PART 2

TECHNICAL ISSUES

Introduction

THE EDITORS

We have already described how the real and absolute costs of computing have continued their precipitous fall of recent years, and how the attendant developments in computer graphics and visualisation have provided necessary (although not in themselves sufficient) conditions for putting GIS principles into practice. Yet this is only part of the story, and here in this Technical Issues part of the book we will explore changes in GIS architecture, issues of data collection and database management, and developments in the ways in which data are transformed and linked together. We begin with an extended discussion of the many ways in which GIS are configured, and the wide range of interactions with computers in general and GIS in particular.

In the opening chapter, Michael Batty provides a succinct yet wide-ranging review of the development of computer technology, in which he emphasises the unpredictability of change and our inability to anticipate it – a point we return to below with respect to the technical predictions made in the first edition of this book. He sees technology as also providing a stimulus to the proliferation of digital data sources, and the consequent increased richness of digital analysis. It seems inevitable that the pace of technical change will continue to accelerate, and that computation will continue to be a fast-changing and diversifying medium. Batty's own general predictions are that data-rich computing will soon be distributed across global networks, that decentralisation of software will bring changes in the way in which it is both licensed and used, that there will be rapid technical advance in voice input and output, and that there will be knock-on consequences for the development of new kinds of virtual realities.

The prospects for GIS are equally dramatic. The vendors of proprietary systems have constantly to adapt to change by packaging software and data into niche market solutions, by facilitating data exchange (particularly across networked environments), and by developing novel approaches to business solutions and consulting.

Software and information exchange is crucial to these technical developments. One of the most far-reaching (yet unanticipated – even in the first edition of this book!) changes in recent years has been the development of data and software transfer across the Internet. David Coleman describes in Chapter 22 how sophisticated network environments and browser systems have developed from the early distributed computing systems of local- and wide-area networks.

An accompanying development has been that as software converges across platforms, so geographical components are becoming more pervasive within general-purpose software – for example, spreadsheets now have GIS capability and vice versa. This is seen most clearly in the development of so-called 'desktop' GIS (Elshaw Thrall and Thrall, Chapter 23) which has come to embrace a range of general-purpose application and consumer mapping products, including digital atlases, digital gazetteers, geographically-enabled spreadsheets, and thematic mapping products. Such 'shrink-wrapped' products lack most, or even all, of the analytical capabilities of 'true GIS', yet are clearly geographical software products. In these circumstances, any distinct identity of GIS inevitably begins to blur. Taken together with the developments in networking, this suggests that GIS is becoming both more specialised in its range of possible applications, and more pervasive in its wider usage as a background technology. The broad picture is that software is both breaking up – fragmenting on the desktop so that users can construct all kinds of tailor-made applications from individual elements – and coming together – in that vendors are providing non-traditional functions within their traditional software, 'hooks', and linkages to other related software and openness to networked environments.

The implication of all of this is that software will emerge which is extremely basic to the computational environment and that programming languages will develop which enable this software to be connected in diverse ways. This is almost a full circle back to the

early days of computer cartography and GIS when researchers wrote their own FORTRAN programs, although the elemental building blocks are very different. Now, there is the prospect of GIS users assembling reusable software 'modules' using the highest of high-level languages, in order to develop highly customised solutions to their problems. Already this is possible at a somewhat lower level using the various macro languages which are available within GIS. In the future, graphics, data elements, routing algorithms, modelling methods, and so on are likely to be packaged in whatever manner the user requires, using software which simply exists within appropriate environments – possibly based on networks rather than on desktops. The vendor response to this has been recognition of the need for vendor-neutral computing standards, and so-called 'open systems'. This is the theme of 'GIS interoperability' which is explored by Mark Sondheim, Kenn Gardels, and Kurt Buehler in Chapter 24.

There have been other sea changes in the organisation of the GIS industry. For example, the longest-established GIS companies, such as Intergraph, were initially primarily hardware developers, but are now more concerned with software and consultancy provision; while more recent entrants, such as ESRI, are increasingly involved with the development of desktop systems, network platforms, consulting, and data provision. Overlain onto this is the drive across the industry to develop new niche markets around reusable software modules. This is leading GIS vendors to work closely with their clients to develop customised system specifications, designs, and implementations, with or without the assistance of in-house consultancy services. The means and methods of GIS customisation in a wide range of applications are discussed here by David Maguire (Chapter 25).

This is the second edition of *Geographical Information Systems*, and it is perhaps appropriate to contrast the contemporary technological setting with the first edition's projections for 'GIS 2000' (Rhind et al 1991: 320–2). The first edition did, of course, draw attention to the changes in computer architectures consequent upon the growth of computer power – specifically, the shift away from mainframe and mini computers to PCs and workstations – but did not anticipate the development of the Internet. A second prediction was that the diffusion and wide uptake of GIS would likely lead to dramatic falls in real software prices. While we might quibble whether the prediction of a 'fully functional GIS for about $500 in the mid 1990s' was strictly speaking realised, each of the contributions to this section demonstrates that GIS has become a more affordable and routine technology. Indeed if our definition of GIS is drawn more loosely than Susan Elshaw Thrall and Grant Thrall's (Chapter 23) 'true GIS' (e.g. to include Microsoft and MapInfo GI products), the number of systems actually in use by the year 2000 now seems set to exceed the first edition prediction of 580 000. The range of application areas has continued to diversify, to the point at which it is perhaps more instructive to comment on areas in which GIS has not been used than to enumerate those in which it has: this is a theme that is picked up in the Applications part to this edition.

Which new technologies were not anticipated in the first edition? As suggested above, it failed entirely to predict the emergence of the Internet and the World Wide Web from its early civilian use in inter-university electronic mail. Second, there was at best only a hazy conception of the many ways in which GIS functionality would be packaged into specific 'shrink-wrapped' applications for the current generation of low-cost, application-specific desktop systems. Third, and related to this, there was still a sense in the first edition of even the most rudimentary GIS applications being the preserve of 'GIS specialists'. The book failed to anticipate the degree that this would be overcome by the development of vastly improved graphical user interfaces. Fourth, there was perhaps an over-emphasis upon the anticipated differentiation of proprietary products at the expense of the drive towards GIS interoperability, a development which has gained impetus with network-based data transfer and the use of the Internet as a GIS platform. Fifth and finally, these technological changes have led to organisational changes in the ways in which GIS is customised to specific applications, and the development of new application tools. These themes are all developed here in this section of the second edition.

Reference

Rhind D W, Goodchild M F, Maguire D J 1991 Epilogue. In Maguire D J, Goodchild, M F, Rhind D W (eds) *Geographical information systems: principles and applications.* Harlow, Longman/New York, John Wiley & Sons Inc. Vol. 2: 313–27