GIS Organizational Structure and Staffing

An ESRI® Technical Paper • August 2004

ESRI 380 New York St., Redlands, CA 92373-8100, USA • TEL 909-793-2853 • FAX 909-793-5953 • E-MAIL info@esri.com • WEB www.esri.com

GIS Organizational Structure and Staffing

An ESRI Technical Paper

Contents **Page**

GIS Organizational Structure and Staffing

Introduction

In identifying what is required for a successful geographic information system (GIS) implementation we may overlook several critical aspects while concentrating on the obvious: software, hardware, data, and work flow. While these are certainly essential components, the way an organization structures itself to implement and support GIS is very important as well. This structure is especially critical as the usage of GIS spreads within an organization and as the size of GIS-related expenditures increases. We know we need hardware and software architecture planning, but we may not recognize the importance of a parallel track—organizational and staffing planning. What are the objectives of this planning?

- To ensure that the GIS deployment is congruent with the organizational mission, values, culture, and priorities.
- To deploy GIS-related decision making throughout the organization, empowering key stakeholders.
- To ensure that the GIS is effectively utilized in the organization.
- To ensure that the information technology (IT) and GIS functions understand each other's needs and can work together effectively.

Although organizational adaptation will occur in response to GIS deployment without any prior planning, the result may not be very effective and may be painful to correct after the fact.

In this document we will discuss best "practices" for staffing and structuring the various GIS organizational elements. These are scale dependent, obviously; larger organizations will have the resources and requirements to form several layers of standing GIS-related committees or working groups, while smaller organizations may rely on a few GIS staff members and users who meet with management periodically to discuss GIS-related matters. Larger organizations may have a central GIS department, while smaller organizations might have GIS staff assigned to several departments without any central organization. The type of organization (multinational company vs. small local business, government entity vs. council of governments, etc.) as well as its culture will affect the choice of organizational structure. In any case, it is helpful to think carefully about this as you implement, expand, or operationally organize your GIS. This is not a one-time effort either—as your overall organization makes transitions through expansion,

downsizing, or reorganization it is also useful to revisit your organizational structure for GIS to see if it still makes sense.

Who should be involved in this process? Clearly, the GIS staff will be a major participant. For some organizations this is as far as they go. There are other important stakeholders, however. GIS users are often enormous consumers of IT infrastructure resources, and GIS users typically must share these resources with other network applications. Consequently IT departments have a large stake and responsibility in GIS implementations. In some cases, especially in organizations relatively new to GIS, the IT department may not understand the details of GIS deployments, and GIS technicians often do not understand the IT implications of their GIS implementations. To be successful, the IT and GIS staff must communicate effectively and frequently and develop a common vocabulary for planning and operating a GIS using IT resources. Therefore, the IT department should be adequately represented in GIS-oriented technical and management committees.

In addition to IT- and GIS-centric staff, decision making bodies should include management representatives of the consumers/users of GIS information products. Their inclusion will ensure that the user's needs and priorities are considered in the decision making processes.

Effective GIS implementation also requires that staff members possess a broad range of technical skills. This will also vary with the size and type of organization, but in any GIS endeavor there are certain key skills that must be present. After our discussion of organizational structure we include descriptions of these skills/functions along with suggestions for the formal training required for each.

It is important to note that the most effective enterprise GIS operations are adequately supported, both in terms of funding and internal organization. Achieving the full benefits of shared enterprise GIS data and applications will not occur without the right people deployed in an effective organizational structure with the proper resources. This requires recognition of the value of GIS and a corresponding commitment to GIS by the overall organization.

GIS Organizational Evolution

As the GIS matures within an organization, it often faces the hurdle of exploding demand for services and inadequate resources to provide them. To acquire those resources (money, staff, network resources, etc.) GIS staff members are placed in the position of having to "sell" their larger organization on the benefits of GIS and point out the opportunities for exploitation of this technology. However, GIS staff members may not be the best advocates for their own services. It can be helpful instead if one or more upper-level business managers become the sales force for GIS, providing the translation between the technical language and values of GIS-centric staff and the business-focused language and values of upper management. Since upper management has the authority to provide resources in the context of the entire organization, its understanding and commitment to GIS is critical to the long-term success of a GIS implementation. Upper-level manager advocates can often be more successful in communicating the costs and benefits of GIS to the larger organization.

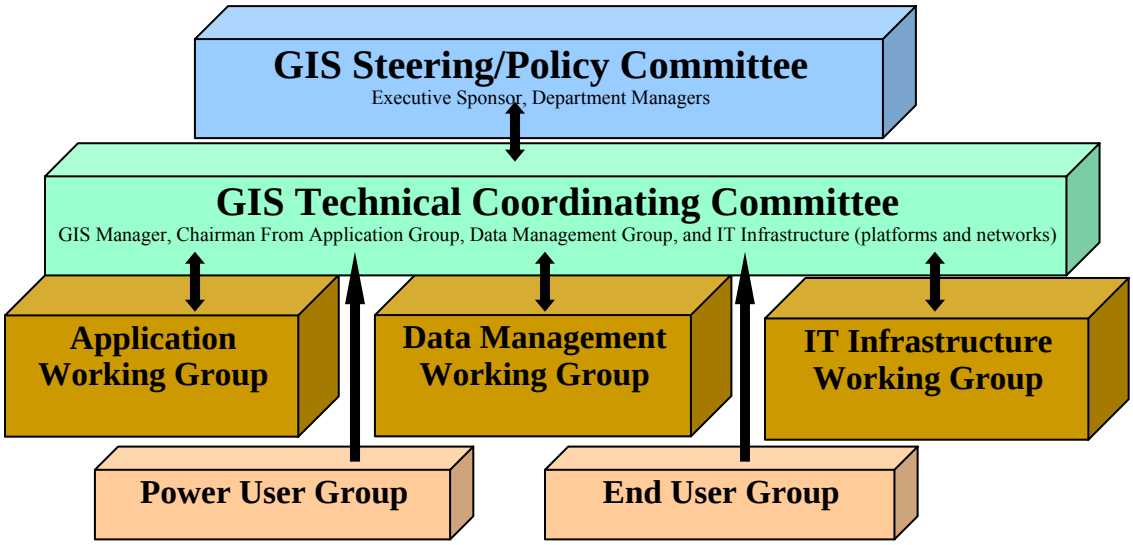
GIS is often first implemented in one or two departments or work groups within an organization. As the value of the data within the GIS is recognized and as GIS use grows, organizations often move from a decentralized, department-oriented organizational structure to a more centralized GIS function. This transition can be difficult as it often has a number of political and economic ramifications within the organization. The benefits to this centralization process, however, can be substantial. It can provide a greater degree of coordination with multiple departments and/or agencies. It can provide an organizational location for GIS authority and responsibility to be concentrated, thus effectively focusing organizational energies on GIS-related matters. It is also easier to identify opportunities for sharing data and applications and taking advantage of already existing resources in a centralized environment. Independence from individual departments or agencies can also provide the GIS department with greater flexibility in responding to organizational needs and can afford opportunities to prioritize resource allocation across the entire organization rather than at the department or agency level. Complex technologies that require very specific skills, such as database administration, system performance tuning, and server software configuration (to name a few), can be more effectively managed when they are centralized, and it is difficult to centralize the technology without also centralizing the supporting organization to some degree.

The GIS functions within an enterprise are usually dependent on the organization's IT department to procure, install, and maintain the workstations, servers, networks, and software that are utilized in the GIS. As GIS use grows within an organization, the utilization of these IT resources can increase dramatically and, without joint planning, can cause huge technical and organizational difficulties. GIS applications are some of the most compute- and data-intensive applications that an organization will support. Therefore, as the usage grows for these applications, it is important to develop effective planning and communication strategies including representation on each other's standing committees at almost every level. The relationship between IT and GIS functions can easily become adversarial without a defined structure in which to make joint decisions.

As the GIS structure within an organization matures further, it is also useful for authority for managing GIS to move from external policy or management committees to the GIS management staff. These managers can most effectively enforce data standards, maintain shared data, enforce policy, hire staff, and develop shared applications. Without the proper authority, GIS staff members will not be able to assume responsibilities that naturally should rest with them. When this happens, the GIS coordination effort typically stalls, which then encourages individual departments or agencies to go their own way. This destroys the benefits of shared policies, data, and other resources and jeopardizes the alliance that was created to exploit these. In the section below we describe the elements of a typical GIS organizational structure.

Figure 1

Traditional GIS Organizational Structure



GIS Steering or Policy Committee

In medium- to large-sized organizations it is important to have a steering committee that is responsible for setting the policy for organizationwide GIS coordination and implementation. These policy makers make decisions based on input and recommendations from technical and user staff and provide leadership and direction for the organization's GIS development. A policy committee with strong authority is particularly important in a large multiagency GIS implementation. In the absence of a steering committee whose decision making is binding upon all participating agencies, the process of coordinating GIS implementation is pushed down to the individual agency or department level. Individual agencies or departments, however, do not have the resources or the perspective to consider the organizationwide consequences of their actions and certainly do not have the authority to require other agencies to follow their decisions. Thus, without a high-level policy committee, GIS implementations become much more fragmented, proceed more slowly, have a higher risk of failure, and do not yield the level of benefits experienced by coordinated efforts.

The degree of authority that a steering/policy committee wields often varies with the composition of the committee. If lower level managers are the major contributors, then the committee will generally have less authority and will be less successful in generating and enforcing policy. If the committee includes department managers, top-level administrators, or designated representatives from elected officials of the government, it has a much greater chance of success.

In situations where multiple agencies have a stake in producing and consuming shared GIS information products, it is useful to include high-level representatives from all agencies on the policy making committee. Examples might include the GIS manager and CIO of independent utility companies (e.g., telephone, cable, water), city managers, county administrators, and high-level representatives of national government agencies who have an essential role in the success of the enterprise GIS. Committee meetings should be held on a regular basis—monthly or quarterly, as established by the needs of the organizations.

The responsibilities of a policy/steering committee generally include the following:

- **Strategic planning—**Create and periodically review the GIS strategic plan for the organization(s) that embodies the mission, values, and goals of the organization.

- **Policy formulation—**Set policies necessary to ensure a coordinated GIS implementation such as database standards, implementation priorities, and system standards. These policies are based on technical materials and recommendations provided by technical coordination committee(s).

- **General oversight—**Monitor the overall GIS implementation to make sure progress is being made by each participating agency in general compliance with the adopted implementation strategy.

- **Financial and budgetary decisions—**Set annual budgets for GIS implementation activities that are part of building the enterprise GIS solution. While departmental GIS budgets may be coordinated with the enterprise GIS budget, the financial and budgetary decisions of individual departments usually are not part of the responsibilities of the GIS policy committee.

- **Growth and expansion of participant base**—Expand the enterprise GIS to include additional departments or outside agencies.

- **Status review—**Periodically check the progress of critical implementation activities, especially those activities that affect several agencies.

- **Approval of special license agreements—**Approve agreements to purchase GIS resources and agreements to market and sell the GIS resources created by the organization.

- **Product pricing—**Set pricing for GIS products and services provided to the public or other agencies. Pricing will be based on recommendations established by the technical coordination committee.

- **Direction to the GIS department—**Provide direction in the form of priorities and schedules for GIS implementation tasks that are critical to building the enterprise GIS. In organizations that have a single GIS department, this direction is provided to that single agency. However, when no one department is responsible for GIS implementation, direction must be provided to all participating agencies through the technical coordination committee.

- **Legal obligations—**Provide direction regarding legal and policy issues related to data automation, data access, and other matters.

- **IT policy/steering committee representation—**Provide a GIS perspective to enterprise IT policy/steering committees in developing IT policies and structures. Also provide a mechanism for IT and GIS policy makers to coordinate and collaborate in strategic planning and overall coordination of resources.

GIS Technical Coordination Committee

The technical coordination committee facilitates interdepartmental/interagency communication and cooperation. It is generally composed of the technical lead person from each working group or from participating departments or agencies, depending on the type of organization. User groups also provide input to this committee, and may participate in meetings or other committee activities. Regular meetings are held monthly or quarterly, as established by the committee.

Responsibilities of the technical coordination committee generally include the following:

- **Provide technical direction and standards—**Formulate technical requirements and standards for all components of an enterprise GIS implementation; when necessary, this information is submitted to the policy committee to establish the overall policy direction.

- **Recommend projects and studies—**Establish the annual work plan of implementation projects and studies needed to create the enterprise and individual agency GIS systems.

- **Recommend database/application development—**Set annual priorities, identify common needs and requirements, and resolve conflicts related to database system and application development.

- **Address system integration/expansion issues—**Identify and resolve technical questions regarding linking individual GIS implementations.

- **Conduct user training—**Provide standard training courses through the purchase of training from vendors or through a GIS training center.

Working Groups

As noted in Figure 1, it is often useful to create several working groups to manage the details of drafting policy recommendations, making funding requests, and making project decision. There are at least three important areas to manage: applications, data, and IT infrastructure. Staff members working in these groups generally have responsible positions within the organization in the area they represent. Working groups may meet more frequently than the coordinating committees and policy groups as they are working with more of the day-to-day aspects of GIS. These groups' major functions are the following:

- **Implement and operate the GIS with the policies, standards, and procedures adopted by the policy committee and coordinating committee(s).**
- **Develop recommendations for technical direction and standards—**Under the direction of the GIS technical coordinating committee, formulate draft technical requirements and standards for their GIS components. This information is fed to the GIS technical coordinating committee for consideration and decision making.
- **Develop recommendations for projects and studies—**Develop proposed project information, work plans, priorities, and costs and assist with drafting the annual work plan of implementation projects and studies needed for their work area.
- **Recommend database/application development—**Develop draft recommendations, costs, priorities, needs, and requirements for their work areas.
- **Address system integration/expansion issues—**Assist with identifying and resolving technical questions in their areas regarding linking individual GIS implementations.
- **Provide representation on the GIS Coordination Committee—**Lead specialists from each area sit on the GIS coordination committee.

User Groups

Users produce and consume the information produced by the GIS. In Figure 1 we split the user community representation into two groups: power users and end users. For this purpose we define power users as those who perform intensive data maintenance and analysis tasks and utilize the most sophisticated and complex software applications. End users are consumers of information products that may reside on Web-based systems, or they may utilize applications primarily constructed for relatively lightweight analysis or spatial data display. End users may have less sophistication regarding the tools they use but may be very dependent on the data and applications for their work responsibilities.

Each group may have quite different needs and requirements, and one is not more important than the other. For this reason, each group should feel free to develop its recommendations and priorities and requirements independent of other groups. The overall purpose of these groups is to give users a venue for sharing information across the organization and an opportunity to provide recommendations and feedback to the standing committees. The general functions of user groups are to

- Share information about technology, applications, spatial data, and current and future projects.
- Provide feedback and recommendations to the technical coordinating committee, working groups, and other committees on standards, policies, priorities, and work plans.
- Identify requirements and make requests/recommendations for software acquisitions, staffing, and training.
- Identify and discuss problems regarding GIS implementations and operations and provide information to the working groups.

In designing oversight groups and committees, organizations must also be careful to not burden the employees "doing the work" with too many layers of decision makers and approval mechanisms. A proper balance in this regard allows communication and decision making to occur throughout the organization at the level appropriate to the task. Pushing the responsibility for decision making down to the lowest level that is appropriate allows the entire organization to be more responsive to internal and external needs. It also allows the organization to move more quickly and take advantage of opportunities to make GIS a valuable and truly enterprisewide resource.

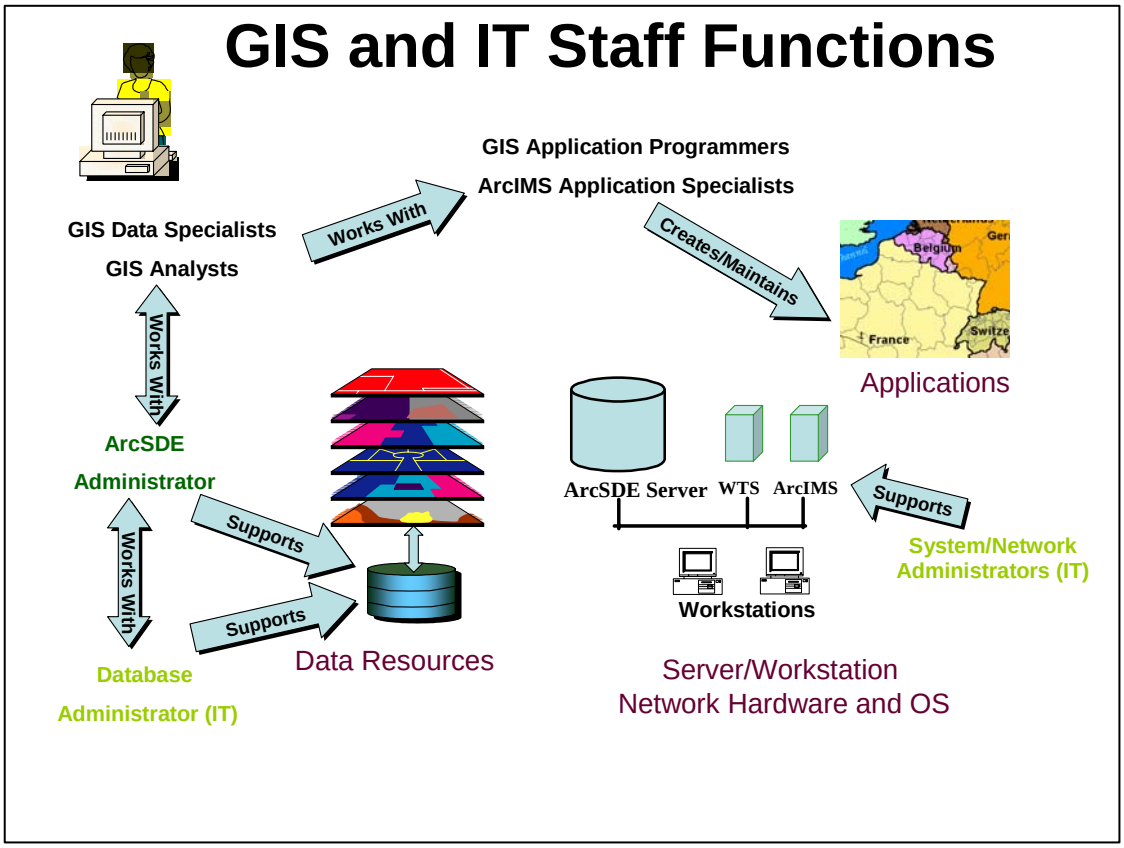
Operational Staffing for GIS

The GIS operational staff provides technical and database services for the shared database and system resources of an enterprisewide GIS. This can be set up as a separate department or as part of several different departments. In either case individual departments may also have their own dedicated GIS operational staff, especially in larger organizations. The type of structure varies depending on the size of the GIS staff, the amount and variety of GIS applications and data in the enterprise, the size of the organization, the maturity of the GIS function within the organization, and the variety and number of departments that use GIS services (in addition to the politics of the organization). In a multiagency GIS implementation, the operational staff may be under one of the participating agencies, especially if that agency has taken the lead in GIS implementation. However, as mentioned earlier, GIS implementation is most successful when the GIS operational staff members who are responsible for shared data resources are housed independently from any one particular department or agency.

Regardless of the actual size and complexity of the GIS, organizations need people with a variety of skill sets to properly implement and support a GIS. In Figure 2 we show many of the common functions needed, what they support, and some sense of how they interact with each other. Note that several functions are commonly housed in the IT department, although this is not always the case. If the GIS function is quite large, or the database demands warrant it, a database administrator may be dedicated to and be a part of the GIS organization.

J-9304

Figure 2



The position responsibilities for each function is described below, separated into GIS- and IT-related functions required to operate and manage an enterprise GIS implementation.

GIS functions include the following:

GIS Manager/Coordinator
▪ Provides planning and direction for GIS growth to serve multiple departments ▪ Serves as chairman of the technical coordinating committee ▪ Provides overall management for all GIS implementation tasks ▪ Manages setting of priorities for database and applications development ▪ Serves as liaison to other departments and outside agencies ▪ Provides overall management for all contracted work

GIS Analyst/Technical Lead

- Provides technical leadership to GIS users
- Serves as executive secretary of the technical coordinating committee
- Provides project implementation services
- Provides interdepartment technical coordination
- Provides GIS technical support services
- Coordinates project work for departments and outside agencies
- Provides user training services
- Performs troubleshooting on custom application problems

ArcSDE Geodatabase Administrator

- Provides ArcSDE® installation and software upgrades
- Has ownership and manages ArcSDE and geodatabase schema objects
- Manages the ArcSDE service
- Compresses a geodatabase
- Works with the database administrator (DBA) in configuring and maintaining the geodatabase

GIS Data Administrator

- Data model design—Works with GIS analysts to develop logical data structures for applications, works with ArcSDE administrator and DBA to create logical and physical models
- Data validation and quality—topology, domains
- Version management
- Spatial data management—Data loading, spatial index tuning, database management system (DBMS) statistics

GIS Application Programmer

- Develops and enforces programming standards
- Works with GIS analysts and users to develop requirements and specifications
- Performs desktop application development and code maintenance
- Provides desktop client application support
- Performs desktop application performance tuning
- Provides ArcGIS® Server/ArcObjects™ application programming

ArcIMS Application and System Specialist

- Configures ArcIMS®
- Provides Web services development and maintenance
- Provides Web services application and system performance tuning

The IT functions include the following:

System/Network Administrator

- Hardware—Procurement, installation, and configuration
- Network infrastructure—Installation, configuration, and tuning
- Server system performance tuning/troubleshooting
- Server operating system installation and maintenance
- Storage subsystem management/configuration/performance
- System and data backup and recovery
- Windows Terminal Server/Citrix installation/configuration
- Other related software (upgrades and service packs)

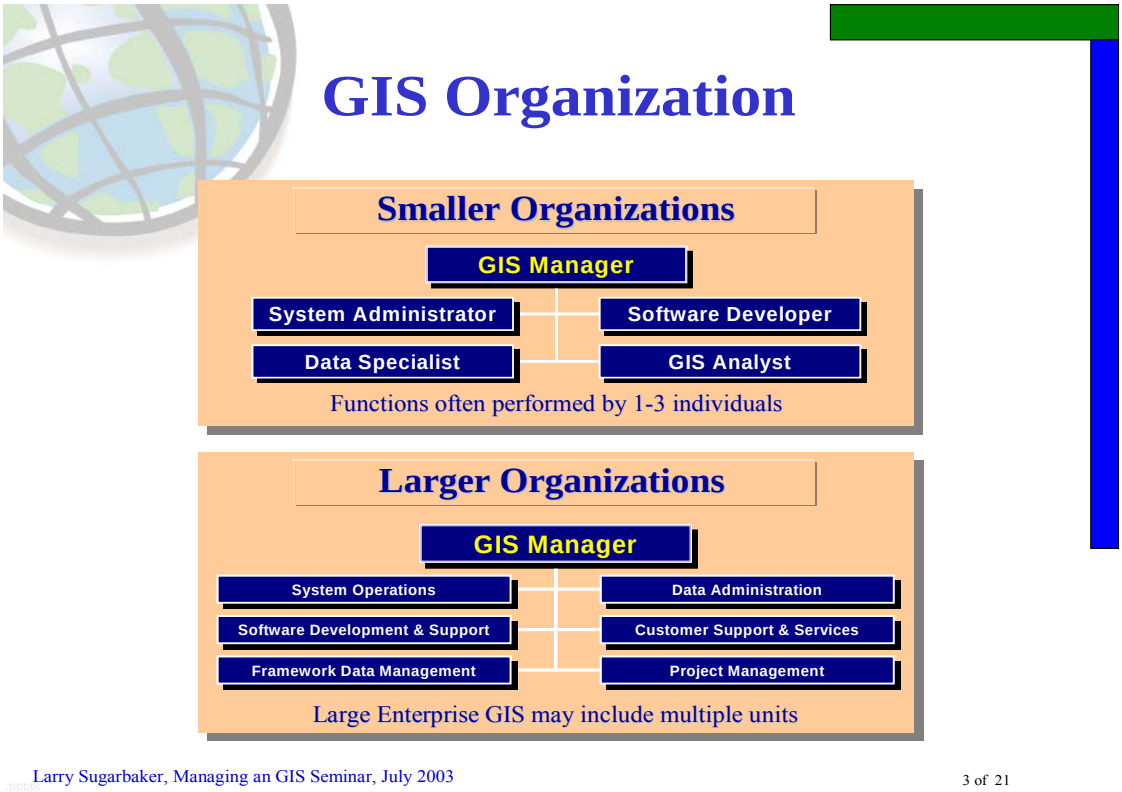
Database Administrator

- Database configuration
- Data model implementation
- Database security
- Performance tuning
- Data backup and recovery
- Data replication
- DBMS software upgrades and service packs

In smaller organizations, several of these functions will, of necessity, be assigned to a single person, while in larger entities each function might have one or more people dedicated to each of those responsibilities. Figure 3 illustrates this. A GIS application programmer, for example, might also be the GIS analyst and the GIS data specialist in a small department, while each of these job functions might be performed by one, two or more people in a large organization. Similarly a database administrator in a small organization might be able to handle the DBA needs of the GIS and also accommodate Human Resources and several other departments. In a large GIS enterprise, a DBA (or even more than one) might be dedicated just to GIS.

J-9304

Figure 3



Regardless of size, it is very important to have a proficient database administrator available for your GIS systems—assuming you are using a geodatabase. GIS databases are complex, often very large in size, and require careful tuning and optimization to provide effective service. Some organizations try to get by without this expertise, and it can be a major stumbling block to meeting performance goals such as reasonable map display response time and transaction throughput. If you have or plan to use ArcIMS, ArcGIS Server, or ArcSDE, you will also need to develop or acquire expertise in these server-based systems optimize your investment in hardware and software and provide adequate overall performance.

In addition to the IT staffing questions addressed above, customers often ask what issues the IT department typically faces and the kind of support required for GIS systems and implementations. We have included a table in Appendix A that describes these in greater detail.

J-9304

Training Requirements

Training for GIS Operational Staff	GIS Manager / Coordinator	GIS Analyst / Technical Lead	System administrator	Database administrator (DBA)	ArcSDE database administrator	Data administrator	GIS Application Programmer	ArcIMS Application Specialist
GIS Software Training								
What's New in ArcGIS 8.3/9.0	○	○	○	○	○	○	○	○
Introduction to ArcGIS I	●	●	●	●	●	●	●	●
Introduction to ArcGIS II	●	●	○	○	●	●	●	●
Customizing ArcGIS (Web course)	○	●		○	○	●	●	
Introduction to Programming ArcObjects	○	●		○	○	●	●	
Advanced ArcObjects Component Development I & II	○	●		○	○	●	●	
Geodatabase Design Concepts	○	●	○	●	○	○	○	
Building Geodatabases I & II	○	○	○	●	○	○	○	
Modeling Geodatabases using CASE Tools	○	○	○	●	○	○	○	
System Architecture Design for GIS	●	●	●	○		○	○	●
GIS Procedures Training								
Storing Raster Data in ArcSDE Geodatabase		○		●	●	○	○	○
Understanding ArcSDE Table Relationships		○		●	●	○	○	
Understanding the ArcSDE Spatial Index		○		●	●	○	○	
Introduction to ArcIMS		●	○					●
ArcIMS Administration			○					●
Introduction to ArcSDE		●	○	○	●			○
ArcSDE Administration for DB2/SQL/Oracle			○	○	●			○
● Recommended Training								
○ Optional Training								

In addition to having the correct organizational structure and the right people, to be successful your GIS staff must have the proper skills. These skills can be acquired over time on the job or through training. Finding people with expertise in relatively new technology may not always be feasible, so training staff is often the best way to develop the skills your organization needs. The table above shows recommended training for various GIS-related job functions. Inexperienced new hires will especially benefit from a comprehensive training program that, over time, will provide them with the skills to

become proficient in their responsibilities. As new software elements or new versions are released, it is also helpful to review your training needs to ensure that your staff stays current with the technology generally in use or that will be introduced into your organization in the near future. Providing adequate and timely training (including a personalized training plan) can also help with staff turnover as employees view the organization's investment of resources to keep them up-to-date as an important part of their benefits as an employee.

An alternative to training your own staff or hiring GIS professional staff with fully developed skill sets is to contract GIS implementation services that can quickly provide the needed skills. This is especially useful if you are building a new GIS department and need to be productive quickly. It can also help when projects come along that you cannot staff properly internally because of existing workloads or inadequate skill sets. In either case, you can save time and the expense of training your own staff, although this may not always be the best long-term strategy. Contract employees take valuable organization-specific knowledge about your business practices, data, and work flows with them when they leave; knowledge which, if lost, could negatively impact the effectiveness of your GIS operations. There are many scenarios, however, in which the judicious use of contract workers can bridge a seemingly insurmountable gap in your organization.

Conclusion

In technology-related fields, managers often focus on technical issues and may ignore other important aspects of their organizations that, without attention, can reduce the overall effectiveness of the GIS. Indications of organizational or staffing problems include high staff turnover, employee dissatisfaction, frequent project failures or delays, continual disagreement about priorities and technical direction, lack of funding for strategic projects, under- or overutilization of staff resources, and ongoing poor system performance. When one or more of these is present it is time to look carefully at the factors that are contributing to these problems. With those in hand, restructuring can take place to help "relieve" the organizational stress that has built up.

Although there are many permutations possible when designing effective organizational structures and to staffing your GIS, in our experience (and those of our clients) there are a few key strategies that can help ensure success in your GIS endeavors. Some of the most important benefits arise from just being aware of, and open to, resolving the issues that are related to the organizational structure and staffing. While taking action is also important, it may not be necessary to make radical changes to your organization. Small but strategic changes over time can often provide the results you need while providing the opportunity for the organization to adapt incrementally to the changes that have been put in place without creating unwanted resistance. Involving staff in the decision making process rather than imposing a restructure on them will also help in bringing change into the organization.

In addition to either avoiding or fixing problems, a good organizational structure promotes increased sharing of existing spatial data, the discovery of new spatial data, and an expanded use of spatial applications. An organization is like the water pipes in a building, with spatial data acting as the water. If pipes have constrictions, if they are not part of a good network of pipes, or if there are leaks—water will not flow properly. It

may be there to share, but it will not get to all the places it should. With the right structure and staffing, the full potential of your GIS data and applications can flow unimpeded throughout your organization.

Appendix A: Site Licenses

- Server Requirements
  - Servers—ArcSDE servers, application servers, batch process servers, file servers, license server
  - Server hardware requirements
  - Appropriate number and types of servers (how much to budget? which years?)
  - Load balancing
- Workstation and User Login Issues
  - Login and enterprise domain issues
  - Installation and distribution of ArcGIS and other software throughout the life cycle of the system: development, test, production, and upgrades
  - Monitoring GIS usage and user loads by application group
  - Tracking errors and capturing application, user, and hardware statistics
  - Roaming profiles
- Database
  - DBA support needed to maintain an enterprise geodatabase
  - Configuring Table Space (DBTUNE)
  - Maintaining multiple instances of ArcSDE geodatabase for different environments: development, test, production, and training
- File Services/Storage Issues
  - What types of data are stored where and how much storage capacity is needed?
  - GIS file sharing requirements
  - User profile storage (where?)
  - Storage Area Networks (SAN)

- Network Support
  - Network requirements: local area network (LAN) versus wide area network (WAN)
  - Application bandwidth issues
  - Virtual private network (VPN)/Remote development access for remote users, vendors, and contractors
- Printing/Plotting
  - User printing and plotting requirements
  - potential application printing issues
  - Potential Citrix printing issues
  - Print and plot testing
- Security
  - Firewalls
  - User login and access privileges: network, database, and applications
  - Interapplication communication
- Citrix Management
  - Deploying application changes
  - Tuning and monitoring
- Testing
  - Systems and environments needed to support testing throughout the application life cycle
- Training
  - Systems and environments needed to support training