, organisational, and business issues associated with implementing a national system of land administration. One of the features of this chapter is that it discusses the application of many of the technical and management issues discussed at length in the previous Parts of this Book. As the authors point out, many countries have large, sophisticated, mature systems of land administration. These go by various titles, such as (using English translations as necessary) the Austrian Database of Real Estates, the Hungarian National Land Registration System, the Swedish Land Data Bank System, the UK National Land Information Service, and the Australian Land Information System. Some of these have been developed using private funding according to the non-interventionist model (e.g. the US Realtors Information System), others use public money and a centralist model (the Swedish Land Data Bank System), while some emerge as a hybrid of the two (the Dutch National Cadastre). Although the early systems were predominantly text-based, more recent developments have seen a significant move to incorporating spatial information as a core part of such systems. In the simple systems this may mean incorporation of a land parcel centroid, but the more sophisticated include a detailed description of the parcel boundary and its relation to other features. Not only do such facilities improve the accuracy and precision of registration, they also offer the scope for creating maps for use in land transactions, inventory assessments, taxation, and so forth. Land administration systems can assist enormously in the process of data integration and the creation of a truly national land (geographical) information system.

Closely related to land administration and management, and often to be found in the same operational department, is the function of urban planning. As Tony Yeh notes (Chapter 62), GIS is a well-proven operational and affordable information system for urban planning. Urban planners use GIS for general administration, development (building) control, and plan making. The first two of these tasks can be regarded as routine operations usually undertaken on a daily basis. For example, applications for new developments need to be logged and their status tracked through the planning approval process. Plan making, on the other hand, is often undertaken less frequently and is regarded as a strategic planning tool. It requires new local and regional plans to be devised. Mapping has proved to be an efficient and effective way to encode and visualise urban planning information. Today, most advanced government planning departments have computerised their operational activities. Increasingly, this involves using a fully integrated GIS for resource inventory, the analysis of existing situations, modelling and projection, the development of planning options, selection of planning options, plan implementation, and plan evaluation, monitoring, and feedback.

Defence agencies were among the earliest users of GIS. The military advantages the technology offers persuaded many governments to invest heavily in advanced research and development projects. Rather surprisingly, this has not led to the widespread adoption of GIS across wide areas of the military today. David Swann argues in Chapter 63 that GIS uptake has been comparatively slow in some areas of the military because of problems of affordability, the excessive burden it places on training, the limited hardware characteristics (the absence of voice input and high disk and display capacity), the need for improved software (especially better terrain analysis, visualisation, and data management), as well as the lack of data (particularly high-resolution imagery and large-scale vector data for very large areas). These limitations have most impact on battlefield-oriented systems. In stark contrast, base plant, barrack, and general mapping applications are well developed. Here, military applications have much in common with the utility, transportation, emergency management, land management, and urban planning applications featured earlier.

The final chapter in this operational GIS subsection is by Prudence Adler and Mary Larsgaard (Chapter 64). It looks at GIS and libraries: both how libraries can facilitate access to GIS technology, geographical data, and geoprocessing, and how GIS can be used to enhance the traditional work of libraries. Within the last few years, libraries of all types – research, public, academic, and special-purpose – have become active users and providers of GIS resources. The interest in GIS has been sparked by a number of factors. First is the utilisation of new technologies such as GIS in support of education, research, and effective access to information resources. Second, collecting, maintaining, preserving, and providing access to spatial resources is not new to libraries, but the advent of GIS has resulted in libraries exploring new approaches to many, if not all, of these 'traditional' library functions. Third, there has been rapid expansion and utilisation of networked services, particularly within the academic sector, as communication and educational tools present new opportunities for libraries to address the information needs of a diverse clientele. These changes are occurring at the same time as libraries are in a state of transition, experimentation, and transformation. It is clear that the library of the future will be increasingly digital and that GIS will have a significant role to play in the cataloguing and visualisation of information.

Reference

LGMB 1993 *Geographic information systems (GIS) case studies. Experiences in geographic information management*. Luton, Local Government Management Board