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Managing an operational GIS

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The importance of GIS is ultimately judged by how successful they are for the operational purposes for which they have been installed. Good management practices are essential to ensure success. This chapter describes the basic elements of managing and progressively replacing a GIS. It describes the crucial need for customer support, the need to provide support for operations, data management, and applications development. The need for sound project management is stressed. Workload planning and budgeting – the latter varying with stages in the life-cycle of the GIS – are both described, as is the desirable relationship between GIS management and that for the organisation as a whole. Finally, the management implications of likely future changes in technology and societal norms are anticipated.

1 INTRODUCTION

The organisational structure and management direction will determine the type of GIS organisation to be created (see also Campbell, Chapter 44). The three types of installations include corporate (or enterprise), departmental, and project GIS.

The corporate GIS is used by multiple programmes to support mission-critical functions across an organisation. Management responsibility normally lies with a central information technology-support organisation. The corporate GIS requires extensive planning since all of the control and operations functions are needed. Complex business requirements that span multiple departments contribute significantly to the system complexity. Business requirements are satisfied by creating software applications that utilise a corporate database management system linked to the GIS. The benefits of this corporate management approach are often measured in terms of overall productivity or profitability improvements. With the corporate approach, there will also be benefits that are accrued at the department level. While the management overhead cost may exceed other implementation strategies, it may be the only way to achieve these corporate benefits.

The departmental GIS supports one critical business area of an organisation. It is managed within the department that it supports. Often, the departmental GIS receives network, computing, and database services from a central information technology organisation. This management approach is most appropriate when GIS functions within the organisation are only needed by one department. Consequently, all of the benefits and costs attributed to this technology are allocated to the department where it is managed.

The GIS project is a third type of installation. A GIS project has a well-defined deliverable which is a product and not an operational system. There are beginning and ending dates and, upon completion, staff are assigned to other activities. The benefits of this type of installation are determined from the value of the product which is produced. The entire project cost must be considered in the cost–benefit analysis. Residual (depreciated) value of equipment can be recovered upon its sale or transfer to other projects. The GIS project is often managed without oversight or guidance from a central information technology organisation. Consequently, there is little chance of a project GIS evolving into a departmental or enterprise GIS.

2 MANAGING AN OPERATIONAL SYSTEM

Every operational information system has a predictable life-cycle. An organisation has requirements to automate certain business functions. A project is planned and the business application is developed. Following development, the system is put into operation – see Bernhardsen (Chapter 21) and Maguire (Chapter 25) for details of alternative modes of system implementation. Over time, business needs change and technology advances offer new approaches for meeting these needs. Typically, old systems are then replaced and the cycle starts all over again, as shown in Figure 1.

The particular management approach which is adopted can have dramatic impacts upon the characteristics of the GIS life-cycle. From a business perspective, it is highly desirable to modify systems as business requirements change. Further, the cycle of development and operation can create major swings in budget and overall system performance. A disciplined management approach should involve a continuous process of enhancing systems as business needs and technology change. This is easier said than done, although two key factors affect management ability to achieve this objective. First, today's technology is modular – so it should not be necessary to change an entire infrastructure in order to achieve incremental benefits. The second factor is more a function of the management approach. The disciplined manager will be in tune with changing business strategies (see Birkin et al, Chapter 51). Organisational workload planning will facilitate the change process. Proposed projects are prioritised by their ability to support business needs. It is incumbent upon the manager to propose technology infrastructure projects which meet these demanding business expectations.

GIS management functions include customer support, operations, data management, and application development and support. GIS organisations may also have staff dedicated to project management. Every GIS requires staff support for these functions. The large 'GIS shop' may have multiple staff positions supporting each of these functions. It may organise along these functional lines as well. Staff at smaller installations may perform two or more of the support functions. Typically, when there are fewer than seven or eight employees in a GIS organisation there is little need for multiple supervisors or a multiple level organisational structure. It is important, however, to have clear definitions of support roles and responsibilities for all staff. It is quite common to organise along functional lines. Staff are then assigned to projects that cross all of these lines in order to create a matrix organisation. A different approach is to organise by project teams. Staff are brought together to support all of the functions for a particular project. Upon completion of a project, staff are assigned to new teams.

2.1 Customer support

The customer support function will involve many activities in a typical GIS organisation. Critical to the success of any GIS operation is a customer help

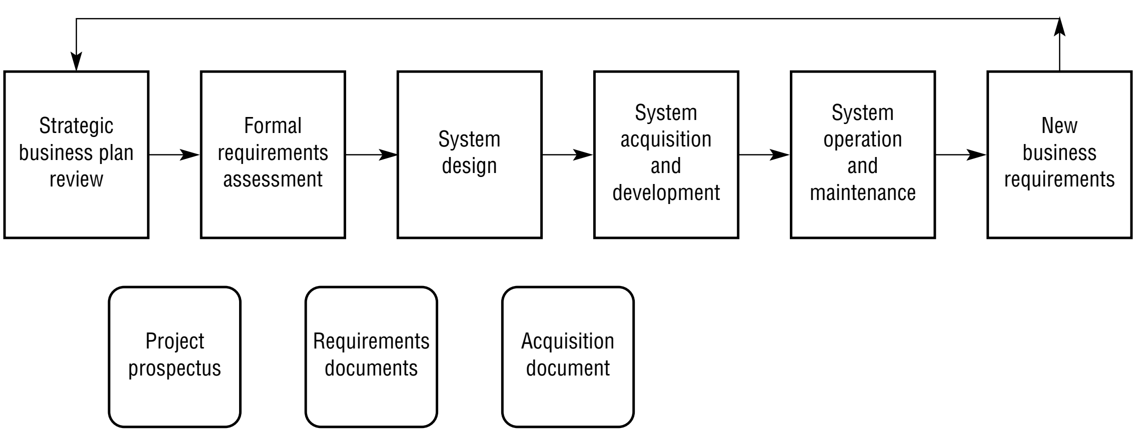

Fig 1. The information system life-cycle.

desk that logs inquiries and responds to customer requests for information. This is usually the first customer contact point and is where impressions of the organisation are formulated. Geographical data requests are usually handled as a support function in this unit. A customer support unit may either arrange for training or provide training on an organisation's internal procedures and GIS software applications. The nature of almost every GIS installation is that a certain amount of ad hoc reporting and special projects are inevitable. This is highly desirable because a GIS should be designed to handle questions which deal with strategic issues. The GIS is then viewed as a tool that supports strategic change, rather than one that imposes rigid institutional structure. A customer support function within any organisation should therefore include GIS analysts who know the data and the technology.

The help desk function can be a very simple call logging and follow-up activity or it can be a problem resolution centre with high-level analysts solving problems as they become known. A smaller organisation will often rotate the help desk function among the staff. Assistance for any given problem is then provided by the individual most capable of resolving an issue. Regardless of how this service is provided, it is useful to log incoming calls and formally close out a call when an issue is resolved. This serves two important purposes. First, the chances that a customer's problem will go unresolved increases as more people become involved. A formal call logging and close-out process insures that customers receive feedback. Second, if problem resolutions are logged as well, the source of reoccurring problems can be identified and actions taken to reduce the level of customer problems. This can take a number of forms, such as increased training, correction of software bugs, or technology infrastructure improvements.

A GIS manager who recognises the value of highly trained staff and users will be in an excellent position to provide quality service. Information technology continues to be very complex and the rate of change is rapid. GIS is no exception. Typically, system administrators and software development engineers will receive training from the system and software vendors. There is, however, an increasing number of firms that provide this specialised training. Customer training to use applications and to perform rudimentary GIS analysis is often provided by GIS support staff. Training courses can be acquired from the vendors or developed in house.

Applications analysts are called upon to perform complex GIS analysis and create products from the GIS. These specialists need to have a comprehensive understanding of the GIS capabilities and the data resources necessary to perform the most complex analysis. It is always helpful if these individuals also know the business operation well enough to assist in finding creative solutions to real business problems.

2.2 Operations support

System operations include system administration, maintenance, security, backups, technology acquisitions, and a host of other support functions. System administration forms the cornerstone of this important operations function. The systems administrator is often the operations manager or, in a very large operation, the administrator will have key technology responsibilities. Clear service delivery requirements must be understood and written in an operations service document or plan. The operations manager will be challenged on a daily basis to maintain a high up-time operation. GIS installations have peripheral equipment and requirements which are unique to the GIS technology. For example, the network bandwidth requirements used to support spatial data are high. Peripherals such as large scanners and digitisers have their own unique requirements. Operation services such as network support often come from multiple parts of an information organisation. For this reason, it is important that these requirements are well-documented in the operations plan (see also Bernhardsen, Chapter 41).

The operations service document should include service hours and scheduled down-time for system maintenance. Target up-time as well as procedures for reporting system problems form an important part of the document. Without this, the customer's expectation will be for 24 hours per day, seven days a week service with no system failures. Closer examination shows why this is important. Very high up-time system performance is possible but it comes at a high price. Thus the customers need to be a part of the planning process to determine service hours and up-time requirements. It is best to address these issues in the project planning phases rather than when system failures occur. The service document should accurately describe the full range of services that is offered, such as which vendor software products are supported, how new services are requested, and how off-hours support can be obtained if needed.

System security comprises a large number of activities and it is important for a variety of reasons. The common notion is that data security is most compromised by individuals with destructive intentions. But the reality is that a very high percentage of data corruption and losses are caused by inadvertent actions or system failures. So system security involves locks and passwords, but it also includes thought-through procedures to protect data and other system components against inadvertent destruction. Regular system data backups, for example, must be completed according to a plan. How often a backup is taken is a function of the database and the requirements for currency. For example, a banking institution will require a 'point in time' recovery capability since losing *any* customer transaction would be disastrous. GIS almost always have a recovery requirement that is somewhat less demanding than a banking institution. System backups are normally cycled to an off-site location when they become two or three generations old. The first generation backup is usually kept on site so quick recoveries can be completed when a user inadvertently destroys a data file. The second generation backup will be available from the off-site location in the event that a major disaster results in total destruction of the database. It is essential that multiple generations are kept since, in the extreme, a system virus may be planted in a file with a timed release. More typical, however, is that corrupted files resulting from user or application errors go undiscovered for more than one generation of backup. A secure system will also have software environments established for production software as well as development and testing. A programmer check-in and check-out procedure will help secure the production environment.

Other system operation duties are more mundane. Staff routinely install new releases of vendor software, investigate problems, and incorporate patches into the administered software environment. Network address and user identifications are assigned. Systems are monitored for performance and loading. Disk space is managed and projections for when new storage space is needed are maintained. New hardware and software installations are completed. Maintenance contracts are managed. Peripheral equipment is cleaned and supplies are ordered. All of this may sensibly be carried out within procedures defined within a quality system, perhaps based on ISO 9000 standards.

2.3 Data management support

Base geographical data within a GIS are often managed as part of the system infrastructure. Many of the other chapters in this book entail discussions about data, but the emphasis here will be upon an organisational management perspective. Most information technology applications create data through on-line user transactions that build or modify a database one record at a time. In other cases, the application processes a transaction through a system and upon completion it is discarded. Summary level data may be all that are retained. It is true that many GIS also serve these kinds of function. Examples include permit processing, delivery dispatching, and a host of other applications. GIS, however, have a special requirement for base data upon which customer applications depend. For example, a base data layer of transportation is needed for a delivery company to calculate service routes. The same base transportation data are needed to produce road maps, process building permits, complete environmental assessments, plan road maintenance, and meet many other needs. For this reason, it makes sense to manage the base data in a GIS as part of the basic infrastructure. Indeed software vendors are catching onto this as they begin to bundle their products with base geographical data (see Batty, Chapter 21; Elshaw Thrall and Thrall, Chapter 23).

The concept that base data are a part of the infrastructure is not new. In fact, mapping organisations around the world have produced base cartographic products in hard copy form for years. Many organisations have continued this support function by converting to automated cartography or GIS during the past 20 years. The conversion process is nearing completion in many parts of the world. Now the attention has shifted to maintaining base data and creating ways to move this valuable product throughout the information infrastructure without compromising its integrity. Other terms, such as framework, are evolving to describe the base data (see Guptill, Chapter 49). The concepts of framework are different today in that they also address the issue of maintenance and data sharing (see Smith and Rhind, Chapter 47; Rhind, Chapter 56). Conversely, some of the original methods of moving paper products between and through organisations today are no longer relevant.

If base data are part of the GIS infrastructure, then it follows that data management strategies and procedures are an important component of GIS operations. The GIS base data layers may include the geodetic control, digital terrain, orthoimagery, transportation, boundaries, hydrology, cadastral, and natural resources data (Mapping Science Committee 1995). Historically, organisations have acquired these data from mapping organisations. They have managed the data as part of their internal cartographic support function. This made sense when the final product was a hard copy map. Today, the desired product is the database and the map is a derivative. Many organisations are restructuring to reflect this shift which has been created by advances in GIS and database technologies. The respective roles of the mapping and information technology functions within an organisation thus becomes a strategic direction issue. The primary business functions served will ultimately influence the management solution within any given organisation.

Geographical data collection and support functions are changing in the GIS industry. Today, new base data are being collected by virtually every GIS organisation. This is no longer a task reserved for the map-making organisations. New technologies are also emerging that will further proliferate the potential sources of usable digital data (see Batty, Chapter 21; Lange and Gilbert, Chapter 33). Organisations are still needed to support the base data requirements but their role in the future will be quite different (Morrison 1997). Operations support may mean that coordination, developing standards, and facilitating partnerships becomes a primary activity (Salgé, Chapter 50). Meanwhile, the GIS manager is caught up in this exciting time of reinventing the way data are created, managed, and used (see Goodchild and Longley, Chapter 40).

There are many organisational approaches to the creation and management of base geographical data. Historically – at least in the USA – base data have been digitised from existing maps by multiple organisations as their internal needs dictated. This has resulted in duplicated efforts as datasets are created to meet different business requirements for content and accuracy. While this practice will continue to some degree, the prevailing sentiment will be to economise and work with other organisations to create a common data infrastructure. This opens opportunities to privatise certain functions or to develop consortia to manage base geographical data. Many public organisations seem likely to let contracts to the private sector to collect base data. Upon completion, the public organisation may manage the data and provide information services or copies of the data to other organisations. This may be done for a fee intended to recover costs of development and management. Private sector companies that provide base data services for profit are emerging in this market place as well.

Data administration and database administration are important support functions within any GIS organisation. Depending on the size of the GIS organisation, this function can be part of the GIS data production support activity, the applications support, or a stand-alone function. A smaller organisation will often combine both of these functions into a single position. A database administrator is responsible for ensuring that all stored data meet standards of accuracy, integrity, and compatibility established by the organisation. The database administrator is normally responsible for designing physical storage from logical data models and consulting with developers on accessing data from the database management systems. The data administrator is also responsible for the planning of the organisation's data and metadata (data about data) resources. This individual will consult with business experts in determining information technology project requirements. The data administrator often uses Computer Aided Systems Engineering (CASE) tools to construct logical data models. Data dictionary maintenance typically falls under the responsibility of this position.

2.4 Application development and support

Software application support staff have the responsibility to create new applications to support business needs. The application development process requires that developers continuously learn new software tools. They must be able to adapt to the ever-changing software infrastructure that supports them. A larger organisation may have specialists in spatial and tabular data as well as software engineering. Other organisations may limit the complexity of application they develop or hire contractors to build applications. Regardless of the detail, the application development environment will continue to change very rapidly. This change catalyst means application and development requirements will add complexity to the GIS management environment.

Software documentation standards and procedures are critical to the long-term support of the GIS. A quality project plan for development should allow time to follow these conventions. It is generally too easy to drop documentation requirements or squeeze development time in order to complete a project on time. The long-term impact of these management decisions will affect the ability of a product to be supported over time. From another perspective, over-zealous developers should not insist on exacting procedures and complex development methodologies for an application that has a short life expectancy. This only adds unnecessary costs to a project.

From a management perspective, it is desirable to assign developers full time to a new project. When it is complete, staff reassignment would then be made to the next project. Yet the manager rarely has the luxury of doing this and it is rare that a developer has just one project going at a time. In addition, applications developers usually have software maintenance responsibilities for existing applications. A formal change control process becomes an important management tool for scheduling this type of work. When customers require changes to their applications, it is normal to assume that these take priority over other activities. A closer examination may reveal several things. Changes which are enhancement requests should be scrutinised for priority in the same way as other, completely new, projects. When a system has a large number of change requests on file, this is an indication that either the maintenance support function is understaffed and/or the application is obsolete. A global look at the change request log may reveal that a new application would be more cost-effective.

2.5 Project management

GIS-user organisations will almost always have multiple projects active at any given time. In a smaller organisation, the GIS manager may serve as the project manager and assign tasks to staff as needed to complete work. The project management function becomes increasingly important as projects become larger or more complex. Within organisations where there are multiple large projects, project management specialists may be assigned to oversee staff, to manage budgets, and to direct the completion of all project elements.

3 WORKLOAD PLANNING

The GIS manager has an ongoing responsibility to assign staff to projects and to provide the support necessary to maintain a viable operation. There will always be more work than there are staff resources to accomplish it. Without workload management, there will be little organisational discipline. Staff may tend to work on the things they enjoy doing. Likewise, the GIS manager will likely be responding to operational problems rather than leading the organisation towards its strategic objectives. While workload planning never really ends, there should be a periodic planning activity that coincides with budget development. Customers are brought into the process and a survey of anticipated work is completed. Workload estimates are completed and all proposed projects are prioritised relative to the organisation's strategic business plan. Since it is unlikely that there will be enough funds or institutional capacity to do all projects, it is critical that each project prospectus is evaluated. The prospectus should contain all of the information necessary to complete this evaluation. If prospective customers do not have a project prospectus, it is likely that they have not thought the proposal through. There will also be other projects that are in later stages of development which will require prioritisation and continued funding.

The preliminary workload plan will be organised according to the type of activity to be supported. For example, the plan may include system operations, customer support, application maintenance, and new projects. The workload plan is then linked to budget elements. An example of a workload plan is shown in Table 1. When budgets are set, the plan is adjusted to reflect organisational priorities. A review of the completed plan will reveal a great deal about a mature GIS and its role in an organisation. The plan should include a good mix of activities necessary to maintain a viable organisation. For example, there should be planned projects to

Table 1 GIS organisation workplan, courtesy of State of Washington, Department of Natural Resources.

Geographic Information Section *PROJECT NAME/DESCRIPTION*	*DIV.*	***FY96*** *Staff Months*	***FY97*** *Staff Months*	*IT Board*	*Agency Priority*	*Status*	*Project Phase*	*Strategic Goal, Objective*
SUPPORT ACTIVITIES								
Management/Support/IT Coord.	ITD	12.00	12.00			Ongoing		1.1.01
Computing Service	ITD	45.00	45.00			Ongoing		
Training Support	ITD	12.00	15.00			Ongoing		2.1.01
Consulting Support	ITD	24.00	24.00			Ongoing		2.1.01
Standard Data Products	ITD	12.00	12.00			Ongoing		1.1.01
Special Product Requests	ITD	24.00	24.00			Ongoing		1.1.01
Spatial Data Maintenance	ITD	24.00	24.00			Ongoing		1.1.01
Software Configuration Management	ITD	0.00	3.00			New		
Region GIS Coordination	ITD	42.00	42.00			Ongoing		4.1.01
WORKLOAD – Support Activities		195.00	201.00					
SOFTWARE MAINTENANCE								
System Utilities	ITD	6.00	4.00			Ongoing		
TRANS, HYDRO Update Applications	FPD	1.00	1.00			Ongoing		1.1.01
Cadastre Update Application	FRD	1.00	1.00			Ongoing		1.1.01
Land Use Cover Application	FRD	1.00	1.00			Ongoing		
Resource Management Applications	ITD	24.00	18.00			Ongoing		
DISPLAY Application	ITD	4.00	4.00			Ongoing		
Permit System Application	FPD	6.00	12.00			Ongoing		
Planning & Tracking Application	FRD	0.00	8.00			New		
Forest Inventory Application	FRD	12.00	12.00			Ongoing		
WORKLOAD – Maintenance Activities		55.00	61.00					
OPERATIONS PROJECTS								
Conversion to SOLARIS	ITD	6.00	6.00	New		Inactive	Complete	
DBMS Pilot/Transition Plan	ITD	15.00	15.00	Awareness		Active	Development	
Software Configuration Management	ITD		3.00	New		Active	Requirements	
DBMS Transition	ITD	8.00	8.00	Awareness		Active	Pilot	
Spatial Data Framework Pilot	ITD	10.00	10.00	New		Active	Prospectus	1.1.01
Map Display/Query	ITD	4.00	6.00	New		Inactive	Prospectus Needed	
Desktop Applications for Unix Users	ITD	1.00	1.00	New		Active	Pilot	
NAD83 Database Modification	ITD	0.00	3.00	New		Inactive	Prospectus	1.101
Data Dictionary – User Interface	ITD	0.00	3.00	New		Inactive	Prospectus Needed	
Windows NT – Investigation	ITD	3.00	1.00	New		Inactive	Prospectus Needed	
GPS Interface with Update Applications	ITD	1.00	3.00	New		Inactive	Prospectus Needed	
Spatial Metadata – FGDC Grant	ITD-DIS	2.00	2.00	New		Active	Implementation	1.1.01
WORKLOAD – Shared Data Production		50.00	61.00					
FRAMEWORK DATA PROJECTS								
DATA96	ITD	18.00	1.00	Awareness		Inactive	Complete	1.1.01, 4.1.01
Cadastre Framework	FRD	0.00	16.00	New		Active	Scoping	1.1.01, 4.1.01
Transportation Framework	FRD	0.00	3.00	New		Proposed	Prospectus Needed	1.1.01, 4.1.01
Hydrology Framework	FPD	0.00	0.00	New		Proposed	Prospectus Needed	1.1.01, 4.1.01
DEM Framework	ITD	3.00	0.00	New		Active	Development	1.1.01, 4.1.01
Orthophoto Framework	ED	0.00	6.00	New		Proposed	Prospectus Needed	1.1.01, 4.1.01
WORKLOAD – Shared Data Production		21.00	26.00					
BUSINESS APPLICATIONS								
Forest Harvest Permitting – Release 1.0	FPD	24.00	12.00	Mandated	2	Active	Implementation	4.1.01
Forest Harvest Permitting – Release 2.0	FPD	0.00	6.00	Mandated	2	Active	Construction	4.1.01
Planning and Tracking – Release 1.0	FRD	24.00	48.00	3 yr Pri.	5	Active	Construction	4.1.01
Forest Inventory – Release 2.0	FRD	0.00	0.00	3 yr Pri.	6	Active	Construction	4.1.01
Aquatic Ownership Data	ALD	0.25	0.25	3 yr Pri.	7	Active	Requirements	1.1.01, 4.1.01
Harvest Planning – Release 2.0	RPAM	9.00	9.00	Reviewed	8	Active	Development	4.1.01
Geology Data Layer	G&ERD	1.00	2.00	Awareness		Active	Construction	1.1.01, 4.1.01
Natural Heritage Data Layer	FRD	2.00	0.00	Awareness		Active	Requirements	1.1.01, 4.1.01
Reforestation – Nursery Automation	FRD	0.00	0.00	New		Active	Scoping	4.1.01
Resource Planning Data System	RPAM	0.00	0.00	New		Delayed	Prospectus	4.1.01
Landscape Planning	RPAM	0.00	0.00	New		Delayed	Prospectus	4.1.01
Agricultural Data Layer	AgRD	0.00	0.00	New		Active	Prospectus	4.1.01
WORKLOAD – Development Activities		60.25	77.25					
WORKLOAD – All Activities		**360.25**	**400.25**					

Note: All staff month allocations are initial assignments from planning in early 1995. Actual allocations have changed.
Project list includes updated information from staff planning exercises in February, 1996. Several are new proposals.
The FRAMEWORK98 project has been subdivided into a PILOT and several Data Layer related projects.

*Permanent positions in Geographic Information Section and Data Administration Section allocated to GIS support, operations and proposals.

modernise the technology infrastructure on a continuous basis. Nearly every piece of equipment in the GIS world has a useful life of three to five years. Assuming a straight line depreciation, about 20 per cent of the infrastructure should be replaced on an annual basis. This will only be accomplished if replacement is built into the workload plan. Further, an organisation's strategic business goals and objectives will almost certainly be continually defining new directions. There should be technology projects to support these strategic business plans. Finally, ongoing support functions cannot be ignored. An expanding customer base will require additional user and application support. The work planning process is not a simple task: the GIS manager should strive to have a balanced workload that supports each of the important system functions.

4 BUDGETING

Methods of budgeting for any service are always a topic of discussion. Likewise, there are probably as many variations of approaches as there are people in an organisation. Regardless of the budget method utilised, there is usually more work than money or time to do it. It is important that GIS managers understand and articulate the importance of various work activities to their supervisors. Many people in an organisation will be competing for resources in order to complete their work. The GIS manager needs a source of funds to support computing infrastructure. These funds will be the same funds needed to create GIS applications. If a balanced approach to funding infrastructure and application projects does not occur, then a fragmented GIS environment will result. It is important to bear in mind that – unlike some other information technology applications – GIS has a data component that is part of the infrastructure. The GIS workload planning must account for the ongoing costs associated with maintaining the database.

An operational budget will change over time as a system matures. The three primary components of an operational budget include staff, goods and services, and capital investments. Each category may be broken down into more refined tracking units that suit the needs of an organisation. The distribution of costs between these three elements will shift over time as a system operation matures. In the early years, when initial investments are being made in establishing an infrastructure, capital costs are almost always higher. Likewise, initial goods and services costs are likely to be lower because first year maintenance costs are often included as part of the equipment purchase. Other goods and services costs are also lower since there is usually a smaller user base to support during the start-up period. Table 2 was developed from the author's own budget experience of managing an operational budget for more than 15 years. The per cent breakdown of the major budget element clearly shows a shift in budget over time. As indicated earlier, one important factor to recognise is that infrastructure improvements and replacements are an essential part of any budget. Too many managers assume that capital costs will be very low after the initial acquisitions are complete. The author's own experience and other case studies (see Dickinson and Calkins 1988) clearly suggest that this is not the case.

When contract services are a significant part of the budget, the costs elements will differ significantly from the example provided. Contract services may be acquired for operations support, equipment and software maintenance, application development, and database development and support. Most organisations use at least some level of contract services to support their GIS. It is important to recognise that there is a significant administrative cost for overseeing contracts and services provided by contractors. On the other hand, it is often easier to get access to high quality services through contracting than to hire and train new staff. Another benefit of contracting for some services is that highly specialised work can be accomplished on a schedule without detracting from already planned work.

There are two basic ways in which an organisation can manage a budget and account for

Table 2 Distribution GIS operational budget elements over time based on the author's experience.
(All figures are percentages of the total expenditure.)

Budget object	*Year 1–2*	*Year 1–6*	*Year 12*
Staff and benefits	30	46	51
Goods and services	26	30	27
Equipment & software	44	24	22
TOTAL	100	100	100

Courtesy of the State of Washington, Department of Natural Resources.

costs. The first way is that the GIS unit can receive a direct allocation of funds, along with a clear set of performance and output expectations. Second, there may be no allocation of funds but a pay-for-service (cost recovery) arrangement with other operating programmes. Each way has its advantages and disadvantages. There are many variations of these two approaches that may be used successfully. The cost recovery model is good in that costs become associated directly with the benefiting departments and customers have more control of how their budgets are allocated. The disadvantage of this approach is that corporate infrastructure, data administration, and management support costs are often viewed as unnecessary costs which are built into service fees. By contrast, the centralised GIS budget approach allows for key corporate level business needs to be planned for and met. These objectives and accountability can be more directly associated with budget. However, the GIS organisation that is given an operational budget runs the risk of being viewed as a cost centre. It could become a target every time business costs need to be reduced. A mixture of these two approaches may be the best approach for most GIS organisations. Budget elements which are associated directly to key corporate level business strategies can be allocated to the GIS organisation. Departmental level objectives can receive their own allocation. Departments then pay the GIS service organisation for costs which can be directly linked to services received. These costs would include usage fees for computing services, staff, and materials for maintaining or developing new applications.

5 MANAGEMENT OVERSIGHT

We often hear the GIS technician saying ‘if management would only let me get my job done’. Likewise, managers may wish that GIS staff would work on the ‘important’ things. Regardless of these individual complaints, there is an appropriate level of management interaction with any organisation which is critical to its success. Many of these problems can be avoided when there is an ongoing dialogue between corporate management and the GIS organisation. There should be at least two fora to facilitate this dialogue. First, information technology strategic directions and key project decisions should be made in the context of a corporate technology vision. Steering committees or technology boards are often used to formulate these strategies and recommendations for corporate level decisions. A technology board should have membership representation from all levels of the organisation including customers, users, and corporate management, as shown in Figure 2. The technology board should understand the corporate business goals and it should have knowledge of information technology management principles. This is the organisation that makes final recommendations for corporate budget planning and funding of information technology activities. If this management structure is actively supported, the GIS manager should never be concerned about being in conflict with a corporate vision.

A second forum for communication with the management structure is an ongoing reporting and meeting function. Regular reports which give a clear picture of progress are essential. Progress reports should always include a chart of key project milestones and completion status relative to the project targets. Honest assessments should be made by the project manager about how identified risk factors are being managed. The progress reports become a tool which facilitates useful dialogue with management. It will be possible to address problems before they become too large to solve. Likewise, successes will also receive the attention they deserve (this is less common but is a characteristic of good management).

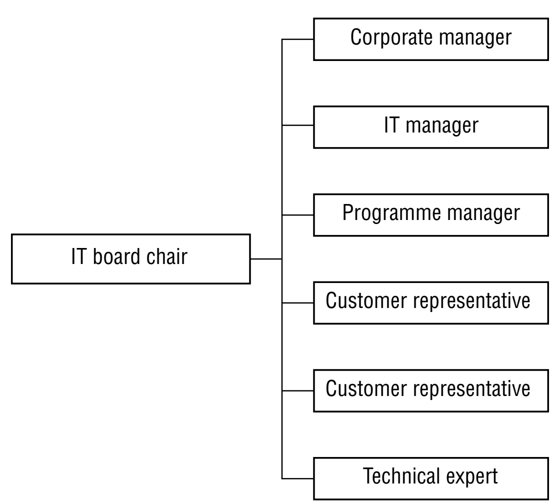

Fig 2. The information technology board: an example of membership and organisation.

6 INFORMATION TECHNOLOGY TRENDS AND THEIR MANAGEMENT IMPLICATIONS

Changes are occurring in and around the GIS industry which will fundamentally change the way work is accomplished. The last 20 years have seen this industry evolve to the point at which the technology is present in most natural resource management and larger government organisations within developed countries. Today, the technology is rapidly moving into the transport and retail industries, as well as small and rural government organisations (see Birkin et al, Chapter 51; Elshaw Thrall and Thrall, Chapter 23; Waters, Chapter 59). Developing nations are seeking ways to introduce the technology effectively into mainstream decision-making. As a result of all this, every GIS manager will be challenged continuously to stay current with technology and remain a leader within their own organisations.

Future trends which are likely to affect the spatial data community were discussed at a workshop in April 1996 (Mapping Science Committee 1997). One of the workshop activities was to identify the technology developments and societal changes that will likely impact on the spatial data community in the year 2010. Taken together, these predictions presented a very different prognosis for GIS technology. It is widely assumed that computing capacity will continue to grow and to get cheaper. A change that we may not be prepared for is that the time lag between data collection and its availability for use will approach zero as real-time data collection systems are realised. Intelligent instrumentation will guide us through real-life situations like driving to work. Or maybe we will all work from home. We will always know where our children are because they will be transmitting their locations in real time. On-board systems will be making decisions based on environmental factors and locations. But modern day systems will provide more than intelligent instrumentation and real-time data. GIS managers will need to work out how to cope with the massive flow of real-time data. Partnerships will involve everyone, not just a few major data producers. From a societal perspective, citizen involvement in government will be in real time. We will also still likely be dealing with privatisation and 'data for free or fee' issues (Rhind, Chapter 56).

As a consequence of all of the above, GIS management will inevitably change. When spatial data become an integral part of every information infrastructure, every information manager will be a GIS manager. Spatial literacy and awareness will open up educational opportunities to which the GIS manager must respond (Forer and Unwin, Chapter 54). The trends in information processing and utilisation in our business systems will continue to place demands on current thinking. Some managers will respond by developing strategies to lead this change. Others will try to slow it down. Thus managing an operational GIS will not be a static or routine endeavour.

This chapter was designed to spur a management realisation that operations continuously change. Projects will come and go. As a backcloth to this there will be an evolving information infrastructure. Strategic planning gives us the chance to examine these change agents. Workload planning allows us to add structure to the operations management process. Other readings have been identified in the reference section (see Aronoff 1989; Korte 1994; Huxhold and Levinsohn 1995; Martin 1991; Obermeyer and Pinto 1994) so that the GIS manager can explore these topics in greater detail.

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