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THE COMMERCIAL SETTING OF GIS

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This chapter deals with the commercial setting of GIS, in contrast with historical, technological, government or academic settings. After an introduction and a brief indication of the present scope of the GIS business, GIS firms are distinguished from those in closely related technologies, and a typical commercial GIS is briefly described. Then, in the chapter's major section, the wide variety of commercial GIS firms are categorized, and each category briefly described; a related section describes how commercial firms support the GIS systems cycle. Then the contribution of commercial firms to the field, their problems, some of their frustrations, the GIS trends of which they are a part, and the future of the commercial sector are each discussed in turn. Finally, some brief concluding remarks are provided.

INTRODUCTION

GIS technology provides a framework for all forms of spatial data storage, retrieval, analysis, display and modelling. It provides the 'front end' technology for multimedia spatial databases including video, CD-ROM, tabular, and other forms of data.

Market forces and healthy commercial competition are a primary driving force causing thinkers to forge ahead with new ideas, concepts and techniques in any technological field. It was apparent, 20 years ago, that the GIS field would grow rapidly only if large commercial organizations could be enticed to enter it.

Development in the GIS field demanded many elements: hardware, to provide the fundamental enabling capabilities required; construction of a sound theoretical basis for geographical relationships and a model of how geographical reality could be abstracted for data processing; engineered software products which would encapsulate the scientific notions of spatial analysis and geographical data processing; creation of demand for spatial information in order to address complex problems about geography; creation of an industry which could manufacture and distribute GIS technology; and creation of a research environment with all its competitive mechanisms, for ensuring advances in methods and techniques. Each of these elements required appropriate institutional settings and the development of people who would create and drive these institutions.

Over the last two decades, these elements have come into being. The GIS field is now coming of age with: the founding of the US National Center for Geographic Information and Analysis (NCGIA) and its equivalent in other countries; the selection by IBM of GIS as one of its five strategic markets for the 1990s; the adoption of GIS by virtually all US national agencies; the massive emerging general interest in cartography and geography; environmental crises at local, national and global levels; resource shortages; the decay as well as rapid growth of cities; and the need to manage natural resources better.

This chapter describes what GIS in the commercial sector presently supplies, how it goes about its business, what problems it faces, and where present trends are leading. The chapter

concentrates on those aspects of commercial operations which are influenced directly by doing business in the GIS field. The perspective is that of a major firm in the field, which now supplies a broad range of GIS technology, but which recalls vividly what a 'start-up mode' of operation was like.

THE LITERATURE

In comparison with the literature of the computer field, the literature of the GIS field is still in a rather undeveloped state; this is especially so with regard to the strictly commercial aspects of the field. Nevertheless, there are a few sources which identify vendors of GIS hardware, software, and services. Often company profiles are also provided.

Surveys of the commercial sector in the United Kingdom are included in the AGI Yearbooks (Shand and Moore 1989; Foster and Shand 1990). The most thorough survey of the US industry is that by Walker and Miller (1990). An annually updated sourcebook for the United States (*GISWorld* 1990) also provides useful up-to-date information.

A number of privately prepared (and quite costly) survey reports aim to describe the commercial GIS field. These provide dollar estimates of total revenues, market share, sales by sector, estimates of growth rates by sector and similar kinds of data. Some also include company profiles and technical accounts of recent developments. These include, for example, those of Dataquest, Inc. (San Jose, California, a subsidiary of Dun & Bradstreet) and Daratech, Inc. (Cambridge, Massachusetts).

SCOPE OF COMMERCIAL GIS BUSINESS

The GIS business began about 20 to 25 years ago, was relatively small for the first decade of its existence, and has been growing very rapidly in the last decade. While estimates vary, growth rates around 25–35 per cent per year over the next five years seem reasonable (see Maguire 1991 in this volume). The number of firms which claim to provide at least some GIS-related goods or services is now approaching 1 000. Annual gross sales are difficult to determine, in part because of varying definitions of what the GIS business includes (e.g. including or excluding sales of general-purpose computing machinery which is used for GIS applications). Using a broad definition, annual sales of GIS technology are probably about 500 million US dollars at the present time. Software sales may represent a quarter of that amount.

Commercial GIS and closely related technologies

Commercial GIS are commonly based on both vector and raster computer technologies; however, the commercial GIS field is also related to a number of other spatial information technologies, usually because of interchanging data with them, or using them in managing or displaying data. Many commercial firms supply these other technologies along with GIS-related products. Many commercial organizations which perform photointerpretation, remote sensing, photogrammetry, or image processing now offer some GIS-related products, such as creating automated geographical databases which include the products of their work; many organizations which supply computer aided drafting or cartographic services also offer GIS-related products. A number of computer hardware manufacturers have begun to offer GIS software as well. A large number of firms which have specialized in services to a particular industry (e.g. forestry, engineering) have begun to offer GIS services and consulting in support of their project work. General purpose computer software suppliers are now creating some software (such as DBMS software) useful in GIS.

'TYPICAL' COMMERCIAL GIS

A minimal GIS might consist of a computer with accompanying memory, some sort of GIS software, geographical data, a person to operate the system, and a set of procedures which are to be followed in its use. More complete GIS commonly include digitizing tablets, colour graphics terminals, and hardcopy devices such as plotters, electrostatic printer/plotters, or the like. Larger GIS can be

created by adding more components; using larger capacity or more sophisticated devices; connecting components together; and increasing staffing, data and organizational complexity. Because GIS often perform compute-intensive operations (such as overlaying), many user organizations have found it best to dedicate a computer system entirely to GIS operations rather than running GIS as one of several applications. Even then, graphic displays are often slow unless a very powerful graphics processor is included in the system. Because large databases are usually involved, GIS often require very large memory resources. At present, commercial GIS can be based on mainframe computers, minicomputers, workstations, or personal computers, and GIS and their component hardware can be networked together in various ways. The accompanying figures (Figs. 4.1–4.5) show several such GIS configurations and their approximate costs (in US dollars). At present, sales of workstation and personal computer based systems are growing more rapidly than those of other configurations.

CATEGORIES OF COMMERCIAL GIS

Primary GIS businesses

Hardware technology

Hardware development continues to be a major driving force in the development of GIS. The major trend in this area is towards less expensive, faster and smaller computers; in the early 1990s these are workstations of the 20–50 MIPS variety. By the mid-1990s, these are expected to become 50–250 MIPS workstations at a cost affordable for personal computing. These computers, together with file servers and very large capacity storage devices, are rapidly being networked and, in the future, they will operate as nodes within a vast computer and data management environment (for more discussion of the technological setting of GIS see Goodchild 1991 in this volume).

Most hardware development is of general-purpose computing machinery, which is then applied to GIS. Only a few hardware devices are completely GIS specific, but some devices, such as digitizers, plotters and scanners, find especially important applications in the GIS field. The marketing of computer hardware for GIS use has become increasingly oriented to an 'open system' approach in which buyers are purchasing a variety of independent system devices and avoiding the overhead costs of solutions in which a single vendor supplies all the hardware for a complete GIS.

A discussion of the diversity of the commercial hardware business, even as it applies to GIS, is far beyond the scope of this chapter.

Software technology

Software used in GIS may be GIS specific, although some software, such as DBMS software, may be a general purpose product applied to GIS. The development of GIS-specific software may represent the 'purest' primary GIS business, since the product has no other application than GIS and is essential to the existence of a GIS.

Because of intense competition and rapid technical developments, the most critical factor in a firm's commercial success in GIS software development is probably a programme of continuous research and development, together with the creation of popular user applications. Reputation among users, the number of installed systems, the quality of software documentation and user training, and the firm's ability to deal with its customers/users are also quite critical to commercial success. To meet these demands, a successful GIS software developer probably requires staff trained in computer science, geography, cartography and a range of related disciplines. As the software becomes more sophisticated, staff specializing in the particular fields to which the GIS software is to be applied also become valuable.

Some commercial GIS software systems are hardware specific, others run on a variety of hardware systems. Similarly, some systems interface with a variety of DBMS, graphics software, and so on, while others offer less flexibility. A variety of strategies are used in coping with the problems which portability, or lack of it, presents.

The organization and functions of a commercial firm supplying GIS software are similar to firms supplying other kinds of software. These include functions like software development, quality assurance, documentation, installation, training, field support, marketing, and the like. Sales of software for major GIS often involve considerable consulting, often by third parties. Sales and distribution seem to be most effective when potential users receive actual demonstrations of the

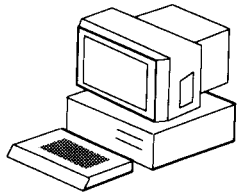

Fig. 4.1 Personal computer ($5 000–$25 000)

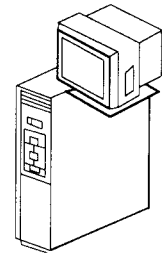

Fig. 4.2 Single user workstation ($10 000–$50 000)

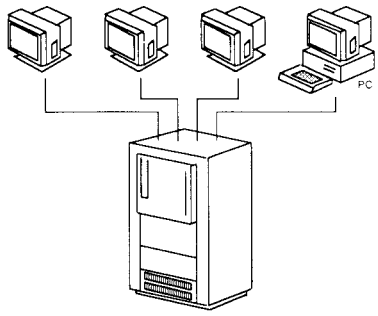

Fig. 4.3 Minicomputer using VMS, AOS/VS, X-OS, or similar operating systems ($80 000–$1 million)

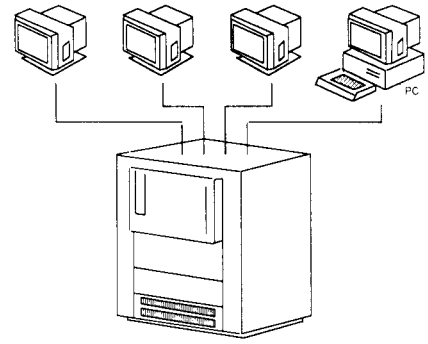

Fig. 4.4 Mainframe using VM/CMS, MVS, or similar operating systems ($2 million–$15 million)

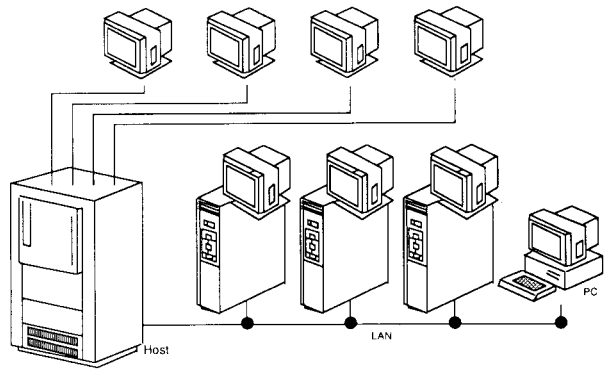

Fig. 4.5 Network with server(s) using UNIX and mainframe or minicomputer operating systems ($100 000–virtually unlimited)

Five different hardware platform approaches to supporting geographical information systems and ranges of typical hardware cost. (Cost ranges assume purchase of new equipment)

capabilities of the software, although with the wider distribution of GIS, more potential buyers are familiar with GIS capabilities before they contact software vendors. Programming support and hotline support are important in the GIS field because the technology is relatively new, because it is just beginning to be taught extensively in colleges and universities, and because the applications of the technology are rapidly diversifying. User groups are still useful because of these same factors, but they are already specializing by application type, hastened by the rapid increase in the number of GIS users in the world.

Sales of GIS software for personal computers is already a much simpler process than that for GIS software on other computer platforms: following receipt of a written or phone request, and subsequent payment for the product, the user receives the user installable software, written documentation and a training package (perhaps including videotaped instruction and a training database). As personal computers continue their evolution into higher performance workstations, these lower end focused application products will play the valuable role of attracting new users into the GIS field.

Applications programming

General purpose GIS software must often be adapted to particular applications (urban planning, forestry, etc.; see also the chapters in Section III of this volume). This application may be accomplished by the user, by the original software vendor who offers prepackaged applications, by using 'macro' languages (which make it easier for users to write their own applications programs), or by a custom programming service. A major trend in recent years has been the development of third party organizations which provide application assistance to users. Many persons who gained experience in the GIS field in the late 1970s and early 1980s are now providing such 'value added' services to clients who have GIS systems. Some of these firms are also becoming GIS software distributors for the major GIS software vendors. They then add value by providing either their applications software packages or custom programming support.

Database development

The largest cost in most GIS continues to be the database. For the last 20 years automation of geographical data has been performed chiefly by digitizing and key entry. In recent years, scanning and conversion from existing automated files have also become important. Nevertheless, no present technology permits easy and inexpensive capture of previously mapped data, let alone spatial data in other non-digital forms.

For this and other reasons, there is an enormous backlog of geographical data which various organizations would like to put into digital form. A growing number of firms is providing complete assistance in the processes of database design, data capture, data conversion, data automation, data editing, database creation and related services. Many of these firms specialize, some working chiefly with natural resource data, others with urban data, and so on.

Database creation is an exceedingly complex task (see, for example, Dangermond and Harnden 1990), involves many steps, and requires great care, skill and experience if the result is to be satisfactory. Some of the firms perform their work parameter by parameter, perhaps integrating the data after automation; others integrate and standardize data before they are automated.

Some GIS are old enough that one or more cycles of complete updating by commercial firms have now been undertaken (as in rapidly growing urban areas).

Many GIS are now being designed for continuous updating through transactions, presenting problems in GIS administration which are now under intense study.

Commercial organizations applying GIS technology

The growth in the number of commercial firms which apply GIS technology in particular fields has been explosive in the last few years. Such organizations work in the fields of surveying, photointerpretation and photogrammetry, image processing, urban and regional planning, real estate, vehicle navigation, utilities, energy, mining and minerals, market research, landscape architecture, architecture, development, forestry, coastal planning, ecology, environmental planning and regulation, parks and recreation, land management, agriculture, military/defence, cartography and national mapping, water resources, flood control, civil engineering, transportation engineering, sanitary engineering, transportation planning, communications, and many others. (In

part because of the employment opportunities being created in such firms, a growing number of colleges and universities are acquiring GIS for use in teaching.)

Consulting

A significant number of organizations and individuals now offer consulting on various aspects of GIS. The services offered include assessment of possible applications of GIS, GIS feasibility studies, system and database design, project design, assistance in designing specifications and Requests for Proposals (RFPs), project supervision, benchmark testing, advice on special problems in GIS, and so on. Some of the consultants also offer the capability to execute the plans they devise, including complete implementation of a system; others are third-party providers of services only.

General-purpose GIS technology firms

A few firms offer to provide a very wide range of GIS-related goods and services. These are often firms which have been in the field for more than a decade, are relatively large in size, and have accumulated a good deal of experience. These firms typically offer a wide range of consulting services, turnkey GIS, database creation, custom software programming, and complete project support services, from concept to final working system. Another approach is for a firm to offer organizational management and financing for the GIS, and then contract for all the required elements of the final GIS.

GIS-related businesses

Training/education

As contrasted with colleges and universities which may deal with education, these firms usually offer highly specific training about GIS and its applications. Some of these firms offer a broad range of related services as well. A few concentrate on seminars and courses which introduce GIS in a more academic setting. A number of commercial organizations now offer services in organizing GIS-related meetings, conferences, symposia and the like. These seem to function in ways somewhat similar to professional societies.

Publishing

A number of commercial organizations are now heavily involved in providing GIS-related journals, newsletters, market reports, research reports, and the like. A much larger number of such organizations deal with the field more peripherally by running occasional GIS-related advertisements, articles, reviews, application descriptions and similar materials. As well as potential sources of revenue, these offer a useful means of information dissemination and advertising.

Database publishers

A few commercial firms exist which might be said to be 'database publishers'. These firms provide previously created digital databases of various kinds of geographical information in some exchange format. An example is the firms providing road centreline files, initially driven by the requirements of road navigation systems. As rights in data are clarified, arrangements for data sharing with governmental agencies are worked out, and the demand for quick availability of geographical data increases, these firms may find an important niche in the GIS field, much like national government's publication of digital files.

Others

In addition to the firms mentioned above with involvement in photogrammetry, image processing, there are other firms, in a wide range of data capture and data processing areas, which simply supply their products to others for automation. These firms, nevertheless, play an absolutely essential role in the creation and support of GIS technology: their development in the last 20 years, along with developments in computer hardware technology, are probably the two major driving forces in the growth of the GIS field itself.

SYSTEM CYCLE SUPPORT

While some experienced GIS user organizations continue to buy selected GIS goods and services, the rapid growth of GIS use has meant that a growing number of customers want complete support for their GIS, from initial concept to a complete functioning system. The complete GIS

development cycle, as it is supported by some commercial organizations, will be sketched out in this section. The basic steps in the development cycle are indicated in Figure 4.6 (see also Clarke 1991 in this volume).

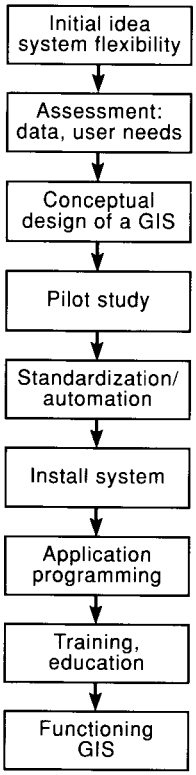

Fig. 4.6 A simplified view of the GIS system cycle

The process (described here only in skeleton outline) begins with formulation of needs and a concept; this is best done under a single director, using hard working, highly motivated 'teams of two' persons (one technically oriented, the other management oriented). Then a thorough study is made of user needs, of existing data resources, and of how the GIS will affect decision making. A cost/benefit or feasibility analysis of the proposed GIS may be performed at this point. The hardware, software, database, staff, organization, and other resources required are identified and then a design for the system and an implementation plan are created and reviewed with the user organization. If approved, the system implementation is begun. Vendors are contacted, site visits made, necessary consultants employed, applications identified, alternatives considered. A request for proposal may be drafted, including specifications, performance criteria, requirements for a technology selection test, and other requirements. Vendor selection follows. The data to be used are gathered, organized, reclassified as necessary, standardized for the new database, updated as necessary, integrated, prepared for automation, automated, edited, displayed for comparison with the source data, prepared for storage, and included in the growing database. Hardware is acquired, installed and tested, and systems software installed. Software is acquired and installed. Users are trained, and then their training reinforced by work on a pilot project which tests the entire GIS.

For a specific project, the system is used to prepare atlas maps of the project site, models are prepared for analysing the project data, outputs of various kinds are obtained, and, based on these, a plan, recommendations, decisions, or similar outputs are provided.

For a GIS providing continuing support to an organization's decision-making process, the initial database is gradually expanded, updated and enhanced, perhaps through the transaction process. Over the years the system cycle may have to be repeated, providing for updated, enlarged, or additional capabilities. Reorganizations, changes in mission or mandate, and other changes, may affect this process. Experience suggests that many GIS will have to be expanded as soon as users discover what they are capable of doing. Upgrading of skills, introduction to new techniques and methods, and similar ongoing education and training are required throughout the system's life.

Commercial organizations may also assist in integration of a GIS with an existing information system, GIS technology transfer, software conversion to new hardware platforms, creation of specific GIS products (such as atlases, special maps, etc.), and other, more specialized, services.

COMMERCIAL FIRMS' CONTRIBUTIONS TO THE GIS FIELD

The commercial sector makes a variety of contributions to the GIS field as a whole. A good deal of research and development is undertaken, in order to bring new products to the market; pilot

studies of actual applications are often an important part of the process. Commercial firms are often the first actually to provide delivery of new technology to users in the form of hardware, software, methods and techniques, applications, training and so on. Having made it available, commercial firms continue its support through hotlines, technical consulting, technical literature, user groups and the like. Commercial firms may provide partial or complete subsidies of the development of new technology by other sectors, especially educational institutions and individual researchers; they may also make the technology (e.g. hardware, software, project support) available at low cost or no cost to educational institutions and special classes of users, such as non-profit organizations, international organizations dealing with the underdeveloped world, or the like. Donations of new and used equipment may be made to institutions which could not otherwise afford to acquire it. Commercial organizations usually provide major sponsorship of technical meetings and conferences, technical journals and technical research. Advertising by such firms performs an educational function for potential users, making them more aware of the technology and what it can do; advertising revenues are a major source of funds supporting the existence of professional journals. Representatives of individual firms or industry groups often take the lead in organizing industry committees and working groups or joint committees involving all the sectors of the GIS field, such as those dealing with standards; industry representatives often provide certain kinds of public policy advice to government agencies at nominal cost. Industry is a major employer of persons who practise GIS, probably exceeded by government, but, today, ahead of academia in this regard. Commercial firms often conduct extensive education and training efforts for their own employees, either formally or informally, and create a major reservoir of trained and experienced professionals and technicians which eventually enriches all sectors of the GIS field.

PROBLEMS OF COMMERCIAL GIS BUSINESS

While its success has been remarkable in recent years, the commercial sector of the GIS field must work hard to solve various problems if it is to continue to flourish; a few of these problems are mentioned below.

Problems of perception and understanding of the technology

The vast majority of people who could usefully employ GIS technology still know little or nothing about it. The message about its usefulness is still not being heard in the places where the technology is most needed, such as in the Third World, in the vast majority of municipal governments throughout the world, on the farms of the world, and by average citizens, whose access to the technology (often paid for by public funds) is difficult or impossible. Present educational efforts in colleges and universities, and even the expanding use of the technology, will only improve this situation over a period measured in decades (see Unwin 1991 in this volume for further details).

Potential buyers and users of GIS technology continue to be confused and, in some cases, turned away from GIS use by various advertising and sales practices of some commercial GIS firms. The number of commercial firms claiming to have GIS is rapidly expanding, but the vast majority of these software systems have only rudimentary GIS capabilities.

Companies continue to announce GIS software long in advance of the earliest possible delivery dates, and many such programs are never delivered to users at all. Many GIS continue to perform so badly that users, and those who listen to them, are convinced that the 'promise' of GIS technology is no more than a deception.

Many of these problems would be eliminated if potential users were far better informed and educated about the technology, if professional standards of practice were observed, and if more users would make use of objective tests, such as benchmarks, to evaluate the competing claims of vendors. But beyond this, all sectors of the GIS field need to work harder at explaining what GIS technology is, what it can do, and how it can be most effectively and inexpensively employed.

Problems with GIS technology

There are numerous technical problems to resolve at the present time, but, perhaps paradoxically,

these are likely to be resolved much sooner than the problems mentioned above. These technical problems, discussed elsewhere in this volume, include the difficulties in connecting hardware and software from different vendors; the difficulties in interconverting data created in different ways; the data automation problem; and so on.

Problems between the sectors of the GIS field

Finally, commercial organizations continue to find themselves in competition with government and sometimes academia in providing goods and services to users. As in other technical fields, this is a source of concern for all parties; it may also be a source of creative tension which benefits all.

SOME FRUSTRATIONS OF THE COMMERCIAL SECTOR

Some problems are so intractable and persistent that they colour every aspect of commercial operations in the GIS field. While opinions will differ as to what these intractable problems are, here is one short list:

- Given the speed with which the field is developing, and the difficulty commercial organizations are having in keeping up with that growth, it may seem paradoxical to suggest that the slowness with which the technology has been accepted is frustrating; but, given what the technology is capable of, and the rapid march of the global problems which it could help to alleviate, the relative snail's pace of its development is extremely frustrating.

- Though costs are falling rapidly, the continuing high cost of the technology is also frustrating.

- It is frustrating to GIS professionals to deliver such an effective and powerful technology and then see it either underused, misused, or abandoned by users, for reasons which have nothing to do with the technology itself. A related frustration is commercial firms' inability, thus far, to deliver GIS technology to those who need it most in the world, the people in underdeveloped countries. Both these frustrations may be related to a third, the difficulty in transferring this technology to users who lack a rather rich educational and, perhaps, cultural background (this issue is explored further in Taylor 1991 in this volume).

- Of the GIS technical problems, the most frustrating continues to be the collection and automation of data, still probably the chief technical barrier to wider use of GIS (see Jackson and Woodsford 1991 in this volume).

TRENDS OF THE COMMERCIAL SECTOR

Many changes have occurred in the business of GIS in the 25 or so years of its existence. Only a few can be mentioned here. Figure 4.7 also indicates some of these.

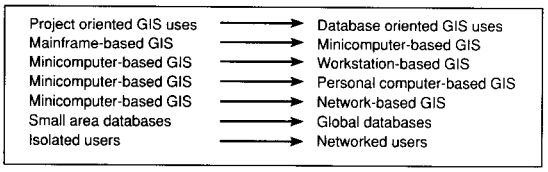

Fig. 4.7 Some of the trends in the commercial sector

The dominant trend in the commercial sector is unquestionably the rapid growth in the sales of GIS. This certainly reflects, in turn, steeply rising user acceptance of, and user demand for, the technology.

An underlying trend, which has probably fuelled these rapid increases, has been the rapid increase in the performance/cost ratio of general-purpose computer hardware over the entire history of GIS. This permitted commercial firms to break into the GIS turnkey system business in the 1970s by being able to support GIS on minicomputers instead of just on mainframes; in the 1980s, GIS could be based on personal computers. Now performance is

being enhanced through the use of workstations and by networking hardware components.

One reflection of these changes has been a clear trend from GIS being used to perform the work of single, isolated projects, to the sale of the technology to users who create databases and systems which they intend to use continuously, over a long period, for a series of applications. This trend has made the industry what it is today. A decade ago the largest part of the business was in services, usually performance of complete projects for users. Now the largest part is sales of hardware, software, training and support, to users.

As users have become increasingly responsible for their own systems, and the cost for entry-level GIS has fallen, the diversity of users (Fig. 4.8) has increased; so also has the number of systems serving many different purposes.

	Computer-aided drafting	Remote sensing	Raster GIS	Vector GIS	Network analysis	Coordinate geometry	3-D modelling	Laser disk storage
National development	■	■	■	■	■	■	■	■
Urban planning	■	■	■	■	■	■	■	■
Renewable resources		■	■	■		■	■	
Utilities	■	■	■	■	■	■		■
Transportation	■	■	■	■	■	■		■
Environment		■	■	■	■	■		
Agriculture		■	■	■		■		

Fig. 4.8 Spatial data technology and applications

The practical upper limit in the size and complexity of GIS databases is growing rapidly; the first true global GIS have only been around for a few years (see Clark, Hastings and Kineman 1991 in this volume). As database size has expanded, increased efforts have been devoted to data capture and automation. As the field has aged, increasing efforts have been devoted to database maintenance and updating.

If present trends in falling cost, increasing ease of use, and rising user interest continue, GIS may become as commonly used as computer graphics.

FUTURE COMMERCIAL DEVELOPMENT OF NEW TECHNOLOGIES

Many factors influence whether and when a particular development in GIS technology becomes 'commercial'. These include cost, potentially useful applications, ease of use or 'user friendliness', concept demonstration through suitable pilot applications, the willingness of one or more firms to invest in bringing the technology to market, availability of necessary supporting technologies, and so on. Sometimes what is most necessary, or most lacking, is a 'champion': a person or an organization to push the technology until it is accepted.

An example of a technology which seems to offer considerable promise, but which is not presently significant in GIS-related sales, is artificial intelligence/expert systems (see Smith and Ye Jiang 1991 in this volume). Some GIS applications have been made, but have not yet been widely accepted by users.

Scanning is finding increasing acceptance for data capture, although it continues to have major technical limitations in dealing with many kinds of mapped data.

CONCLUSIONS

The commercial sector of the GIS field is just beginning its period of most rapid growth. Like the rest of the field, the commercial sector is just emerging from its 'pioneering' phase. As information technology improves and diversifies, users will increasingly be able to mix freely GIS, CADD (computer-aided design and drafting), image processing, and other spatial information technologies. On the one hand, the decade or two just ahead may see commercial GIS further emerge as a recognizable industry; on the other hand, the technology may become so pervasive that it 'disappears', becoming transparent to users in the same way as that of the telephone, the computer and computer graphics. At present, the former course seems the more likely.

The commercial sector of the GIS field is increasingly recognized as a major player in the field as a whole. It provides competitive and market mechanisms and creative forces that can be

channelled to make great progress, if parochialism, protectionism, nationalism, and unfair forms of competition can be avoided, and open, global markets for GIS technology can be created.

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