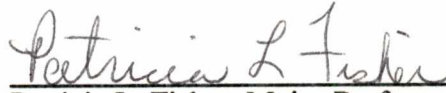


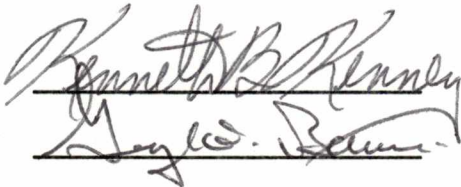
To the Graduate Council:

I am submitting herewith a thesis written by Anna L. Metcalf entitled "Multi-organizational Geographic Information Systems." I have examined the final copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science in Planning.

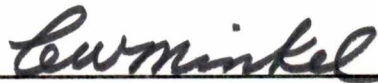
A handwritten signature in cursive script, reading "Patricia L. Fisher", written over a horizontal line.

Patricia L. Fisher, Major Professor

We have read this thesis
and recommend its acceptance:

Two handwritten signatures in cursive script. The top signature reads "Kenneth B. Kenney" and the bottom signature reads "Doyle W. Betune". Both are written over horizontal lines.

Accepted for the Council:

A handwritten signature in cursive script, reading "Lew Mink", written over a horizontal line.

Vice Provost
and the Dean of The Graduate School

**MULTI-ORGANIZATIONAL
GEOGRAPHIC INFORMATION SYSTEMS**

**A Thesis
Presented for the
Master of Science in Planning
Degree
The University of Tennessee, Knoxville**

Anna L. Metcalf

May 1989

This thesis is dedicated
to my parents,
Joseph Leo and Judy Metcalf,
for their love and belief in me,
and to my husband,
J. Thomas Green,
for his never ending
patience and support.

ACKNOWLEDGMENTS

There are many people who have been of great assistance in the research and preparation of this thesis. In particular, I would like to thank Dr. Patricia L. Fisher for her advice, always positive criticism, and encouragement. I would also like to thank the representative from each of the study sites for contributing invaluable information in my research. Finally, I would like to thank Jani Sivills for her superior editing skills.

ABSTRACT

Designing and implementing a multi-organizational GIS requires a great deal of planning and cooperation among participating entities. Often, this requires developing complex design and implementation plans which must address a wide range of topics, including hardware, software and database requirements, cost allocation, financing, and system administration and policy. Developing the plans is complicated by the need to satisfy the requirements and demands of multiple organizations.

The purpose of this thesis is to develop a framework for planners, planning agencies, and local government to understand issues in designing, implementing, and operating a multi-organizational GIS. By rigorously collecting, analyzing, and presenting information about existing installations, many of the basic questions planners may have will be identified without expenditure of valuable resources.

The methodology used in this thesis is descriptive in nature. The research conducted includes literature review and a survey of several multi-organizational systems. The literature review includes books, journals, conference proceeding, and monographs. The information for the detailed description was gathered through a survey of several systems. The survey was comprised of 1) a review of available documentation for each of the selected systems, and 2) a questionnaire administered by telephone to one or more representatives for each of the systems.

Based on this research and analysis, the following recommendations were developed:

1. Gain support for the project throughout the organizations involved, especially at the executive level.
2. Conduct study to define project parameters.
3. Optimize planning and cooperation to design and implement system.

4. Include among participants, at a minimum, city and county government departments of planning, public works, and property appraisal/assessment.
5. Establish an organizational structure that includes, at a minimum, a lead/ administrative agency, policy committee, technical committee or group, and shared staff.
6. Staff the project with personnel to service the shared system function.
7. Provide fair and equal treatment of all participants by shared staff. Aggressively recruit experienced GIS personnel and train existing personnel.
8. Develop the database and applications based on the activities of participating organizations.
9. Establish a cost allocation scheme that is equitable and agreed to by all participants.
10. Remember that benefits include those that are direct and those that are indirect such as improved relations and cooperation.
11. Identify barriers and apply solutions.
12. Promote project through education and communication.
13. Promote cooperation through communication and organization.

TABLE OF CONTENTS

CHAPTER	PAGE
I. INTRODUCTION	1
Problem Statement	3
Need and Purpose.....	3
Overview of Methodology	6
Scope and Limitations	6
Organization of the Thesis	7
II. BACKGROUND	8
Geographic Information Systems	8
Components.....	8
Database Structure.....	11
Capabilities	12
Multi-organizational GISs.....	14
Definition and Concepts	14
Applications	16
Benefits.....	18
Barriers	20
III. SURVEY OF SELECT MULTI-ORGANIZATIONAL GISs.....	23
Objective of Survey.....	23
Sample Selection	23
Survey Design.....	25
Documentation Review	26
Questionnaire.....	27
Data Collection and Recording	29
Limitations	30
IV. ANALYSIS AND EVALUATION OF THE SYSTEMS	31
Introduction.....	31
Characteristics	32
Overview	32
Project Origins and History	40
Database Layers.....	41
Applications	43
Organizational Structure	43
Cost and Financing.....	49
Benefits.....	51
Barriers.....	55
Resolution of Barriers.....	59
Participation by Committees and User Groups	60
Support by Shared Staff	60
Use Third Party or Consultant	62
Communication through Meetings, Status Reports, and Newsletters.....	62

CHAPTER	PAGE
V. SUMMARY, CONCLUSIONS, AND SUGGESTIONS FOR FURTHER STUDY.....	67
Summary.....	67
Introduction	67
GIS Definition and Concepts.....	68
Multi-organizational GIS	69
Survey of Multi-organizational GISs.....	69
Conclusions and Recommendations	70
Project Initiation	70
Participating Organizations	72
Organization Structure	72
Shared Staff.....	72
Database and Applications.....	73
Financing and Cost Allocation	73
Benefits	73
Barriers and Solutions	74
Maintaining Support and Cooperation	74
Suggestions for Further Study	74
GLOSSARY OF TERMS	78
BIBLIOGRAPHY.....	81
APPENDICES.....	88
A. REQUEST FOR STUDY PARTICIPATION SCRIPT.....	89
B. SAMPLE PROJECT PROFILE AND TRANSMITTAL LETTER.....	91
C. SURVEY FORM.....	96
VITA.....	105

LIST OF TABLES

TABLE	PAGE
1. Project Overview.....	34
2. Type of Organization by Project.....	36
3. Organizations Participating in Projects	37
4. Database Layers by Project	42
5. Common Applications.....	44
6. Organizational Structure by Project	47
7. Benefit Ratings	52
8. Summary of Barriers	56
9. Commonly Cited Solutions	61

LIST OF FIGURES

FIGURE	PAGE
1. GIS Hardware Components.....	10
2. GIS Analysis of Soil Erosion Potential.....	13
3. Map Database Layering Concept.....	15
4. Benefit Ratings.....	54
5. Barrier Ratings.....	58
6. Solutions for Barriers.....	63
7. Recommendations for a Multi-organizational GIS.....	71

CHAPTER I

INTRODUCTION

Due to the complexity of the urban environment, large quantities of diverse data are required in the urban decision-making process. Much of this data is spatial (locational) in nature. Municipal executives, department heads, planners, and other urban data analysts often require massive amounts of spatial data, in a specific form, for a particular area. These data needs, however, are seldom met due to inadequate data collection and storage practices.

Historically, spatial information has been collected and coded for a specific task. Once collected, this data is either stored in tabular form and/or manually transferred to a map with a scale suitable to the data collection entity. For example, land use data collected for property assessment may be coded by parcel number and then recorded in a card file and mapped on a small scale, cadastral (parcel) map. However, land use data collected by the planning department may be coded by neighborhood and mapped on a large scale base map. As a result of such inconsistencies, data and maps are difficult to compare and often require time-consuming conversions. Because of these and other similar problems inherent in traditional spatial data handling practices, use and integration of spatial data are tedious, time-consuming, expensive, and sometimes impossible tasks (Bayer, 1982, p. 83).

In response to problems confronting spatial information users, efforts to create a flexible automated data system were initiated in the mid-1960s. The basic concept behind these efforts was *geocoding*, assigning a geographic coordinate or code to all data items recorded. A geocode is a set of x and y grid coordinates assigned to a data value based on the spatial location the data represents (Cooke, 1980, p. 1). Geocoding is accomplished by a process called *digitizing*. Digitizing converts manual map products into a computer readable or digital format.

Developments in geocoding and other *geographic data* processing (geoprocessing) technologies, such as relatively inexpensive hardware devices and advances in software development and data conversion technologies, have made automated geoprocessing a reality. An automated geoprocessing system is usually referred to as a *Geographic Information System (GIS)*. A GIS is a computer system that allows users to store and process geocoded data in digital (numeric) format. Through a GIS, the user can automatically retrieve, overlay, update, analyze and display spatial and non-spatial data (University of Kansas, n.d., p. 1).

Improved geoprocessing technologies and relative decreases in the cost of computer systems have resulted in the proliferation of GISs. Although much of the value derived from a GIS is the ability to serve multiple users and their diverse applications, many GISs are single-user systems developed for a limited number of applications (Wilson, 1984, p. 137). For example, engineering, tax assessing, planning, and other departments may each have separate systems tailored to their specific needs. As a result, several isolated systems may coexist for a single geographic area.

This type of system is often inefficient in the use of valuable resources for several reasons. First, since each system requires much of the same hardware and software, these facilities could be shared by several users. Second, and more significantly, much of the data collected, stored, and maintained is duplicated in each of the systems. A single integrated database developed to meet the needs of several users can eliminate the duplication of data collection and maintenance, and reduce the cost of data storage (Wilson, n.d. p. 2).

In addition to being inefficient, developing multiple isolated systems results in difficulty in integrating data unique to each system. For example, suppose that a planner needs to identify the owner and location of all parcels larger than 20 acres that are in close

proximity to water mains of at least eight inches in diameter. Assuming that both the property assessment and water utility offices have GISs, the parcel data and water line data can be retrieved automatically. However, because the two databases are not integrated and probably not compatible, further processing must be performed manually. Since the data must be processed manually, the GIS in this example fails to adequately meet the needs of an important potential user.

In response to the inefficiencies and limitations of isolated single-user systems, multi-user systems with integrated databases are being designed and implemented. These systems, usually referred to as *multi-organizational GISs*, represent an opportunity to improve the use of GIS capabilities in meeting spatial and non-spatial data needs (Wilson, 1984, p. 137).

1. PROBLEM STATEMENT

Designing and implementing a multi-organizational GIS requires a great deal of planning and cooperation among participating entities. Often, this requires developing complex design and implementation plans which must address a wide range of topics, including hardware, software and database requirements; cost allocation; financing; and system administration and policy. Developing the plans is complicated by the need to satisfy the requirements and demands of multiple organizations.

2. NEED AND PURPOSE

Developing a plan for a multi-organizational GIS requires knowledge not typically found among municipal employees. The most logical means of obtaining this information is to study existing installations. However, due to budget and resource constraints, this type of research is typically not feasible in the local government environment. To

determine the nature and extent of the information about multi-organization GISs, an extensive analysis of the available literature was conducted. This analysis involved search of many types of literature, much of which is unpublished or published in proceedings for conferences. This literature includes: 1) raw data or summaries of raw data about GIS characteristics; 2) articles about the experiences of those involved with a single system; 3) articles describing a particular technical aspect of designing, implementing, or operating a GIS; and 4) articles and books or sections of books generically describing automated mapping and GIS technology.

Over the past ten years, several surveys of GIS installations have been performed. These include, among others:

1. "URISA/SIG-GEO Interactive Graphics Survey of Public Agencies" (Urban and Regional Information System Association, n.d.); and
2. "GIS Installation Survey (PlanGraphics, Inc., 1988).

The focus of these surveys is to collect data about characteristics of GIS installations such as hardware, software, and database components. The raw data or results of these surveys is seldom published. When the results are published, it is simply a summary of statistics such as the number of installations with a particular type of GIS software.

The most common type of literature about GISs and, to a limited extent, multi-organization GISs, are articles describing a single system or a particular aspect of a single system. These articles which commonly appear in conference proceedings or magazines are typically written by those involved with designing and implementing a system. The articles describe the events and experiences as they relate to a particular project.

Frequently, these articles focus on presenting a chronology or history of the system. Other articles presented by those involved in GIS projects describe, in detail, a particular aspect of a project. For example, many articles are written about how the hardware and software

vendor was selected or how data conversion is being performed. Because these articles are project-specific, and usually based on one experience, it is frequently difficult to translate this experience to provide guidelines for others.

Another common type of literature about GISs is articles describing a particular technical aspect of designing, implementing, or operating a GIS. The articles are typically written by those involved in implementing or operating GIS systems, or vendors of GIS-related services. Topics for this type of literature might include establishing a geodetic control network, performing database maintenance, installing hardware and software, and legal aspects relating to GIS databases.

The other type of literature relating to GISs describes GIS technology in general. Among this type of literature are both articles and, to a limited extent, books. This literature describes what automated mapping and geoprocessing is and how it works. This literature is generic in nature and is frequently used as study material by both academicians and practitioners.

While the literature analysis indicated that valuable information is available, this information is difficult to assimilate, and either very specific or very generic. Most of the information contained in this literature describes a basic set of characteristics for a particular system. Very little information is available through literature about benefits, barriers, and resolution of barriers.

Because of these deficiencies, there is a need for research that objectively and independently compares functions and systems, not only in terms of their characteristics, but also in terms of their benefits, barriers, and resolution of barriers.

The purpose of this thesis is to develop a framework for planners, planning agencies, and local government to understand issues in designing, implementing, and operating a multi-organizational GIS. By rigorously collecting, analyzing, and presenting information

about existing installations, many of the basic questions planners may have will be identified without expenditure of valuable resources.

3. OVERVIEW OF METHODOLOGY

The methodology to be used in this thesis is descriptive in nature. The research conducted includes literature review and a survey of several multi-organizational systems. The literature review includes books, journals, conference proceedings, and monographs.

The information derived from the literature review will be the source material for a general description of terms, concepts, and issues related to GISs and multi-organizational GISs. This description serves as a basis for a more detailed and in-depth description of multi-organizational GISs.

The information for the detailed description was gathered through a survey of several systems. The survey was comprised of 1) a review of available documentation for each of the selected systems, and 2) a questionnaire administered by telephone to one or more representatives for each of the systems. Chapter III of this thesis describes the survey design in detail.

4. SCOPE AND LIMITATIONS

For the purpose of this thesis, a multi-organizational GIS is one that has multiple users all having access to a database which has been consolidated to eliminate redundant data (Rosenberg, 1984, p. 253). While many such systems exist at the state and regional levels as well as at the municipal/county level, this thesis is limited to an investigation of municipal level systems. The scope of this study is further limited to institutional issues, including political, financial, administrative, and legal issues. Technical issues relating to GIS technology, such as hardware, software, data communications and database

conversion, will not be addressed. While an understanding of the technical issues involved in designing, implementing, and operating a GIS is important, their treatment requires very specialized knowledge beyond that of the author. Furthermore, technology is advancing so rapidly that the research relating to these areas would be out of date very quickly and be of limited value.

The methodology used for this research includes detailed interviews with one or more representatives for each system studied; this is required for two reasons. First, very little if any documentation exists describing the systems or providing information about the issues described above. Second, gathering the information described about the variety of issues may require interviews with many individuals. Because of the difficulty in collecting detailed information for each of the systems to be described, it was necessary to limit the study to nine installations.

5. ORGANIZATION OF THE THESIS

This thesis consists of five sections: 1) introduction, 2) background, 3) survey of select multi-organizational GISs, 4) analysis and evaluation, and 5) summary of findings. The first two sections provide introductory and background information that will be essential in understanding the remaining sections. Chapter III describes the survey methodology used in collecting data for each of the systems to be studied. Chapter IV presents an analysis and evaluation of the information collected through the survey. Chapter V concludes this thesis with a summary of findings. A glossary is also provided to define many of the terms used in this thesis. Terms that are defined in the glossary are italicized in their initial use in the text.

CHAPTER II

BACKGROUND

The following chapter describes and/or defines key concepts, terms, and issues needed to fully understand information presented later. A geographic information system (GIS) is defined in generic terms. The definition includes a description of the components of a GIS: hardware, software, and database. The database structure required for a GIS is discussed and differentiated from non-geographic databases. A GIS is further defined in terms of the capabilities offered in retrieving, analyzing, and updating maps and geographic information.

Using the GIS definition and description, a multi-organizational GIS is discussed. Key concepts, such as the municipal database, improved accuracy, improved productivity, and cost sharing, are presented. To further define a multi-organizational GIS, key applications possible in an integrated environment are illustrated.

1. GEOGRAPHIC INFORMATION SYSTEMS

A GIS is a computer system that allows users to store and process geocoded data in a digital format. Through a GIS, the user can automatically retrieve, overlay, update, analyze, and display spatial and nonspatial data. The following is a discussion of the components, database structure, and capabilities of a generic GIS.

Components

A GIS consists primarily of three components: hardware, software, and a database. The hardware and software components of a GIS are typically purchased as a "turnkey system". A turnkey system is a complete package of hardware devices and software designed and integrated by a system vendor to operate as a functional unit. The system should provide a comprehensive set of automated mapping and geoprocessing capabilities

at the "turn of a key" (Antenucci, 1985, p. D-2). The following is a description of each of the components.

Hardware. As Figure 1 illustrates, hardware typically includes a *central processing unit*, magnetic tape and *disk memory*, graphic workstations, digitizers, printers, *plotters*, and data communications equipment. A hardware configuration designed for a particular installation may include a number of these devices networked together to meet the needs of the users. Most hardware needs for a GIS are similar to those of other computer systems. However, a GIS requires *graphic display screens*, plotters, and digitizers.

Software. The software required for a GIS includes system software, the *operating system*, and programs for graphic processing, database management, data input and editing, and applications. An operating system is a program that allocates the resources of the computer, including control of all processing, user access, file security, and other system functions (Antenucci, 1986, p. 3-7). *Graphic software* is required for converting data for graphic representation (Rosenberg, 1984, p. 97). A *database management system* is software that edits, sorts, and routes data, both within data storage and to and from *peripheral devices* and the central processing unit (Wolff, 1981, p. 53). Related applications software may include programs for vehicle routing, slope analysis, area calculations for parcels, buffer definition for zoning case review, and many other tasks commonly conducted by local government.

Database. The third component of a GIS is the database. The database typically consists of a large quantity of geocoded data collected from sources, such as aerial photography, parcel maps, zoning maps, engineering maps, census records, and many other sources.

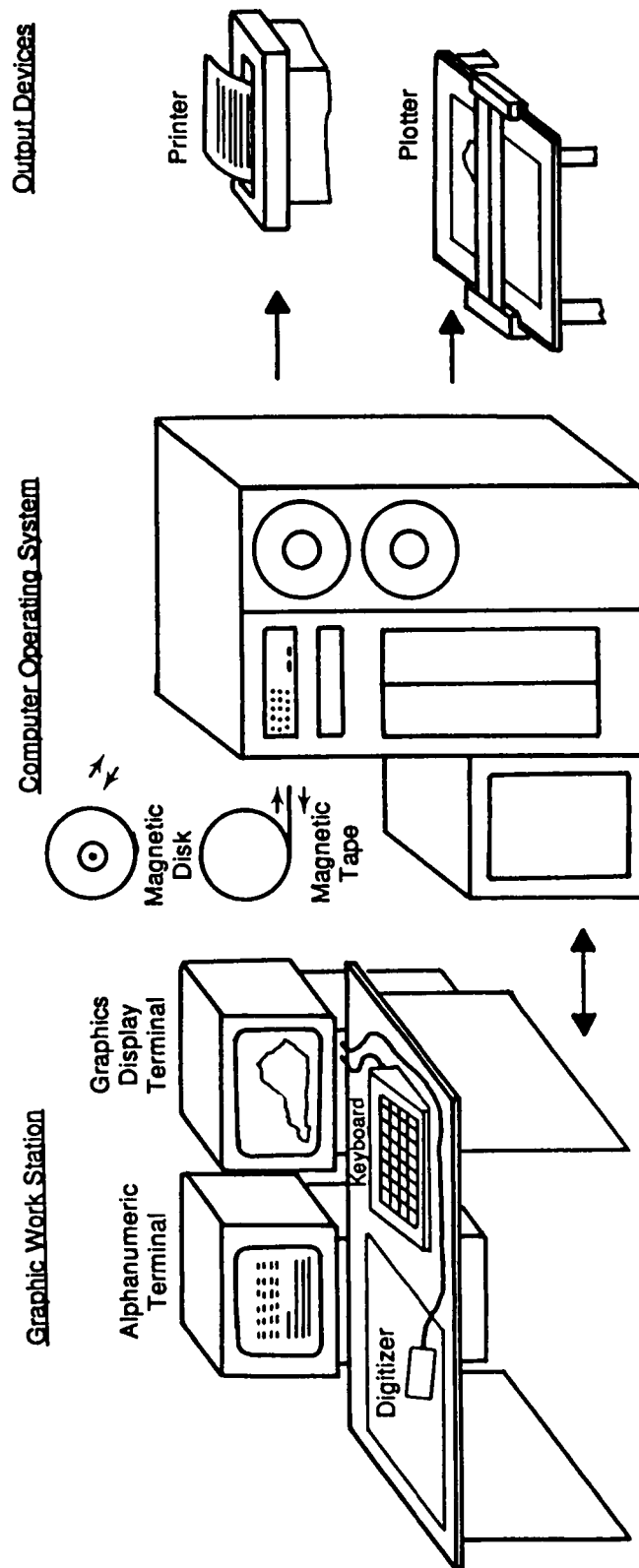


FIGURE 1
GIS HARDWARE COMPONENTS

Derived from (Wolff, 1981, p. 1).

Although the data are captured from many sources, there are only two fundamental kinds of data in a GIS database: geographic data and *attribute data*. Geographic data may describe point locations, area boundaries, and linear features, or they may express relationships of connectivity and adjacency (Monmonier, 1982, p. 21). The three types of geographic data are nominal, *metrical or geometrical*, and topological (Cooke, 1980, p. 10). Nominal data name geographic entries. Examples of nominal data are a parcel number or a street address. Metrical or geometrical data are measurements of length, distance, area, direction, altitude, or coordinates of a geographic entity (Cooke, 1980, p. 10). Examples of metrical data might include a street length, the area of a parcel, and state plane coordinates. *Topological data* are geographic data that "express relationships of connectivity and adjacency" (Cooke, 1980, p. 10). In other words, this type of data is used to describe how and where one geographic entity is located in reference to another geographic entity. An example of topological data is the node number or code that identifies where one street segment connects to another.

The other kind of data found in a GIS database is attribute data. Attribute data can be simply defined as data that provide qualitative and quantitative descriptions of an entity (Monmonier, 1982, p. 21). Examples of attribute data include zoning, land use, population, number of housing units, assessed property value, and number of traffic accidents.

Database Structure

The logical structure of the database is important to understanding its creation and use. In a GIS database, each type of feature, such as a parcel or water line, is assigned a code which defines its type. When a feature or set of features is to be processed, the operator selects the combination of layers or feature types desired and these are retrieved

from data storage. Any combination of features that has been delineated by layer or type code may be used at any time. Figure 2 depicts the layering concept.

The layering of the database must be structured to achieve maximum accuracy and compatibility among features. In general, the hierarchy will begin with geodetic and survey control, which will be the most accurate points used as the basic reference structure for the database. These points are assigned State Plane Coordinates from a reference grid which has been developed for each State in the United States. Next, planimetric features may be digitized using aerial photography and tied to control locations. Beyond the planimetric features, parcel boundaries, utilities lines, zoning, and other layers may be added.

Capabilities

Many information systems can retrieve, update, analyze, or display non-spatial or attribute data. However, only a GIS combines attribute and geographic data to enable processing and display of data based on the geographic location the data represent.

Because of the capability, a GIS can perform complex spatial analysis and generate graphic output, such as maps, in a fast, efficient manner. The following list identifies capabilities that can be performed by a GIS:

1. responding to inquiries from the public or other individuals;
2. retrieving data for decision-making or analysis;
3. performing tabulations and calculations;
4. producing reports, maps, and displays of geographically related data for analysis, presentations, or meetings;
5. identifying locations of items or places of interest;
6. defining or analyzing service areas or routes; and
7. updating, editing, and/or correcting features in the database (Antenucci, 1986, p. 4-2).

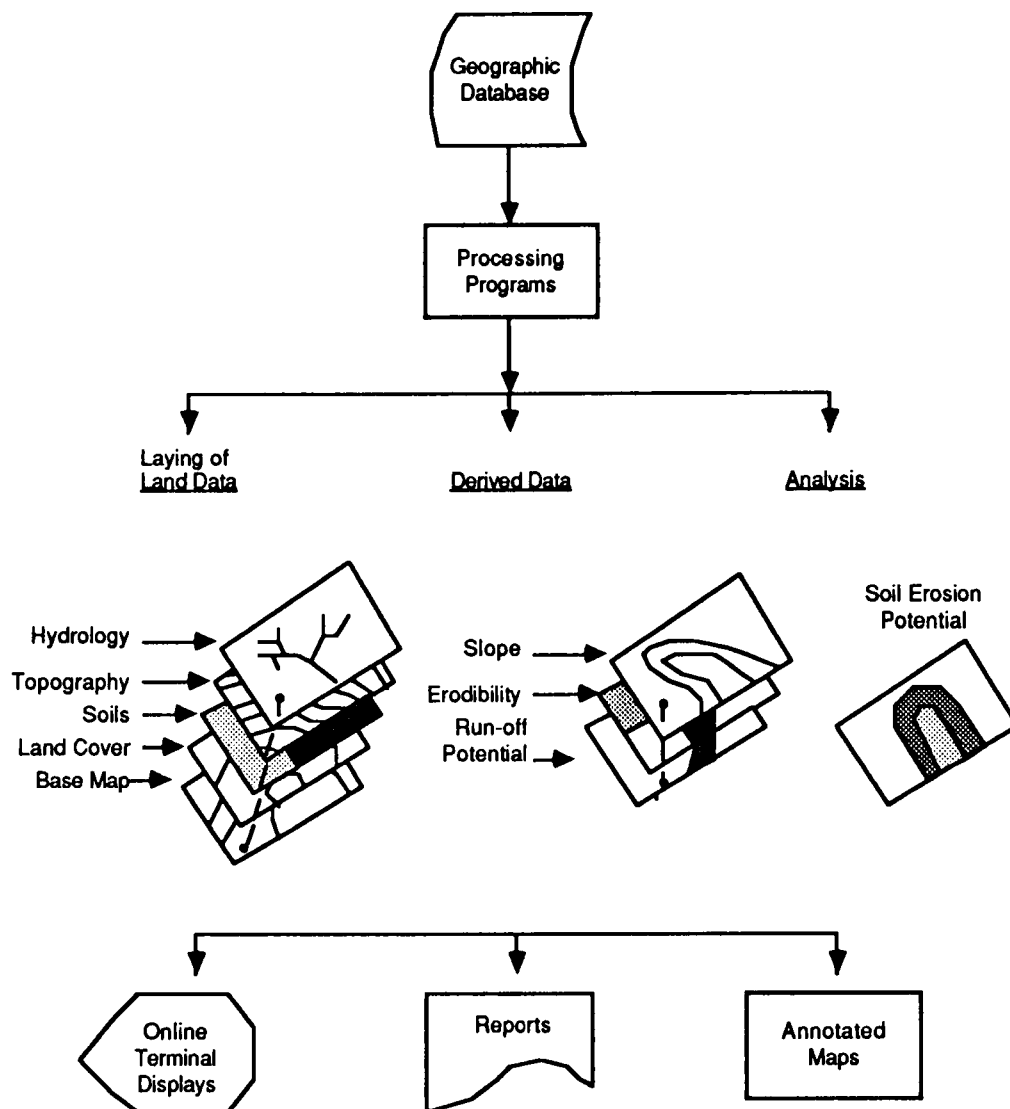


FIGURE 2
GIS ANALYSIS OF SOIL EROSION POTENTIAL.

Derived from (University of Kansas Space Technology Center, n.d., p.4).

The following example illustrates how the GIS capabilities can be used to perform a practical application. A developer applies for a zoning change from agricultural to commercial zoning of a fifty (50) acre tract of land. The planning staff is concerned about potential soil erosion and drainage and wishes to evaluate the possible effect of the rezoning. The planner first goes to a GIS terminal and requests an analysis of soil erosion potential for the specified area. The system retrieves data layers, such as the area hydrology, topography, soils, and land cover, from the database (see Figure 3). The layers are processed to produce "derived" data, such as slope, erodibility, and run-off potential. The system then translates the derived data into an analysis of soil erosion potential. After the analysis is complete, the planner designates the desired output. Output may be in the form of an on-line terminal display, reports, and an annotated map of the study area.

2. MULTI-ORGANIZATIONAL GISs

Definition and Concepts

A multi-organizational GIS is one which has multiple users all having access to a common database which has been designed to meet the needs of the users and to eliminate redundant data. A key component of a multi-organizational GIS, as defined in this thesis, is the common database. This database is built around a municipal database model. A municipal database model describes the components commonly found in a municipal database based on a generic set of municipal tasks or activities (Dangermond, n.d., p. 2). Dangermond states that, "In a conceptual sense, there are ten data components in the municipal data model." These are:

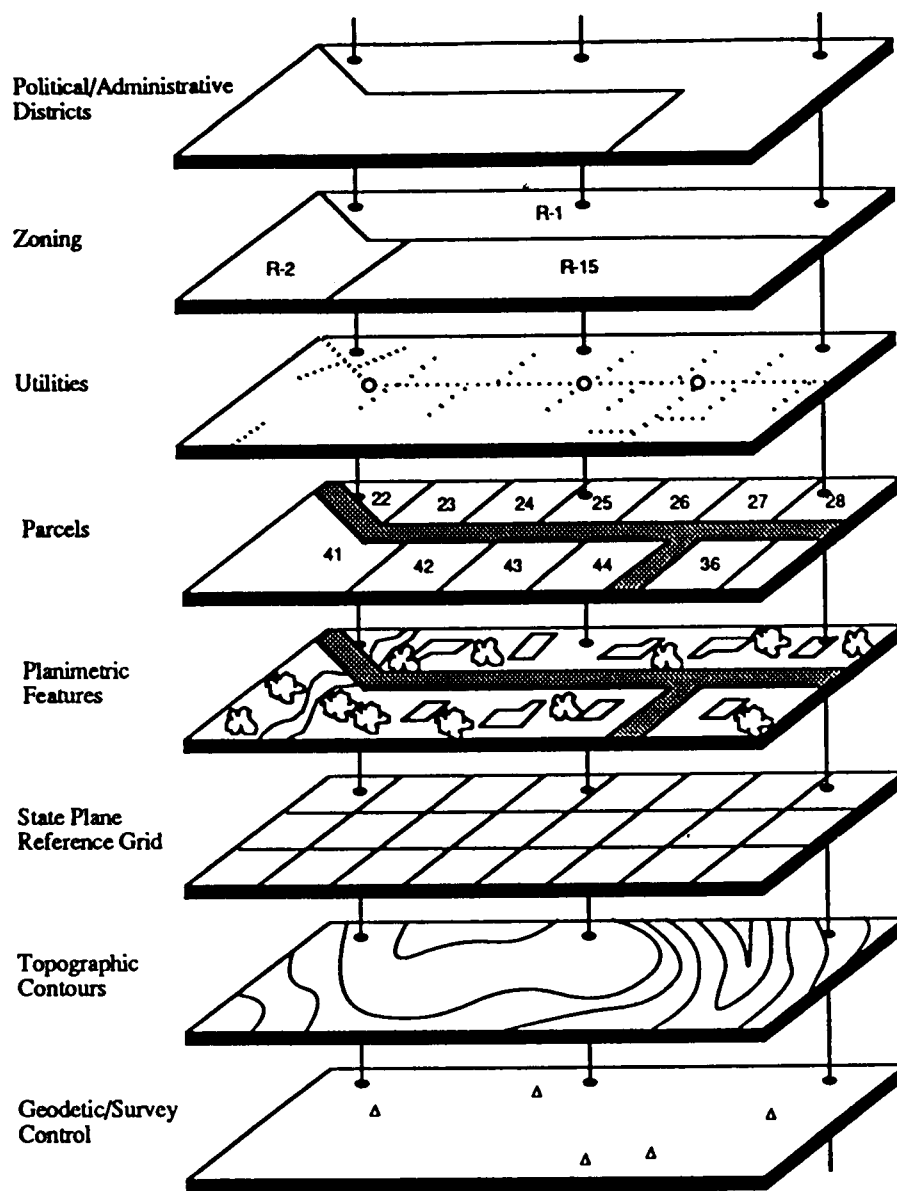


FIGURE 3
MAP DATABASE LAYERING CONCEPT

1. base map (geodetic survey control, planimetry, and topography);
2. environmental overlays (soils, geology, vegetation, etc.);
3. engineering overlays (roads, utilities, and infrastructure);
4. plan/profile drawings (design, construction, and as-built drawings);
5. parcel (property) maps;
6. parcel/street address tabular data (ownership, tax status, area, value, etc.);
7. street network file (street intersections, segments, numbers, and names);
8. street tabular data (traffic, housing type, crime, etc.);
9. area boundary maps (administrative boundaries); and
10. area tabular data (census, population, school district, etc.).

Dangermond further states that to go from concept to a functional model, a detailed description must be developed for data items in each of the general classes. The description should include the data origin, updating mechanism, and potential users. Based on these definitions, linkages and interrelationships among various components can be established. The definitions along with the relationships comprise the municipal data model.

The concept of a municipal data model, promoted by Dangermond and other leaders in the GIS industry, has become the foundation for multi-user or multi-organizational GISs. It is this model, along with the associated applications and benefits described below, that has been the impetus for multi-organizational GISs.

Applications

A GIS contains a selection of powerful capabilities to support many day-to-day and special operations of urban spatial data users. Some of these capabilities were listed above in the general description of a GIS. The following illustrates how these capabilities can be used in a multi-organizational GIS environment to perform some very sophisticated applications (Antenucci, 1986, Section 4).

Development tracking. A development tracking procedure would record selected data about development activities from each application, case, or project. The data for this procedure would be derived from a development index used by various agencies to record transactions, such as rezoning, subdivisions approval, building and other permits, utility plans and construction. The procedure would record data about the type, magnitude, and location of development activities and aggregate activities by areas, such as census tract or neighborhoods. The aggregated data would provide information regarding the type and timing of future development to be used in planning schools, water and sewer service, roads, and other public services. It could also be used in revising long and short-term plans, and in evaluating rezoning requests and proposed subdivisions.

Subdivision review. A multi-organizational GIS could be used in the subdivision review process to verify several aspects of the proposed plan, including location, relationship to surrounding property, availability of services, zoning restrictions, relationship to floodplains, drainage, and other information. Interactive drafting can be used to check alternative alignments, layouts, and other features of the subdivision design. Since multiple organizations typically review a subdivision before approval, the integrated nature of the system would be used to track and facilitate the review process.

Map updating. Many organizations within local government update one or more standard map sets as development, constructions, or other changes occur. Often, these various updates require mapping of the same features. Timely and efficient updating of these maps would be facilitated by participation of multiple organizations in updating the database of a multi-organizational GIS. The individual updates could be made by various organizations responsible for changes, such as subdivision approval, construction of utilities and roads, rezoning, and others. By allowing each organization to make updates as they occur, multiple organizations would not have to make the same updates.

Routing/Scheduling. Several organizations in local government delineate routes and schedules as a part of service delivery. These include, among others, public transportation, fire inspection, trash collection, zoning and codes enforcement, road maintenance, and utility maintenance. Each of these applications has similar characteristics. As a result, much of the same data, such as the street network, and many of the same software capabilities and application programs, could be used to perform the applications. The system user would provide parameters for allocation of service and then the application programs would generate proposed routes and schedules. When an acceptable routing and schedule are achieved, the application would produce appropriate maps and tabular listings of the final route or schedule and supporting data.

Zoning review. An application to retrieve data and assemble a standard package for each zoning case can be developed on a multi-organizational GIS. The package would contain existing and proposed zoning for a buffer area around the study site; identification of others pending or limitations on development activities in the area; maps of existing land use; data on available services, such as utilities and transportation; a mailing list of property owners to be notified; and other necessary information. Because much of this data is collected and stored by multiple agencies, a multi-organizational GIS would enable efficient and expedient collecting and processing of this information.

Benefits

To fully understand the utility of a multi-organizational GIS, benefits to be derived from such a system should be examined. The following is a discussion of some of the commonly described benefits as they relate to an integrated system. These include improved accuracy, increased productivity, better services, and cost sharing.

Improved accuracy. Currently, inconsistencies frequently exist in maps used by different agencies or organizations. As a result, many maps for decision-making are not

accurate. These inconsistencies are usually caused by errors or delays in transferring updates from one agency to another. For example, the city engineer may be using maps to prepare for street maintenance which do not contain accurate or the latest utility lines.

Because of such inaccuracies, costly mistakes are often made. One such mistake is the damage of underground utility lines during construction or repaving of streets. These mistakes could be avoided through the use of a multi-organizational GIS providing a common uniform database. Inconsistencies are eliminated and each agency has access to more accurate information concerning other facilities.

Increased productivity. A multi-organizational GIS will increase productivity in three ways. First, the automation of mapping functions will allow participating organizations to reduce manpower allocation to mapping and divert resources to more essential activities (Antenucci, 1985, p. 4-1).

Second, increased productivity will result from the reduction or elimination of redundant mapping activities. For example, new subdivisions are typically drafted on multiple maps by multiple organizations (Antenucci, 1985, p. 4-1). In most cases, the subdivision serves primarily as a background reference for such features as utility lines, parcel numbers, zoning, and many others. With a multi-organizational GIS, the subdivision data can be entered a single time and it immediately becomes available to all participating organizations. As this example illustrates, productivity would greatly increase, since the same activity would only be performed once.

Productivity will also increase through the use of the GISs capability to perform complex analysis. By using this capability, analysis for processes, such as subdivision approval, property assessment, utility planning, and street improvements, can be performed for a large area in a faster and more efficient manner.

Provides better service. A multi-organizational GIS offers citizens convenience in obtaining information. When fully implemented, it is not necessary for personnel or citizens to visit several offices to acquire needed information. By placing a request with a GIS operator, personnel or citizens are able to make inquiries at a single location and receive the response in a desired format (Antenucci, 1985, p. 4-1).

For example, suppose a citizen is interested in purchasing a lot for a house and wishes to gather information about the property. The citizen wants to know the location of lot lines, utility lines, and any rights-of-way. The citizen may also want to know the current zoning and ownership of the property. Rather than going to several offices, a request could be placed with a GIS operator and all the information could be conveniently obtained at a single location.

Precipitates cost sharing. Since nearly all local government agencies perform some level of geographic information processing, most have funding for information systems. However, the funds may not be sufficient to meet their needs in either developing or maintaining a system. By sharing the cost of common elements of the GIS, the available funds will go further to obtain a system that is co-sponsored by and meets the needs of multiple users.

Barriers

Given the benefits of a multi-organizational GIS, why is integration of users and applications so difficult? A review of the literature about barriers to multi-organizational systems indicated that the reasons are both technical and institutional. Technical factors include area of coverage, data classification, accuracy, geographic referencing, resolution, and volume of data. Institutional factors include timing, public/private issues, legal constraints, cost factors, administrative issues and political problems (Wilson, 1984, p.

159). The following is a discussion of these factors as they relate to barriers of a multi-organizational system.

Gaining and Maintaining Political and Administrative Support. Initiating and implementing a multi-organizational project requires executive support from all participating organizations. Historically, limited coordination and cooperation has existed between officials from one local jurisdiction to another. This is in part due to competition for local resources, such as tax revenues, and also due to the fragmented nature of local government. Each organization has its own goals and responsibilities. As a result, it is difficult to establish the framework for a multi-organizational project. Gaining and maintaining support is further frustrated by the introduction of new decision makers at each election. Multi-organizational projects require long-term policy setting and decision making which usually is not the environment in local government (Eichelberge, 1988, p. 25).

Meeting Multi-organizational Requirements. Requirements for geographic data closely reflect the nature and the role of the organization. Because of differences in needs in relation to timing and accuracy, different entities may not be able to justify a common effort (Wilson, n.d.b. p. 3). Timing is particularly significant, since participants must be satisfied that their scheduling and budget needs are met (Montgomery, 1988, p. 207).

Changing Functions/Activities of Participating Agencies. A multi-organizational GIS requires some changes in the participating organizations' functions (Eichelberge, 1988, p. 25). These systems require both new activities, and the elimination or consolidation of previous activities. As a result, changes must take place throughout the organizations. These changes include altering work allocation, shifting responsibilities, retraining and educating staff, and creating new branches of government, or modifying the existing structure (Eichelberge, 1988, p. 25).

Cost Sharing and Allocation. "Unless it can be shown that the cost of a particular data collection effort is lower for each agency involved in a cooperative effort, there will be resistance to cooperation (Wilson, n.d.b., p. 3)." Because some level of compromise is always required in a cooperative effort, there is a tendency to prefer the path of least resistance and develop a system in isolation. Many local government agencies will conduct their own effort unless the value of sharing can be shown. Another issue in cost sharing is allocation of costs. Determining and agreeing on an equitable formula or basis for allocation is a difficult matter (Wilson, n.d.b., p. 3).

CHAPTER III

SURVEY OF SELECT MULTI-ORGANIZATIONAL GISs

1. OBJECTIVE OF SURVEY

As described previously, limited information is readily available to local government agencies interested in establishing a multi-organizational GIS. A logical means of obtaining this information is to study existing installations. The objective of this survey is to rigorously collect and record information describing several existing multi-organizational installations. This chapter discusses sample selection, survey design, data collection and recording, and limitations and assumptions of the survey.

2. SAMPLE SELECTION

Selecting systems to be included was an important aspect of this project. The first step in this process was establishing criteria to determine whether a GIS can be defined as a multi-organizational GIS. For the purpose of this thesis, a multi-organizational GIS is one that has multiple users all having access to a database which has been consolidated to eliminate redundant data (Rosenberg, 1984, p. 253). Based on this definition, the following tasks were performed to identify appropriate systems for inclusion in the survey:

- 1) interviews with individuals involved in developing GISs;
- 2) a review of the "URISA/SIG-GEO Interactive Computer Graphics Survey of Public Agencies";
- 3) review of other Urban and Regional Information Systems Association (URISA) publications, including conference proceedings for the past seven years;
- 4) review of a survey of approximately 120 GIS installations performed by PlanGraphics, Inc., a GIS consultant ;

- 5) review of documentation for several systems (including documents obtained from PlanGraphics' corporate library; requests to attendees at the 1985 Urban and Regional Information Systems Association conference; telephone conversations with systems identified in items 2, 3, and 4 above; items collected over the last three years in contacts with individuals that have or were implementing systems); and
- 6) interviews with representatives of systems tentatively identified as multi-organizational.

Through these efforts, the following were identified as having multi-organizational systems:

- 1) Automated Information and Management System (AIMS), Johnson County, Kansas;
- 2) Geographic Data System/Common Mapping Project, Eugene/Lane County, Oregon;
- 3) Community Mapping and Data Management System (CM/DMS), Louisville/Jefferson County, Kentucky;
- 4) Geographic Land and Data System (GLADS), Salem/Marion County, Oregon;
- 5) Geographic Information System (GIS), Knoxville/Knox County, Tennessee;
- 6) Land Information System, Metro Toronto, Toronto/Ontario, Canada;
- 7) Management and Planning System (MAPS), Wilmington/New Hanover County, North Carolina;
- 8) Metropolitan Area Geographic Information Consortium, Nashville/Davidson County, Tennessee; and
- 9) Ultimap, Minneapolis/Hennepin County, Minnesota.

A representative of each system was contacted.

Initial contact to determine whether each representative would participate in the survey was carried out in a telephone conversation. During each contact, the purpose, intent, and general procedure of the survey was described and each was asked to participate in the survey. The script used for this contact is contained in Appendix A. Either during the initial contact or in a return telephone call, each agreed to participate. As a follow-up to the telephone conversations, a letter describing the general methodology was sent to each potential participant setting the stage for further contact. The contents of this letter will be discussed in more detail in the following sections.

3. SURVEY DESIGN

The first step in designing the survey was to determine what information describes these systems. As stated in Chapter 1, the purpose of this thesis is to provide a framework for understanding the issues in designing, implementing, and operating a multi-organizational GIS. Keeping the purpose and limitations of this thesis in mind, the following questions were developed:

1. What are the characteristics of these systems?
2. What are the benefits of these systems?
3. What barriers or obstacles must be overcome in a multi-organizational GIS project?
4. How can these barriers be reduced or eliminated?

The next step in designing the survey was to operationalize these questions; that is, what information would be collected and how would it be collected? Operationalizing question 1 above required identifying characteristics that describe the systems. The characteristics selected were as follows:

1. project origin;
2. implementation status;

3. participating agencies;
4. organizational structure;
5. hardware platform;
6. GIS software;
7. database layers;
8. applications;
9. system cost and financing; and
10. cost allocation.

To collect the survey data, two approaches were used: 1) a review of available documentation for each of the selected systems; and 2) a questionnaire administered by telephone to a representative of each system.

Documentation Review

The initial part of the survey involved collecting and reviewing documentation describing each of the study sites. The purpose of this review was to collect as much information as possible about the background and characteristics of each project prior to the telephone interviews. Some of this documentation was identified through a literature review. Other documentation was identified by and collected from the representative of each study site. The documentation review included the following:

1. "URISA/SIG-GEO Interactive Computer Graphics Survey of Public Agencies" (Urban and Regional Information System, n.d.);
2. review of a survey of approximately 120 GIS installations performed by PlanGraphics, Inc., a GIS consultant ;
3. articles, either published or unpublished, describing various aspects of the project; and

4. progress reports, pamphlets, brochures, and other documents describing the projects obtained directly for the survey participants.

As mentioned above, a letter was sent to a representative of each project following the initial telephone contact requesting participation. Attached to the letter was a profile developed for each agency containing select information derived from the review of documentation. This step was taken to verify the currentness of the data. The profile was developed to facilitate gathering and verifying information needed to characterize the study projects. To develop the profiles, information collected prior to the interviews was evaluated. The purpose of this evaluation was to identify characteristics of the projects that could be obtained from sources previously collected.

Data was collected for each project and profiles were generated. A sample letter and attachments are provided in Appendix B. Other information collected from the documentation review was verified during the telephone interview to be discussed in the following chapter. The level of detail and types of information collected from review of documents varied from project to project. For some projects, no additional information was needed. For others, much of the data needed to characterize the project were collected from review of documentation.

Questionnaire

The first step in designing the questionnaire was determining what information for each system was to be collected in the telephone interviews. Generally, this included characteristics not collected in the documentation review, such as benefits, barriers, and solutions to barriers. After identifying general topic areas, a question or series of questions was developed to address each topic area. The questions developed included both free-response (unstructured or open-ended) and fixed-response (structured or closed) questions (Backstrom, 1963, p. 128). The questions relating to characteristics were free-response

and were organized in categories of characteristics, including general, organizational structure, and financial. The following is a listing of the questions included in the questionnaire to obtain data about characteristics of each project:

1. General

- Is the information in the Project Profile correct?
- If not, please indicate corrections and/or modifications.
- What department or divisions of the participating agencies are involved in the project?
- Describe the major events leading to a multi-organizational project.
- Describe the organizational structure under which the system functions in terms of roles and responsibilities.

2. Organizational Structure

- How are technical, financial, administrative, and policy decisions made and who makes and/or approves these decisions?
- How are the "shared functions" of the system staffed and managed (if not covered above)?

3. Financial

- How much is the system estimated to cost?
- What is included in this cost estimate?
- How is the system financed (revenue source or sources)?
- How is the system cost allocated to participating agencies?

The remaining questions included in the questionnaire addressed benefits and barriers. These questions included both fixed and free response questions. The following is a list of these questions:

1. Benefits

- Which of the following are benefits of your system (followed by a list of benefits to be discussed below)?
- Can you identify other benefits?

- Of your system benefits, which are very important, moderately important, or slightly important?

2. Barriers

- Which of the following barriers are or were relevant to your project (followed by a list of barriers to be discussed below)?
- Can you identify other relevant barriers/issues?
- Of the relevant barriers/issues, which are/were very significant, moderately significant, or slightly significant?
- Which of the relevant barriers/issues have been resolved?
- Describe how each was resolved.
- For those not resolved, what solutions have been or are being tried?

To facilitate data collection, potential benefits and barriers were listed in the questionnaire. These benefits and barriers were identified based on a review of literature as discussed in Chapter 2 of this thesis. The questions were then organized and formatted for distribution to the project representatives for review prior to the telephone interview. The formatting of the questionnaire was based on the fact that the questionnaire would be used as a guide for the interview and not for recording detailed answers to the questions. A sample questionnaire is shown in Appendix C.

4. DATA COLLECTION AND RECORDING

Initial data collection involved reviewing documentation on each system. To facilitate the content analysis of the documents, a project profile form was developed to record the information about each project. The form was particularly useful, since it provided a format for identifying missing information and for submitting the information for review by each project representative. To facilitate data collection during the interviews, the questionnaire was sent to each participant approximately one and a half weeks prior to the interview. The individuals to be interviewed were requested to review the questionnaire

and prepare to answer the questions during a telephone interview to be conducted at a pre-arranged time and date.

Interviews were scheduled and held during the last two weeks in January, 1989. Each interview lasted approximately one and a half hours. Interviews lasted approximately two hours for projects where characteristics collected from the documentation review were limited to the project profile.

5. LIMITATIONS

Limitations of this survey include those of both scope and methodology. Because of the level of detail required for the study and resource limitations, only a limited number of multi-organizational sites were included in the survey. The study was further limited by the inclusion of only one representative as spokesperson for each site. This limitation is due to both resources on the part of the author and a desire not to infringe on resources within each of the participating installations. The third limitation of this study is reliance on the memory of interviewees to relate events that have occurred over several years. In addition to taking notes during the interview, an audio recording was made of each interview. This recording was used to identify and correct any errors in the notes taken during the interviews.

CHAPTER IV

ANALYSIS AND EVALUATION OF THE SYSTEMS

1. INTRODUCTION

This chapter presents an analysis and evaluation of the data collected through the survey of systems described in Chapter III. Included in this chapter is a presentation of findings concerning characteristics, benefits, barriers, and solutions to barriers. Most of the data describing characteristics is presented in terms of each of the systems studied. However, much of the data collected for this study is politically sensitive. As a result, some data describing characteristics and all of the data describing benefits, barriers, and resolution of barriers is presented without identifying a particular system.

The characteristics presented are in terms of several categories. These categories include an overview or summary characteristics, project origin and history, database layers, applications, organizational structure, and cost and finance. Tables and figures are used extensively to present the survey results in an efficient manner. Readers are encouraged to carefully study these tables and figures since some of the information is only presented in tabular form.

As indicated in Chapter III, the systems studied are as follows:

- 1) Automated Information and Management System (AIMS), Johnson County, Kansas;
- 2) Geographic Data System/Common Mapping Project, Eugene/Lane County, Oregon;
- 3) Community Mapping and Data Management System (CM/DMS), Louisville/Jefferson County, Kentucky;
- 4) Geographic Land and Data System (GLADS), Salem/Marion County, Oregon;
- 5) Geographic Information System (GIS), Knoxville/Knox County, Tennessee;

- 6) Land Information System, Metro Toronto, Toronto/Ontario, Canada;
- 7) Management and Planning System (MAPS), Wilmington/New Hanover County, North Carolina;
- 8) Metropolitan Area Geographic Information Consortium, Nashville/Davidson County, Tennessee; and
- 9) Ultimap, Minneapolis/Hennepin County, Minnesota.

2. CHARACTERISTICS

To describe multi-organizational systems, characteristics were collected about the origins, status, database components, applications, organizational structure, and cost/financing the study systems. The following is a summary and analysis of the data collected.

Overview

As discussed in Chapter III, nine systems were surveyed. As shown in Table 1, the survey included systems in six states and one in Canada. These states included Kansas, Oregon, Kentucky, Tennessee, North Carolina, and Minnesota. The system in Canada is located in Toronto, Ontario. Note that two of the systems are in Oregon, and two are in Tennessee.

The duration of these projects varies from 19 years to three years. Three of the projects began before 1980 and the other six began after 1980. The majority of the projects began during or after 1985. Of the projects began before 1980, two are now fully operational. All seven other projects are partially operational. As will be discussed later in this thesis, the long duration of the partially operational phase is largely due to the length of time it takes to perform data conversion of the massive amounts of data needed for a fully operational system.

The hardware platforms used by the study projects include Apollo minicomputers, Digital Equipment Corporation's VAX minicomputers, Sun minicomputers, and Prime mainframes. As shown in Table 1, the platform for most of the study systems is the VAX minicomputer. Six of the nine systems have VAX hardware platforms.

The software platforms used by the study projects include Environmental System Research Institute's ARC/INFO, GeoVision's GIS/AMS, Intergraph's IGDS/DMRS, Synercom's INFORMAP, and Ultimap's GIS. Three of the projects have an INFORMAP platform and three have an ARC/INFO platform.

To further characterize the study systems, participating organizations were identified. As shown in Table 2, participants for nearly all systems studied include city and county governments or a metropolitan government. Other common types of participants include regional planning, and water, wastewater, gas, and electric utilities. Table 3 provides a more detailed listing of participants for each project. An analysis of the agencies/departments indicates that each project includes public works, property appraisal or assessment, and planning. Other types of agencies/departments commonly included among participants are: code enforcement, data processing, electric utility, elections and voter registration, fire, gas utility, parks and recreation, police, real estate, wastewater utility, and water utility.

Table 3 also indicates the lead or administrative agency for each project. As shown in this table, there is a great deal of variety among the projects with respect to the type of unit administering the project. Lead agencies include planning, wastewater utility, data processing, public works, and newly created GIS departments. The roles, responsibilities, and origins of the lead agencies will be discussed in more detail in the Organization Structure section below.

TABLE 1
PROJECT OVERVIEW

Project Name	Project Location	Year Project Began	Implementation Status	Hardware Platform	GIS Software
Automated Information Management System	Johnson County, Kansas	1985	Partially operational	Prime	Environmental Systems Research Institute (ESRI) ARC/INFO
Common Mapping Project	Eugene/Lane County, Oregon	1970	Fully operational	Digital Equipment Corporation (DEC)-VAX	Synercom INFORMAP
Community Mapping and Data Management System	Louisville/Jefferson County, Kentucky	1985	Partially operational	Prime/SUN	ESRI ARC/INFO
Geographic Land and Data System	Salem/Marion County, Oregon	1979	Partially operational	DEC-VAX	Synercom INFORMAP
Knoxville/Knox County GIS	Knoxville/Knox County, Tennessee	1984	Partially operational	DEC-VAX	Intergraph IGDS/DMRS
Land Information System	Toronto/Ontario, Canada	1981	Partially operational	DEC-VAX	ESRI ARC/INFO
Management and Planning System	Wilmington/New Hanover County, North Carolina	1986	Partially operational	DEC-VAX	GeoVision GIS/AMS

TABLE 1 (continued)

Project Name	Project Location	Year Project Began	Implementation Status	Hardware Platform	GIS Software
Metropolitan Area Geographic Information Consortium	Nashville/Davidson County, Tennessee	1985	Partially operational	DEC-VAX	Synercom INFORMAP
Ultimap	Minneapolis/Hennepin County, Minnesota	1971	Fully operational	Apollo	Ultimap GIS

**TABLE 2
TYPE OF ORGANIZATION BY PROJECT**

<i>Type of Organization</i>	Automated Information Management System, Johnson County, KS	Common Mapping Project, Eugene/Lane County, OR	Community Mapping and Data Management System, Louisville/Jefferson County, KY	Geographic Land and Data System, Salem/Marion County, OR	Knoxville/Knox County GIS, Knoxville/Knox County, TN	Land Information System, Toronto/Ontario, Canada	Management and Planning System, Wilmington/New Hanover County, NC	Metropolitan Area Geographic Information Consortium, Nashville/Davidson County, TN	Ultimap, Minneapolis/Hennepin County, MN
City Government		●	●	●	●	●	●		●
County Government	●	●	●	●	●		●		●
Metropolitan Government						●		●	
Water Utility		●			●	●		●	●
Wastewater Utility	●		●		●	●		●	●
Gas Utility					●	●		●	●
Electric Utility		●			●	●		●	●
Regional Planning		●				●			

TABLE 3
ORGANIZATIONS PARTICIPATING IN PROJECTS

Project Name/Location	Lead/Administrative Agency	Participating Agencies/ Departments
Automated Information Management System, Johnson County, Kansas	Johnson County Planning	Johnson County Clerk Johnson County Public Works Appraisal Wastewater Utility
Common Mapping Project Eugene/Lane County, Oregon	Lane Council of Governments	Lane County Public Works Lane County Assessor Lane County Planning City of Springfield City of Eugene Eugene Water & Electric Board
Community Mapping and Data Management System Louisville/Jefferson County, Kentucky	Metropolitan Sewer District	Louisville Public Works Louisville Inspections, Licenses, and Permits Jefferson County Public Works City/County Planning Commission Property Valuation Administrator
Geographic Land and Data System Salem/Marion County, Oregon	Salem Data Center	Marion County Assessor Marion County Planning Marion County Elections Department Salem Public Works Salem Community Development Salem Fire Department Salem Police Department Polk County

TABLE 3 (continued)

Project Name/Location	Lead/Administrative Agency	Participating Agencies/ Departments
Knoxville/Knox County GIS Knoxville/Knox County, Tennessee	Knox County GIS Dept.	Knoxville City Engineer Knoxville Public Works Knoxville Police Knoxville E911 Knox County Property Assessor Knox County Highway Department Knox County Engineering Department Planning Commission Knoxville Utility Board
Land Information System Toronto/Ontario, Canada	Metro Toronto Central Mapping Agency	Metropolitan Toronto Departments Regional Planning Cities Wastewater Utilities Gas Utilities Electric Utilities Telephone Utilities
Management and Planning System Wilmington/New Hanover County, North Carolina	Wilmington Information Services	Wilmington Transportation Engineer Wilmington Public Utilities Wilmington Planning Dept. New Hanover County Management Information Services New Hanover County Land Records New Hanover County Planning
Metropolitan Area Geographic Information Consortium Nashville/Davidson County, Tennessee	Metropolitan Nashville GIS Department	Metro Planning Metro Water Services Metro Public Works Nashville Electric Service Nashville Gas Company

TABLE 3 (continued)

Project Name/Location	Lead/Administrative Agency	Participating Agencies/ Departments
Ultimap Minneapolis/Hennepin County, Minnesota	Minneapolis Street Design Department Hennepin County Public Works	City Public Works/Utilities City Real Estate City Planning City Assessor City Parks Board City Fire County Public Works County Planning and Development County Surveyor County Parks Private Utilities

Project Origins and History

The factors and events leading to the creation of a multi-organizational project are unique to each project. However, the projects can be divided into two groups: those that were initiated at the executive level, and those that were initiated from the mid-management or technical level. The projects initiated at the executive level include GLADS, MAPS, Knoxville/Knox County GIS, MAGIC, and Ultimap. The projects initiated at the mid-management or technical level include AIMS, CM/DMS, Common Mapping Project, and Land Information System.

Initiation at the executive level took several different forms. In some cases, the initiation was directly related to implementation of a multi-organizational project. Such was the case with the Knoxville/Knox County Project. Initiation of the Knoxville project came about through a request for a team to study a joint GIS from the City Mayor, County Executives, and the Knoxville Utilities Board (KUB) Executive Director. In other projects, the initiation at the executive level was indirectly related to creation of a multi-organizational project. For example, the initiation of the MAPS projects was an indirect result of the Wilmington city council's request for a study of ways to improve services. One outcome of the study was the formation of an Advisory Group to evaluate and implement a multi-organizational system. For projects initiated at the mid-management or technical level, initiation for the most part came about through the creation of a multi-organizational committee or group to study the feasibility of a joint system.

Another common factor or event in initiation of all the systems was a study to evaluate and define needs. These studies were performed by consultants for six of the projects and performed by in-house staff for three of the projects.

Database Layers

Since the whole concept of a multi-organizational system is centered around data sharing, an important characteristic of these systems is the database layers. Table 4 indicates the database layers for each study system that are currently in use or planned. Of the 26 data layers indicated in Table 4, none of the systems indicated fewer than 11 data layers as currently in, or planned, for their database. As indicated in Table 4, the most common data layers are:

1. administrative district boundaries;
2. geodetic control;
3. land use;
4. land/property parcels;
5. maintenance/service districts;
6. planimetric base map;
7. political boundaries;
8. sanitary sewer (wastewater) facilities;
9. soils; and
10. street/road/railroad centerlines.

The data shown in Table 4 further indicates that database layers 2, 4, 6, 7, and 10 above tend to be in the initial phases of database creation. This may be due to the necessary sequencing of database creation and/or priorities assigned to the layers.

TABLE 4
DATABASE LAYERS BY PROJECT

DATABASE LAYERS	Legend: ● = Current ○ = Planned								
	Automated Information Management System	Common Mapping Project	Community Mapping and Data Management System	Geographic Land and Data System	Knoxville/Knox County GIS	Land Information System	Management and Planning System	Metropolitan Area Geographic Information Consortium	Ultimap
Administrative District Boundaries	●	●	○	●	○	●	●	○	●
Demography/Marketing		●	○	○		●	○	○	●
Digital Elevation Model	●	○	●		●			○	●
Electric Distribution		○			○			○	
Electric Transmission		○			○	●		○	●
Elevation Contours		○	●	○	●	●		●	●
Environmental Features/Boundaries		●		○			○		●
Gas Transmission		○			○			○	●
Gas Distribution		○			○			○	
Geodetic Control	●	●	●	●	●	●	●	●	●
Geologic Features			○						●
Land Cover	●	●	●	○	●			●	●
Land Use	○	○	○	○	○	●	○	○	●
Land Parcels	●	●	○	●	●	●	●	○	●
Maintenance/Service Districts	○	●	○	○	●	●	○	○	●
Planimetric Base Map	●		●	●	●	●	●	●	●
Political Boundaries	●	●	●	●	●		●	○	●
Sanitary Sewer System Facilities	○	●	○	●	○	●	○	○	●
Soils	●	●	○	○	●		○	○	○
Storm Sewer Facilities		●	○	●	○		○	○	●
Street/Road/Railroad Centerlines	●	●	●	●	●	●	●	○	●
Subsurface Hydrology							●		●
Surface Hydrologic Features			●	●	●			○	
Telephone Outside Plant		○							●
Water Distribution Facilities		○		●	○		○	○	●
Zoning	○	●	○	●	○				

Applications

Ultimately, the most important characteristics of a multi-organizational system are the applications. As indicated in Table 5, there are many applications that can be performed in the multi-organizational GIS environment. These include applications related to land use planning and zoning, property mapping and appraisal, public works facility management, water and sewer facility management, and natural resource management. As shown in Table 5, the most common applications are in the areas of land use planning and zoning, property mapping and appraisal, and public works facility management. While the systems are capable of performing many types of analyses, generating various types of maps was cited more often than any type of application. Other common applications are demographic analysis, permit and development tracking, ownership search and query, and traffic volume/accident analysis.

Organizational Structure

A multi-organizational project crosses the bounds of the organizational and administrative duties of all participants involved. As a result, an organizational structure must be established for managing and administering this kind of project. In all the projects studied, the existing structure was modified and/or enhanced by newly created committees, groups, and departments or divisions. None of the projects studied involved creating a new organization solely to administer and coordinate the GIS project. However, in several projects, a new department or division of an existing organization was created. In most cases, the lead or administrative agency was determined early in the project.

Factors contributing to designation of the lead agency included interest in the project, ability to administer the project, relationship among the participants, and, to a large extent, desire at the initiation to administer the project. Several of the project representatives indicated that the administrative agency was designated by default.

**TABLE 5
COMMON APPLICATIONS**

APPLICATIONS	Legend: ● = Current ○ = Planned								
	Automated Information Management System	Common Mapping Project	Community Mapping and Data Management System	Geographic Land and Data System	Knoxville/Knox County GIS	Land Information System	Management and Planning System	Metropolitan Area Geographic Information Consortium	Ultimap
Land Use Planning/Zoning									
Zoning Map Production	●	●	○	●	○	●	○	○	●
Land Use Map Production	○		○	○	●		○		●
Special Thematic Map Production	○	●	○		●	●	○	○	●
Support for Comprehensive Planning	○	●	○	○	●		○	○	●
Rezoning Evaluations	○	●	○		●			○	
Demographic Analysis	○	●	○	○	○	●	○	○	
Permit/Development Tracking	○	●	●	○	●	●	○	○	
Redistricting	○	●	○		●		○	○	
Site Suitability Analysis		●	○			○		○	
Property Mapping/Property Appraisal									
Property Map Production	●	●	○	●	●		●	○	○
Tax Neighborhood Analysis	●	●	○	●			○	○	○
Support for Field Appraisal	●		○	●	●		○	○	●
Special Map Generation/Analysis	●		○	●	●			○	●
Ownership Searches/Query	●	●	○	●	●		●	○	●
Public Works Facility Management									
Engineering Design/Drafting	○	●		●			○	○	●
Pavement Management	○	○	○			○	○	○	
Sign/Streetlight Inventory/Mapping	○	●	○	○		○	●		●
Plat/Site Plan Review	○	○	○		●		●	○	●
Work Order Management	○	○	○				○		
Maintenance History Tracking	○		○	○			○	○	
Traffic Volume/Accident Analysis	○	●	○	○	●		○		●
Transportation Modeling	○	●	○		●	○	○		
Route Analysis	○		○		●	○	○		
Drainage Analysis	○	○	○		●		○		

TABLE 5 (continued)

	Automated Information Management System	Common Mapping Project	Community Mapping and Data Management System	Geographic Land and Data System	Knoxville/Knox County GIS	Land Information System	Management and Planning System	Metropolitan Area Geographic Information Consortium	Ultimap
Legend: ● = Current ○ = Planned									
APPLICATIONS									
Water/Sewer Utilities									
Map Generation/Update	○		○	●	●	●	●	○	●
Network Tracing	○		○		○	○	○		
Emergency Response			○			○			
Pressure Analysis	○				○				
Cathodic Protection Analysis					○				
Flow Modeling	○		○		●				
Inspection/Maintenance	○		○		○		○		
Infiltration/Inflow Analysis			○		○				
Treatment Facility Control	○		○						
Load Forecasting	○				○		○		
Engineering Analysis	○		○	●	●		○	○	●
Engineering Drawing Preparation				●		●	○	○	●
Work Order Tracking			○				○	○	
Natural Resources									
Forest Resource Mapping		○							
Soil Erosion Analysis		●	○						
Groundwater Modeling		○							
Surface Water Modeling/Analysis/Planning		○	○						
Wildlife/Habitat Analysis		○							
Land Use Suitability Analysis		●	○				○	○	
Land Cover Analysis		●	○					○	
Flood Zone Analysis					●				
General Pollution/Contaminant Tracking		○	○	○				○	
Other									
Gas Map Generation/Update					●			○	
Gas Property Record Tracking		●			●			○	
Electric Map Generation/Update		●			○	●		●	
Evacuation Planning		●		○					
Incident Mapping	○	●	○	○		●	○	○	
Planimetric Map Production	●		●		●			●	
Support for Dispatch	○	○	○		●	●	○		

In addition to the lead/administrative agency, other types of units making up the organizational structure include a policy committee, technical committee, user group, project staff, and ad hoc or special committees. While the names and personnel assigned to these committees and groups varied between the projects, the basic roles and responsibilities were similar. Table 6 indicates the type of units formed for each of the projects studied. As shown in Table 6, eight of the nine projects have policy committees, six have technical committees, five have user groups, all have staff, and four have ad hoc or special committees. For those agencies not having policy or technical committees, it was indicated in interviews that such committees have existed in the past or would be useful in the future coordination and administration of their project.

Policy Committee. Roles and responsibilities indicated for the policy committee include the following:

1. develop policies and approve procedures;
2. review, approve and take action on matters of policy or legal issues;
3. approve expenditures, budgets, cost sharing, and user fees;
4. review and approve long and short-term plans;
5. advise on user conflicts; and
6. approve major changes in project direction and priorities.

The membership on the policy committee for some projects was limited to chief executives of each of the participating agencies. For other projects, membership also included representatives from various legislative units such as city councils, county commissions, regional boards, and utility boards. Representatives for some of the projects were department heads of the various participating departments. In all cases, the members on the policy committee were individuals with the authority to make commitments at one level or another.

**TABLE 6
ORGANIZATIONAL STRUCTURE BY PROJECT**

PROJECT NAME	TYPE OF ORGANIZATION	Policy Committee	Technical Committee(s)	User Group	Project Staff	Ad Hoc and Special Committee
Automated Information Management System, Johnson County, KS		●	●		●	
Common Mapping Project, Eugene/Lane County, OR		●	●	●	●	●
Community Mapping and Data Management System, Louisville/Jefferson County, KY		●	●	●	●	●
Geographic Land and Data System, Salem/Marion County, OR		●		●	●	●
Knoxville/Knox County GIS, Knoxville/Knox County, TN		●	●		●	
Land Information System, Toronto/Ontario, Canada		●	●	●	●	
Management and Planning System, Wilmington/New Hanover County, NC		●			●	●
Metropolitan Area Geographic Information Consortium, Nashville/Davidson County, TN		●	●		●	
Ultimap, Minneapolis/Hennepin County, MN				●	●	●

Technical Committee. Roles and responsibilities of the technical committee include the following:

1. provide technical guidance to policy committee;
2. provide coordination between representative organization and policy committee, GIS staff, and other organizations;
3. participate in evaluation of proposal and selection of vendors; and
4. provide input in budgeting process.

Membership on the technical committee varied from project to project. Some projects included department heads, while others were primarily composed of technical-level staff. Many of those interviewed indicated that the composition of the technical committee varied over time, depending on the phase or activities of the project. If project activities were technical in nature, then the committee members tended to be more technical in nature. If activities included administrative, organizational, or policy issues, management-level representatives were more likely.

User Group. The primary function of the user group is to exchange technical information about use of the system. This group includes the hands-on users of the system from participating agencies.

Project Staff. All nine projects reported some level of centralized staffing or activities that were performed for benefit of all users. These activities include the following:

1. manage implementation and operation of GIS share facilities;
2. monitor and report project status;
3. coordinate GIS related activities;
4. promote GIS use within participating agencies and to non-participants;
5. manage GIS shared database;
6. produce and maintain applications;

7. resolve technical problems with hardware and software;
8. provide technical assistance to users; and
9. provide and coordinate training.

Each of the study projects has a project manager or coordinator. Other members of the "core" staffs included a variety of technical support personnel. The number of technical staff members and type of activities varied depending on the level of centralization and nature of project activities. Some of the project had only one staff member beyond the project manager, while others had as many as six.

Ad Hoc and Special Committees. For four of the projects, ad hoc or special committees are formed to address various technical aspects of the projects. These committees are typically created on an as-needed basis to solve a particular problem or address a specific issue. An example of one such committee is a committee established to standardize address assignment procedures.

Cost and Financing

To determine the characteristics of each system regarding cost and financing, each participant was asked a series of questions. They included the following:

1. How much has the system cost in terms of hardware, software, database, and operational cost?
2. How was/is the system financed and what were/are the sources of revenue?
3. How was/is the cost allocated?

The following is a discussion of responses to each of the questions.

Cost. Data collected about system cost was limited and is of questionable value. The reason for this is the variability in the way costs are accounted and distributed. The cost of some systems was included in operating budgets, which also included other types of costs. As a result, it is difficult to isolate which costs are directly attributed to the GIS.

For other systems, especially those that have been in existence for many years, cost estimates are no longer available for early phases in the project. Cost data collected which may be of some value include an estimate of cost for the hardware, software, and database creation. These estimates, however, are site-dependent and vary from \$4,000,000 to \$8,000,000. In addition to these cost estimates, estimates for annual operating costs were collected. These estimates ranged from \$250,000 to \$420,000. Again, these costs are site-specific and are dependent on the level of centralization at each site.

Finance. The two basic methods for financing the systems are through an annual operating budget, or through a bond issue or some other long-term financing mechanism. Five of the nine projects use both methods for financing or funding the GIS. Four of the nine fund the GIS through annual budgets. In addition to bond proceeds, other sources of revenues include local general funds (property tax revenues), utility customers' fees, capital project (public facilities such as streets and sewers) funds, and state general funds (income and sales taxes). In-kind services was also indicated as being considered a source of revenue. In addition to these sources, the sale of products and services to other governmental and private organizations also provides some revenue for a few of the systems.

Cost Allocation. Cost allocation for a multi-organizational system is based on the concept of shared versus dedicated cost. Costs that are generally associated with the common needs of participating organizations are shared by all participants. Dedicated costs are those attributed to one or more of the participants that are not included in the shared cost. Dedicated costs are paid by the organization for which the cost is incurred. For the projects studied, allocation of shared cost is based on either a preagreed-upon percentage of the cost, or based on a measurement or estimate of system usage. Several factors were identified as being used to calculate the preagreed-upon percentage. These include service

area, customer/population base, an estimate of future usage, equal portions to each participant, and ability to pay. One or more of the factors were used in the projects studied to calculate the allocation percentages.

3. BENEFITS

As discussed in Chapter III, potential benefits, based on a review of literature, were identified in the questionnaire. Respondents were asked whether these benefits were important to their projects. If the benefit was important, each respondent was asked to rate the benefits as very important, moderately important, or slightly important. The responses are summarized in Table 7 and Figure 4. As indicated in the table and figure, nearly all the benefits were indicated as being either very important or moderately important by most respondents. The only two benefits that were not important to all respondents were improved data accuracy and eliminated duplication of data storage.

The higher rating of importance (very and moderately) were assigned to the following benefits more frequently than others: improved timeliness of data, improved data availability, and increased productivity. Eliminated duplication of data maintenance was rated as very important by more respondents than any other benefit. Cost savings was indicated as very important by fewer respondents than any other benefit. Increased productivity was rated as moderately important by more respondents than any other benefit. Eliminated duplication of data maintenance was rated as moderately important by fewer respondents.

In addition to these benefits, respondents were asked to identify other benefits of a multi-organizational GIS. The benefits identified were:

1. a common database for all participants;
2. development and implementation of data and mapping standards;

TABLE 7
BENEFIT RATINGS

	Important			Not Important
	Very	Moderately	Slightly	
Benefits				
Improved timeliness of data	4	4	1	
Improved data availability	5	4		
Improved data accuracy	4	2	2	1
Increased productivity	3	6		
Improved geoprocessing capabilities	4	3	2	
Improved mapping capabilities	3	4	2	
Eliminated duplication of data collection	5	2	2	

TABLE 7 (continued)

	Important			Not Important
	Very	Moderately	Slightly	
Eliminated duplication of data storage	4	3	1	1
Eliminated duplication of data maintenance	7		2	
Reduced difficulty in integrating data	5	2	2	
Cost savings	2	5	2	
Cost sharing	4	3	2	

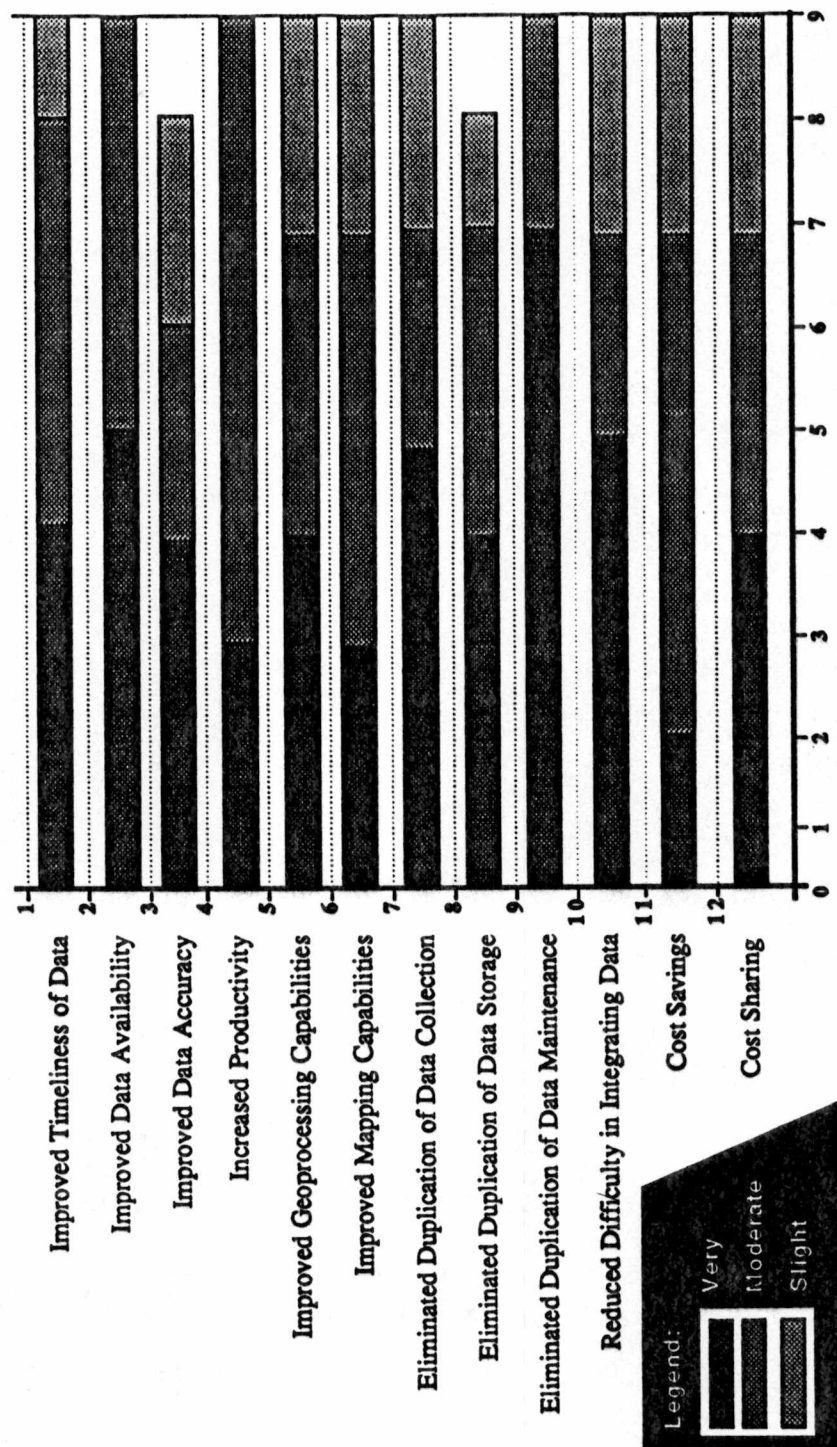


FIGURE 4
BENEFIT RATINGS

3. mechanisms for modernization of land records;
4. facilitating sharing and working together in other areas of local government; and
5. an opportunity for improving procedures and processes in local government.

Of these benefits, sharing and working together in other areas was most commonly cited as an additional benefit. Two of the respondents indicated that this was perhaps the most important benefit of their project.

4. BARRIERS

The treatment of barriers in this study is similar to the treatment of benefits. As discussed in Chapter III, potential barriers, based on a review of literature, were identified in the questionnaire. Respondents were asked whether these barriers were relevant to their projects. If the barrier was relevant, each respondent was asked to rate the barrier as very significant, moderately significant, or slightly significant. These responses are summarized in Table 8 and Figure 5.

As indicated in Table 8 and Figure 5, all of the barriers are/were relevant to at least two projects. The barriers that were relevant to the least number of projects include modifying the organizational structure and collecting allocated cost. Local constraints and financial barriers such as financing the system, allocating cost, and collecting cost were not indicated as very significant by any of the survey participants.

Conversely, the higher rating of importance (very and moderately) was assigned to the following barriers more frequently than others: maintaining support, staffing, conflicts with existing workload, and poor communications between participants. Staffing and conflicts with existing workload were indicated as very significant barriers more frequently than other barriers.

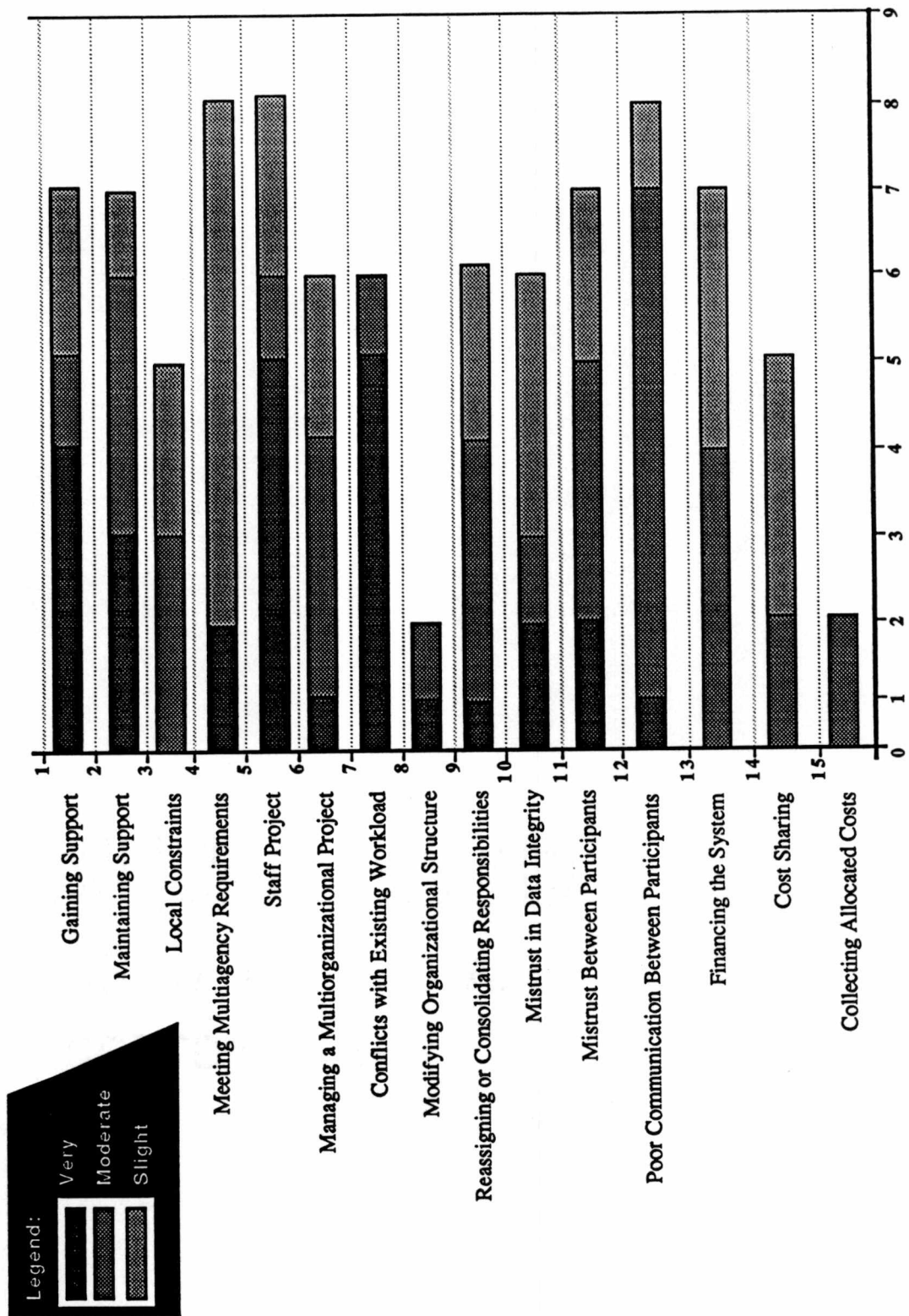
TABLE 8
SUMMARY OF BARRIERS

	Significant			Not Relevant
	Very	Moderate	Slight	
Gaining support	4	1	2	2
Maintaining support	3	3	1	2
Local constraints		3	2	4
Meeting multiagency requirements	2		6	1
Staffing project	5	1	2	1
Managing a multiorganizational project	1	3	2	3
Conflicts with existing workload	5	1		3
Modifying organizational structure	1	1		7

TABLE 8 (continued)

	Significant			Not Relevant
	Very	Moderate	Slight	
Reassigning or consolidating responsibilities	1	3	2	3
Mistrust in data integrity	2	1	3	3
Mistrust between participants	2	3	2	2
Poor communication between participants	1	6	1	1
Financing the system		4	3	2
Allocating system cost		2	3	4
Collecting allocated cost		2		7

FIGURE 5
BARRIERS RATINGS



While rating these barriers, the participants discussed some of the factors contributing to the barriers. Changes in management and elected officials was indicated as the major factor contributing to difficulty in maintaining support. Factors contributing to the staffing barrier include attracting experienced personnel for the salary offered, creating new positions, and an industry-wide shortage of experienced GIS personnel. An additional staffing related barrier is conflicts with existing workload. Factors discussed that relate to this barrier include the burden of meetings and participating in committee and user group activities.

In addition to these barriers, respondents were ask to identify other barriers encountered in their projects. The barriers identified were poor data conversion vendor performance, and the length of time required to implement a multi-organizational project.

5. RESOLUTION OF BARRIERS

To determine possible solutions to the barriers, each respondent in the survey was asked to describe how each barrier was resolved or what solutions have been or are being tried to resolve each barrier. The number of solutions generally corresponded to the severity of the barrier; that is, the more severe the barrier, the greater the number of solutions. Solutions for all barriers except two were discussed. These barriers are local constraints and collecting allocated cost. As discussed previously, these two barriers were indicated as less severe than most of the other barriers.

Of the cited solutions or mechanisms for resolving the barriers, eleven were cited for at least two of the barriers. These include:

1. promote project;
2. participation by committees and user groups;
3. support by shared staff;

4. use of an unbiased third party or consultant;
5. communication through meetings, status reports, and newsletters;
6. demonstrate value by delivering useful products;
7. define project parameters in initial phase;
8. develop and implement long and short-term plans;
9. make decisions through consensus building;
10. educate/train; and
11. establish formal agreements.

Table 9 summarizes the correspondence of these solutions to the barriers. The most frequently cited are 2, 3, 4, and 5 above. Participation by committees and user groups was cited as a solution for seven, or one half, of the barriers. The following is a description of these solutions based on the discussions with survey participants.

Participation by Committees and User Groups

This solution was used in resolving issues more frequently than any other cited. Those interviewed indicated that the committees and user groups were essential in activities such as conveying information, representing their organization in decision making, providing input into system development and operation, and promoting the system. Involvement by these groups was also indicated as necessary throughout all phases of the project. These groups should meet as frequently as necessary in a positive problem solving environment.

Support by Shared Staff

This solution was indicated for many of the same barriers as participation by committees and user groups. The role of shared staff was described as including

TABLE 9
COMMONLY CITED SOLUTIONS

SOLUTIONS	BARRIERS												
	Gaining Support	Maintaining Support	Meeting Multiagency Requirements	Staff Project	Managing a Multiorganizational Project	Conflicts with Existing Workload	Reassigning or Consolidating Responsibilities	Mistrust in Data Integrity	Mistrust between Participants	Poor Communication between Participants	Financing the System	Cost Sharing	Length of Time
Promote Project	•	•											
Participation by Committees/User Groups		•	•		•		•	•	•	•			
Support by Shared Staff		•	•		•	•				•			
Use of Third Party/Consultant	•		•						•		•	•	
Communicate through Meetings, Status Reports, Newsletters, etc.		•			•				•	•			•
Demonstrate Value/Deliverable Products		•											•
Develop and Implement Long and Short-Term Plans			•		•				•		•		
Make Decision by Consensus Building		•	•										
Educate/Train	•			•				•					
Define Project Parameters in Initial Phase			•						•		•		
Formal Agreements		•									•	•	

coordinating GIS activities, distributing information, performing shared system management and operations functions, and providing assistance to participating organizations. Those interviewed stated that it is essential that this staff is truly shared, and that any true or apparent conflict of interest be minimized or eliminated. It was further stated that this staff must serve all participants equally and fairly.

Use Third Party or Consultant

The use of an independent third party such as a consultant was cited as being used to resolve several barriers. The respondents indicated that because the analysis and recommendations were performed by an agreed-upon third party, all participants were more likely to accept the recommendations. Some respondents indicated that the recommendation to develop and implement projects from a third party was helpful in gaining support for a multi-organizational system. Other issues and conflicts between participants which were in part solved through the use of an independent third party included meeting multiagency requirements, financing the system, and allocating cost.

Communication through Meetings, Status Reports, and Newsletters

Respondents indicated that one of the keys to eliminating several barriers is to communicate frequently and effectively. One respondent stated that lack of information leads to mistrust, which leads to all manner of problems. Tools that were identified as useful in communicating with and among participants included meetings, minutes from meetings, status reports, and newsletters.

The four barriers for which none of these solutions were cited are not included in Table 9. These are local constraints, modifying the organizational structure, collecting system cost, and poor data conversion vendor performance. Solutions for these barriers and additional solutions for other barriers are provided in Figure 6.

Gaining Support

- Pre-existing relationship for multi-organizational projects
- Feasibility study included favorable benefit/cost analysis
- Evaluation and recommendations by independent third party
- Public relations and promotion activity
- Support through technical staff of participating agencies
- Initial support from the top
- Sold elected officials on technology
- Educated, promoted, and demonstrated technology potential

Maintaining Support

- Give presentations using video and other presentation materials
- Identify representatives in participating organizations to promote and support the project within
- Make participation voluntary and allow incremental growth
- Distribute some level of control to participants
- Coordinate activities
- Develop and carry out an aggressive public information program
- Promote participation by representatives in all phases of the project - committees, frequent meetings, etc.
- Make decisions through consensus
- Establish formal agreements for long-term commitments
- Demonstrate value of the system with delivery of useful products

Local Constraints - none provided

Meeting Multi-agency Requirements

- Compromise when necessary
- Meet schedules
- Identify needs early in the project
- Involve committees/representatives in all phases of the project
- Use shared staff to coordinate and support activities
- Use consultant to resolve issues and conflicts
- Make decision by consensus
- Committee/representatives assign priorities to activities
- Highest priorities are shared or common activities
- Create a database with multiple levels of resolution

FIGURE 6
SOLUTIONS FOR BARRIERS

Staffing the Project

- Create new positions early in the project
- Get support for staffing from upper management
- Train existing staff
- Minimize turnover of staff
- Support local educational institutions in establishing GIS training
- Aggressively recruit experienced personnel

Managing a Multi-organizational Project

- Identify/Establish unit to manage early in project
- Assign management to an "unbiased" unit
- Management/project staff serves all equally and fairly
- Shared staff coordinates project
- Centralize some activities with shared staff and distribute others to participants
- Conduct frequent meetings
- Develop an organizational structure to support project
- Assign and agree on project priorities
- Develop long and short-term plans
- Periodically reevaluate project

Conflicts with Existing Workload

- Meet only as frequently as necessary
- Obtain or assign sufficient staff
- Dedicate staff for managing shared and distributed activities
- Dedicate key representatives from participating organizations during development phase
- Provide as much assistance as practical from shared staff
- Identify potential staffing shortages
- Share workload among participants' personnel resources where possible

Modifying Organizational Structure - none provided

Reassigning or Consolidating Responsibilities

- Relate current activities to automated environments - show improvement
- Minimize reassignment and retain original responsibilities as much as possible
- Evolve over time
- Use contract labor for short-term or specialized activities
- Work with committees to bring about change

FIGURE 6 (continued)

Mistrust in Data Integrity

- Keep maintenance responsibility with original entity
- Build confidence in data
- Educate about concepts such as accuracy, scale, etc.
- Develop and implement standards and quality control programs
- Eliminate misconceptions about accuracy and reliability
- Use accuracy ratings and indicators
- Involve committees/users in designing and implementing database

Mistrust between Participants

- Work with committees to inform others
- Produce and distribute status reports and other forms of communication
- Create realistic expectations
- Provide strong project coordination
- Use third party to resolve problems
- Develop and agree on priorities
- Establish framework for identifying and solving conflicts
- Conduct frequent formal and informal meetings

Poor Communication between Participants

- Conduct regular meetings to convey information
- Have participants work closely in problem solving
- Produce and distribute minutes of meetings, status reports, and newsletters
- Include manager in committee and groups to support problem resolution
- Create opportunity for social interaction
- Create positive environment
- Resolve issues at appropriate level in organizations

Financing the System

- Keep level annual budget
- Use unbiased third party to develop and recommend financing scheme
- Establish funding scheme up front
- Get support from executives
- Provide estimates of annual cost for budgeting
- Provide long and short-term planning
- Incorporate funding in formal agreements

FIGURE 6 (continued)

Allocating System Cost

- Develop and get support for allocation scheme early in project
- Develop allocation that is fair, reasonable, yet practical
- Allow those not able to participate initially to "buy" in later
- Use unbiased third party to develop and recommend allocation

Collecting Allocated Cost - none provided

Poor Data Conversion Vendor Performance

- Perform very thorough evaluation of vendors
- Provide thorough definition of project scope
- Meet all contractual commitments
- Avoid low bid procurements
- Renegotiate if necessary
- Complete prototype before beginning full production of data conversion

Length of Time Required to Implement Project

- Provide interim products
- Develop in phases
- Develop and meet schedule
- Identify priorities based on common needs and desires

FIGURE 6 (continued)

CHAPTER V

SUMMARY, CONCLUSIONS, AND SUGGESTIONS FOR FURTHER STUDY

1. SUMMARY

Introduction

In response to problems confronting spatial information users, efforts to create a flexible automated data system have been under way since the mid-1960s. These efforts have resulted in the introduction and use of the GIS. Through a GIS, users can automatically retrieve, overlay, update, analyze, and display spatial data.

Improvements in GIS technology and relative decreases in the cost of computer systems have resulted in the proliferation of GISs. Although the value of a GIS is in its ability to serve multiple users and their applications, many GISs are single-user systems developed for a limited number of applications. This type of system is often inefficient in the use of valuable resources. In response to this inefficiency, multi-organizational GISs are being designed and implemented.

Designing and implementing a multi-organizational GIS requires planning and cooperation among participating entities. Often, this requires developing complex design and implementation plans which must address a wide range of topics, including hardware, software and database requirements; financing; cost allocation; and system administration and policy. Developing a plan for a multi-organizational GIS requires knowledge not typically found among municipal employees.

The purpose of this thesis is to develop a framework for understanding issues in designing, implementing, and operating a multi-organizational GIS. The methodology used is descriptive in nature and includes a literature review and survey of nine multi-organizational systems.

GIS Definition and Concepts

A GIS consists primarily of three components: hardware, software, and a database. The hardware and software components of a GIS are typically purchased as a "turnkey system". A turnkey system is a complete package of hardware devices and software designed and integrated by a system vendor to operate as a functional unit. GIS hardware typically includes a central processing unit, magnetic tape and disk memory, graphic workstations, digitizers, printers, plotters, and data communications equipment. The software required for a GIS includes system software, the operating system, and programs for graphic processing, database management, data input and editing, and applications.

The third component of a GIS is the database. The database frequently consists of a large quantity of geocoded data collected from sources such as aerial photography, parcel maps, zoning maps, engineering maps, census records, and many other sources. The two kinds of data in a GIS database are geographic data and attribute data. Geographic data may describe point locations, area boundaries, and linear features, or they may express relationships of connectivity and adjacency. Attribute data can be simply defined as data that provide qualitative and quantitative descriptions of an entity.

In a GIS database, each type of feature, such as a parcel or water line, is assigned a code which defines its type. Any combination of features that have been separated by layer or type code may be used at any time. In general, the hierarchy of layers begins with geodetic and survey control, which will be the most accurate points used as the basic reference structure for the database. Next, planimetric features may be digitized using aerial photography and tied to control locations. Beyond the planimetric features, parcel boundaries, utility lines, zoning, and other layers may be added.

Multi-organizational GIS

A multi-organizational GIS is one which has multiple users all having access to a common database which has been designed to meet the needs of the users and to eliminate redundant data. A key component of a multi-organizational GIS is the common database. The concept of a municipal data model has become the foundation for multi-user or integrated GISs. It is this model, along with the associated applications and benefits, that has been the impetus for multi-organizational GISs.

A GIS contains a powerful selection of capabilities to support many day-to-day and special operations of urban spatial data users. Applications performed using these capabilities as identified in a review of literature included development tracking, subdivision review, map update, routing/scheduling, and zoning review.

To fully understand the utility of an integrated GIS, benefits to be derived from such a system should be examined. The following is a discussion of some of the commonly described benefits as they relate to a multi-organizational system. These include improved accuracy, increased productivity, better services, and cost sharing.

Given the benefits of a multi-organizational GIS, why is integration so difficult? A review of literature identified barriers to integration as gaining and maintaining political support, meeting multi-organizational requirements, changing functions/activities of participants, and cost sharing and allocation.

Survey of Multi-organizational GISs

Due to the limited amount of information available about multi-organizational systems, a survey of select systems was performed. The purpose of the survey was to collect data about characteristics, benefits, barriers, and resolution of barriers. Potential study systems were identified through interviews, review of literature, and surveys that

identified GIS installations. Nine systems were identified and representatives were contacted. Each of the representatives agreed to participate.

Background information was requested from each representative and used for determining characteristics of each system. Each representative also participated in an in-depth telephone interview. The interviews included verification of information collected from other sources, a description of additional characteristics, benefits, barriers, and solutions to barriers.

2. CONCLUSIONS AND RECOMMENDATIONS

The following is a discussion of conclusions and recommendations based on information obtained in the survey. The intent of this discussion, along with the information presented previously, is to serve as a framework for developing and implementing a multi-organizational GIS. The conclusions are organized into several topic areas including: 1) project initiation; 2) participating organizations; 3) organizational structure; 4) shared staff; 5) database and applications; 6) financing and cost allocation; 7) benefits; 8) barriers and solutions; and 9) maintaining support and cooperation. A summary of these recommendations is provided in Figure 7.

Project Initiation

Several crucial activities take place during project initiation. One is obtaining support for the project, and the other is defining the parameters from the project. Support for the project should come from all participating organizations and at all levels within these organizations. Parameters, as used here, refers to aspects of the project such as participating agencies, hardware, software and database requirements, organizational structure, and cost allocation. Two commonly used mechanisms for accomplishing these

1. Gain support for the project throughout the organizations involved, especially at the executive level.
2. Conduct study to define project parameters.
3. Optimize planning and cooperation to design and implement system.
4. Include among participants, at a minimum, city and county government departments of planning, public works, and property appraisal/assessment.
5. Establish an organizational structure that includes, at a minimum, a lead/administrative agency, policy committee, technical committee or group, and shared staff.
6. Staff the project with personnel to service the shared system function.
7. Provide fair and equal treatment of all participants by shared staff. Aggressively recruit experienced GIS personnel and train existing personnel.
8. Develop the database and applications based on the activities of participating organizations.
9. Establish a cost allocation scheme that is equitable and agreed to by
10. Remember that benefits include those that are direct and those that are indirect such as improved relations and cooperation.
11. Identify barriers and apply solutions.
12. Promote project through education and communication.
13. Promote cooperation through communication and organization.

FIGURE 7

**RECOMMENDATIONS FOR A
MULTI-ORGANIZATIONAL GIS**

two activities are the forming of a multi-organizational committee or group and conducting a study to define project parameters.

Participating Organizations

Participating organizations in a shared system should include city and county governments. Specific departments from city and county governments should include, at a minimum, planning, public works, and property appraisal/assessment. Other participants may include, among others, regional planning, water and wastewater, gas, and electric utilities. In the initial phase of the project, these organizations should be approached and invited to participate in a shared GIS.

Organization Structure

To create an organizational structure for support, a multi-organizational project, the existing structure should be modified or enhanced. These modifications include designation of a lead agency and formation of committees. The committees should be established to perform specific functions and may include the following: policy committee, technical committee, user group, and shared staff. It may also be necessary to form ad hoc committees to address some very specific issues.

Shared Staff

One of the key elements of a multi-organizational GIS is shared staff. This core group of individuals should have as their ultimate responsibility the success of the project. Because of the need to coordinate and offer support to the participating agencies, the shared staff must serve all equally and fairly.

Database and Applications

Database components and applications components should be a function of the activities carried out by the participating organizations. Database components for a multi-organizational project will likely include: 1) administrative district boundaries; 2) geodetic control; 3) land use; 4) land parcels or property; 5) maintenance/service districts; and 6) street/road centerlines. Other database components should be identified through study activities by participating agencies. The list of database layers presented previously in Chapter 4 can be used as a reference in performing this activity. Applications in a multi-organizational environment are likely to include these related to land use planning, property mapping and appraisal, and facilities management. Again, applications should be a function of the activities performed and priorities of the organizations involved.

Financing and Cost Allocation

Two basic methods of financing a multi-organizational system are annual operating budgets and bond issue or some other long-term financing mechanism. Depending on the local financial environment and resources, one or both of these methods can be used. Another important financial aspect of a multi-organizational system is cost allocation. Cost allocation is based on the concept of a shared and dedicated cost. Regardless of how the cost is allocated, the scheme must be worked out in advance and be acceptable to all participants.

Benefits

There are many benefits of a multi-organizational GIS. However, some of the most significant are improved timeliness of data, improved data availability, and increased productivity. In addition to these direct benefits, there are also indirect benefits to be

derived from a multi-organizational system. One such benefit is improved relations and cooperation between participants.

Barriers and Solutions

Conversely, there are also barriers to a shared system. Some of the most significant barriers are maintaining support, staffing, conflicts with existing work load, and poor communication between participants. Fortunately, there are also solutions to these barriers.

The most commonly used solutions are:

1. participation by committees and user groups;
2. support by shared staff;
3. use of an unbiased third party or consultant; and
4. communication through meetings, status reports, and newsletters.

Maintaining Support and Cooperation

Once initial support is obtained, those involved must continue to promote the project. Two of the tools for maintaining this support are communication and education. Communication is also a tool for maintaining cooperation. Effective organization should also be used to promote cooperation.

3. SUGGESTIONS FOR FURTHER STUDY

While the author believes that the research presented here contributes to filling the void of objective, independent research, there are many areas relating to a multi-organization GIS that require further study. Suggestions for further study include:

1. a model for defining applications, database components, and hardware and software capabilities based on local government activities;

2. techniques for effective communications between participants in a multi-organizational project;
3. application of problem solving and consensus building techniques in the multi-organizational environment;
4. guideline for an organizational structure that meet goals without creating a burden on personnel resources;
5. ways to increase the trained GIS labor force;
6. quantifying or determining the cost savings associated with multi-organizational GISs;
7. cost associated with a multi-organizational GIS;
8. techniques for cost allocation;
9. life cycle of multi-organizational GISs and the relationship of the duration of the project to aspects of the project including activities, benefits, and barriers; and
10. study of additional multi-organizational systems.

Because of the complexity of defining multi-organizational GISs requirements, there is a need for a mechanism to facilitate the task. The author suggests that a model for defining applications, database components, and hardware and software capabilities based on local government activities can serve this function. The model should be based on empirical research on the relationship between the activities of existing sites and their applications, database components, and hardware and software capabilities.

Effective communications is one of the keys to resolving many of the barriers to a multi-organizational GIS. It is recommended the research be conducted into the application of traditional techniques for effective communications in a multi-organizational GIS environment.

Similar to the suggestion for further research on effective communications, there is a need for research in the application of problem solving and consensus building techniques in the multi-organizational environment.

Guidelines for an organizational structure have been provided in this thesis based on the structure of the study systems. However, many of those interviewed indicated that this structure is somewhat of a burden on personnel resources. Research should be conducted to determine the nature and extent of the burden and recommendations for meeting objectives without creating or minimizing the burden on resources.

One of the barriers which is unresolved for several of the study systems is staffing. To some extent, this problem is due to the shortage in the GIS labor force. There is a need for an investigation of this shortage and ways to increase the trained GIS labor force.

While many benefits for a multi-organizational GIS are presented in the thesis, there is a need quantifying or determining the cost savings associated with these benefits. Because justification of implementing a system is often dependent on whether or not the system is cost-effective, it is very important to identify cost saving that can be achieved in a multi-organizational environment.

Conversely, a thorough study of cost associated with GIS development and implementation is recommended. Data collected about system cost was limited and of questionable value. The reasons for this are the variability in the way costs are accounted and distributed. As a result, it is difficult to isolate which cost are directly attributed to the GIS.

An essential aspect of any multi-organizational project is the fair and equitable allocation of cost. Because of the importance of this aspect, research on alternative techniques for cost allocation is needed. In addition to providing information to those

developing a cost allocation approach, this research would also lend credibility to the the approach and potential make the process of getting approval by participants easier.

While the research presented here described the activities involved in designing and implementing a system, it does not necessarily describe at what point these activities take place or when specific issues should be addressed. Research is needed to describe the life cycle of multi-organizational GISs and the relationship of the duration of the project to aspects of the project including activities, benefits, and barriers. By identifying not only what to expect but when to expect it, those designing and implementing a multi-organizational systems can improve planning needed to achieve a successful project.

In addition to these recommendations for further study, additional research, similar to that presented in this thesis, should be conducted using other multi-organizational systems. A great deal of valuable information was obtained through this study and it stands to reason that study of additional multi-organizational systems will provide additional information of equal value. By studying the experiences of those that have or are implementing a multi-organizational system, the void of available information needed to implement a multi-organizational system can be filled.

GLOSSARY OF TERMS

GLOSSARY OF TERMS

Attribute Data: Data that provide qualitative or quantitative descriptions of an entity (e.g., population, number of housing units, assessed property value, and number of traffic accidents).

Central Processing Unit (CPU): That part of a computer that does the actual computing.

Database Management System: Software that edits, sorts, and routes data, both within data storage and to and from peripheral devices and the central processing unit.

Digitizing: Conversion of manual map products into a computer readable or digital format.

Disk Memory: A peripheral device with rotating circular magnetic plates for storing data.

Geocoding: Assignment of a set of x and y grid coordinates to a data value based on the location the data represent.

Geographic Data: Data that describe point locations, area boundaries or linear features, or data that express relationships of connectivity and adjacency.

Geographic Information System (GIS): An automated geoprocessing system that allows the users to automatically retrieve, overlay, update, analyze, and display spatial and non-spatial data.

Graphic Display Screen: A cathode ray tube (CRT) or display screen that is designed so that individual pixels (small units of a screen) can be addressed.

Graphic Software: Programs that convert data for graphic presentation.

Light Pen: A photosensor that detects the exact time at which an electron beam of the CRT passes the location on the screen pointed to by the operator.

Magnetic Tape Memory: A long, thin magnetically coated storage medium, usually wound on a reel.

Metrical or Geometrical Data: Data that are measurements of the length, distance, area, direction, altitude, or coordinate of a geographic entity (e.g., a street length, area of a parcel, compass points, slope, and latitude/longitude).

Multi-organization Geographic Information System: A GIS that has multiple users all having access to a database which has been consolidated to eliminate redundant data. Multiple users refers to users such as departments within a municipality, municipalities within a metro area, a city or cities, and a county, and so on. This term does not apply to individual users within a single department or a single public or private agency.

Nominal Geographic Data: Data that name geographic entities (e.g., a parcel number or a street address).

Operating System: Controls all processing, user access, file security, system accounting, etc.

Peripheral Devices: Devices for data entry and display that are subordinate to the computer's central processing unit.

Plotter: A device to produce maps and graphics on paper or film.

Topological Data: Geographic data that express relationships of connectivity (e.g., node number or code that identifies where one street segment connects to another).

BIBLIOGRAPHY

BIBLIOGRAPHY

- Antenucci, J. and Kevany, M. and Wingrove, A. (1985). Knoxville-Knox County Assessment of Geographical System Needs: Analysis and Recommendations for a Geographical Information System-Final Report. Unpublished manuscript.
- Antenucci, J. and Croswell, P. and Kevany, M. and Metcalf, A. (1986). Louisville/Jefferson County Community Mapping and Data Management System Feasibility Study - Final Report. Unpublished manuscript.
- Bates, C. Telephone interview, January 13, 1989. (Project Manager, Common Mapping Project, Eugene/Lane County, Oregon).
- Bates, C. Telephone interview, January 31, 1989. (Project Manager, Common Mapping Project, Eugene/Lane County, Oregon).
- Bayer, F. (1982). Computing in the City of Milwaukee: The Data-based Geographical information System. Computers, Environment and Urban Systems, 7, (1/2) 83-88.
- Brelsford, K. Telephone interview, January 16, 1989. (Project Manager, Automated Information Management System, Johnson County, Kansas).
- Brelsford, K. Telephone interview, January 25, 1989. (Project Manager, Automated Information Management System, Johnson County, Kansas).
- Carson, L.M. Telephone interview, February 18, 1985. (Kansas Applied Remote Sensing KARS Program, University of Kansas).
- Chargois, Y. (1984). City of Houston Metro System Special Study. Unpublished manuscript.
- Cooke, D.F. (1980). A Review of Geoprocessing Systems and a Look at Their Future. Computers in Local Government: Urban and Regional Planning. Pennsauken, NJ: Auerback.
- Crews, T. Telephone interview, January 18, 1989. (Acting Project Coordinator, Management and Planning System, Wilmington/New Hanover County, North Carolina).
- Crews, T. Telephone interview, January 30, 1989. (Acting Project Coordinator, Management and Planning System, Wilmington/New Hanover County, North Carolina).
- Dangermond, J. and Freedman, C. (n.d.). Findings Regarding a Conceptual Model of a Municipal Data Base and Implications for Software Design. Unpublished manuscript.
- Dutton, W.H. (1982). Eight Thousand Information Systems: The Utilization of Computing in American Local Governments. Computers, Environment and Urban Systems, 7, (1/2) 21-23.

- Gilbert, A.L. (1982). Data Sharing As Politics: Policy, Tools, and Access. Papers from the Annual Conference of the Urban and Regional Information Systems Association: Practical Applications of Computers in Government. Washington, D.C.: Urban and Regional Information Systems Association.
- Gschwind, R.A. and Allen K. and Huxhold, W.E. (1982). Creating Magic - An Evaluation in Retrospect of the Milwaukee Automated Geographic Information and Cartographic System. Papers from the Annual Conference of the Urban and Regional Information System Association: Practical Application of Computers in Government. Washington, D.C.: Urban and Regional Information Systems Association.
- Henry, B. Telephone interview, January 13, 1989. (Project Manager, Ultimap, Minneapolis/Hennepin County, Minnesota).
- Henry, B. Telephone interview, January 13, 1989. (Project Manager, Ultimap, Minneapolis/Hennepin County, Minnesota).
- Herring, J.C. (1985). Comprehensive Digital Mapping in Local Government. The Experience. Unpublished manuscript.
- Herring, J.C. Telephone interview, June 25, 1985. (Director, Geographic Land and Data Systems, Salem/Marion County, Oregon).
- Herring, J.C. Telephone interview, January 13, 1989. (Director, Geographic Land and Data Systems, Salem/Marion County, Oregon).
- Herring, J.C. Telephone interview, January 27, 1989. (Director, Geographic Land and Data Systems, Salem/Marion County, Oregon).
- Holtzheimer, P.E. (1983). An Introduction to the GBF/Dime: A Primer. Computers, Environment and Urban Systems, 8, (3), 134-173.
- Huxhold, W.E. (1980). Planning Agencies and the Data Processing Department: Working Together Effectively. Computers in Local Government: Urban and Regional Planning. Pennsauken, NJ: Auerback Publishers.
- International Business Machines (n.d.). Geographic Data Systems Aids Land Use Planning: Eugene, Oregon. Unpublished manuscript.
- Kjerne, D. and Dueker, K.J. (1984). Two Approaches to Building the Base Map for a Computer-Aided Land Records System. Papers of the Annual Conference of the Urban and Regional Information Systems Association. Washington, D.C.: Urban and Regional Information Systems Association.
- Lam, A. (1984). Geographic Information Systems (GIS) and Spatial Analysis in Microcomputers. Papers from the 1984 Annual Conference of the Urban and Regional Information Systems Association: The Changing Role of Computers in Public Agencies. Washington D.C.: Urban and Regional Information Systems Association.
- Lane Council of Governments (1984). LCOG: An Overview of the Lane Council of Governments. Eugene, Oregon: Author.

- Latimer, Stanley S. and Paul D. Zwick Ph.D. (1988). Staffing and Managing a Geographic Information System Project for Local Government: Experiences of the GEOMAX Project. Papers from the Annual Conference of the Urban and Regional Information Systems Association- Volume II Geographic Information Systems. Washington, D.C.: Urban and Regional Information Systems Association.
- Lawrence, J. Telephone interview, July 3, 1985. (Mapping Supervisor, Central Mapping Agency, Toronto, Ontario, Canada).
- Liley, R.W. (1985). Integration--The Big Payoff for Geobased Municipal Systems. Papers from the annual conference of the Urban and Regional Information Systems Association. Washington, D.C.: Urban and Regional Information Systems Association.
- Liley, R.W. Telephone interview, July 3, 1985. (President, Robert Liley and Associates, Consultants to Corporation of Burnaby, British Columbia, Canada).
- Lutz, J. Telephone interview, April 18, 1985. (GIS Technical Committee, Knoxville/Knox County, Tennessee).
- Lutz, J. Telephone interview, January 19, 1989. (GIS Technical Committee, Knoxville/Knox County, Tennessee).
- Lutz, J. Telephone interview, January 30, 1989. (GIS Technical Committee, Knoxville/Knox County, Tennessee).
- Madziya, R.G. Telephone interview, January 25, 1985. (Director, Department of Planning and Development, Oshawa, Ontario, Canada).
- Mahan, S. and Spivac, G. and Robert, S. (1978, November). Plotting Land Use in Oregon. Datamation.
- Manchester, M. Telephone interview, January 22, 1985. (School of Engineering and Computer Science, Research and Services, California State University, Northridge).
- Mast, D. Telephone interview, January 16, 1989. (Project Manager, Mapping and Geographic Information Consortium, Nashville/Davidson County, Tennessee).
- Mast, D. Telephone interview, February 6, 1989. (Project Manager, Mapping and Geographic Information Consortium, Nashville/Davidson County, Tennessee).
- Metropolitan Toronto, Central Mapping Agency (1985a). Digital Mapping Specifications for the Map Based Information System. Unpublished manuscript.
- Metropolitan Toronto, Central Mapping Agency (1985b). Data Capture for Digital Base Mapping in the Municipality of Metropolitan Toronto. Unpublished manuscript.
- Metropolitan Toronto, Central Mapping Agency (1985c). Data Transfer for Digital Base Mapping in the Municipality of Metropolitan Toronto, unpublished manuscript.

- Monmonier, M.S. (1982). Computer-Assisted Cartography: Principals and Prospects. Englewood Cliffs, NJ: Prentice-Hall, Inc.
- Montgomery, G. Telephone interview, May 21, 1985. (Principal Consultant, Utility Graphics Consultant, Littleton, Colorado).
- Montgomery, G.E. (1987). Multiparticipant Projects: Achieving Consensus on Technical and Funding Cost Allocation Issues. Papers From the Annual Conference of the Urban and Regional Information Systems Association- Volume IV Demographic, Economic and Additudinal Analysis/Public Information/Regional Agencies/Transportation/Public Works-Utilities/Facilities Management and Mapping. Washington, D.C.: Urban and Regional Information Systems Association.
- Peuquet, D.J. and O'Callaghan, J.O. (Eds.) (1983). The Design and Implementation of Computer-based Geographic Information Systems, Amherst, NY: International Geographical Union Commission on Geographical Data Sensing and Processing.
- Phillips, D.L. Telephone interview, January 22, 1985. (Professor, Urban and Environmental Planning, The University of Virginia, Charlottesville).
- PlanGraphics, Inc. (1988). [GIS Installation Survey]. Unpublished raw data.
- Reece, A. Telephone interview, May 17, 1985. (GIS Technical Committee Knoxville/ Knox County, Tennessee).
- Rodammer, F.A. and Peters, C.T. and Phillips, D.L. (1984). Guidelines to Assist Administrators of Local Governments with the Development and Implementation of Geographic Based Urban Information Systems. Unpublished manuscript.
- Rosenberg, J.M. (1984). Dictionary of Computers. Data Processing and Telecommunications. New York, NY: John Wiley and Sons.
- Seigle, B. Telephone interview, January 13, 1989. (Project Manager, Community Mapping and Data Management System, Louisville/Jefferson County, Kentucky).
- Seigle, B. Telephone interview, January 27, 1989. (Project Manager, Community Mapping and Data Management System, Louisville/Jefferson County, Kentucky).
- Smith, R.A. (1983). A Computer System for a Municipal Mapping Agency. Unpublished manuscript.
- Smith, R.A. (1984). Metropolitan Toronto Municipal Atlas Program. Unpublished manuscript.
- Smith, R.A. (1985). Overview of Municipal Atlas Program Map. Unpublished manuscript.
- Smith R.A. Telephone interview, June 28, 1985. (Director, Central Mapping Agency, Toronto, Ontario, Canada).

- Smith, R.A. Telephone interview, January 13, 1989. (Director, Central Mapping Agency, Toronto, Ontario, Canada).
- Smith, R.A. Telephone interview, January 26, 1989. (Director, Central Mapping Agency, Toronto, Ontario, Canada).
- Smith, Ralph A. (1987). Are Metro Toronto's Clients Satisfied Using A Corporate LIS Network and End-User Computing. Unpublished manuscript.
- Smith, Ralph A. (1985). Metroloplitan Toronto Municipal Atlas Program. Papers From the Keystone VII Automated Mapping/Facilities Management International.
- Somers, R.M. (1984). Calgary's Computer Mapping and Geoprocessing Project: System Development and Evaluation. Papers from the 1984 Annual Conference of the Urban and Regional Information Systems Association: The Changing Role of Computers in Public Agencies. Washington, D.C.: Urban and Regional Information Systems Association.
- Somers, R.M. Telephone interview, July 3, 1985. (Director, Computer Assisted Mapping, Calgary, Canada).
- Swank, R.J. (1982). Data Sharing through Ad-lib: An Organizational Model. Papers from the Annual Conference of the Urban and Regional Information Systems Association: Practical Applications of Computers in Government. Washington, D.C.: Urban and Regional Information Systems Association.
- Swank, R. (1983). Lane County Geographic Data System. Unpublished manuscript.
- Swank, R. Telephone interview, June 28, 1985. (Director, Geographic Data System, Eugene, Oregon).
- Thompson, D. Telephone interview, July 3, 1985. (Assistant Director, Metrocom, Houston, Texas).
- University of Kansas, Space Technology Center. A Survey of Geographic Information Systems for Local Governments. Pamphlet.
- Urban and Regional Information Systems Association (n.d.). [URISA/SIG-GEO Interactive Computer Graphics Survey of Public Agencies]. Unpublished raw data.
- Wilson, P.M. (n.d.a.). Computer Mapping in Local/Regional Environmental Assessment. Unpublished manuscript.
- Wilson, P.M. (n.d.b.). Integration of Local and Regional Data Bases. Unpublished manuscript.
- Wilson, P.M. (1984). Multiple Purpose Geographic Information System. Papers from the 1984 Annual Conference of the Urban and Regional Information System Association: The Changing Role of Computers in Public Agencies. Washington, D.C.: Urban and Regional Information Systems Association.

- Wilson, P.M. Telephone interview, January, 1985. (Geogroup, Consultant to Bay Area Spatial Information System, San Francisco, California).
- Wolff, R.F. (1981, March). Facilities Management in Computer Graphics. Electrical World, pp. 51-66.

APPENDICES

APPENDIX A
REQUEST FOR STUDY PARTICIPATION SCRIPT

APPENDIX A

Hello, this is Annie Metcalf. I am a graduate student at the University of Tennessee and I am conducting research for a thesis on multi-organizational GIS installations. My research involved collecting information about multi-organizational sites and I would like to discuss the possibility of using your installation as one of these sites.

My thesis focuses more on non-technical topics, such as who is involved, how did the multi-organizational GIS develop, what are the benefits, and what are the barriers?

In terms of what would be required of you, if you choose to participate, I will first send a letter outlining the topics for discussion. I will also send you a profile of the information I have already collected about your site. Subsequently, I will send you a series of questions I will be asking you in a telephone interview. You will be asked to verify the information in the profile and prepare and participate in a telephone interview of approximately two to two and a half hours in length.

APPENDIX B
SAMPLE PROJECT PROFILE AND TRANSMITTAL LETTER

January 11, 1989

Ken Brelsford
Johnson County
110 South Cherry
Olathe, KS 66061

Dear Mr. Brelsford:

As we discussed in our telephone conversation, I am conducting research for my thesis about multiorganizational geographic information systems. I am very pleased that you have agreed to participate in my survey of nine multiorganizational sites. I will do everything I can to minimize the amount of time required of you.

Attached is a list of topic areas to be covered in the interviews. For each of these topics, I will ask a series of questions. The estimated duration of the interview will be about one to one and a half hours.

Note that the General Characteristics item references an attached profile. This information was collected from a variety of sources, including a survey of GIS and AM/FM installations conducted by PlanGraphics, Inc., late last year. During our interview, I will ask you to validate or correct the information provided.

As we discussed in our telephone conversation, any background information you can provide prior to our interview would be very helpful. Of particular interest are a history of the system's evolution, profile or description of participating agencies, and background on any of the topic areas listed in the attachment.

I will contact you next week to arrange an interview date and time. Again, I would like to express my gratitude for your cooperation. I look forward to working with you. Please call me if you have any questions at (502) 233-1501 from 9:00 am - 5:00 pm EST or at (502) 875-2781 after 6:00 pm EST.

Sincerely,

Annie Metcalf

AM/js

Attachments

TOPIC AREAS

General Characteristics: Participating Agencies, Hardware/Software, Database Layers, Applications and System Status (See attached profile.)

Events Leading to a Multiorganizational System¹

Definition of Requirements, System Design, and Implementation

Finance and Cost Allocation

Organizational and Management Structure

Benefits of a Multiorganizational Approach for Your System

Resolution of Issues and Barriers in Defining Requirements, Designing and Implementing the System

¹System as used here refers to hardware, software, database, organizational structure, and staff.

PROJECT PROFILE

Project Name: Automated Information and Management System (AIMS)

Project Location: Johnson County, Kansas

Contact: Ken Brelsford

Year Project Began: 1985

Participating Agencies/Users: Johnson County Departments of Planning, County Clerk, Public Works, Appraisal, and Wastewater Utility

Lead Agency: Johnson County

Implementation Status: Partially Operational

Hardware Platform: Prime (Mainframe)

GIS Software: ESRI ARC/INFO

Database Layers:

Current: Administrative District Boundaries
Digital Elevation Model
Geodetic Control
Land Cover
Land Parcel (Property)
Planimetric Base
Political Boundaries
Soils
Street/Road/Railroad Centerline

Planned: Land Use
Maintenance/Service Districts
Sanitary Sewer Facilities
Transit Routes
Zoning

Applications:

Current: Planimetric Map Production
Soils Map Production
Property Map Production
Tax Neighborhood Analysis
Support for Field Appraisal
Special Property Map Generation and Analysis
Ownership Searches/Query

Applications (continued):

Planned: Zoning Map Production
Land Use Map Production
Special Thematic Map Production
Support for Comprehensive Planning
Rezoning Evaluation
Special Demographic Analysis
Permit/Development Tracking
Redistricting
Engineering Design/Drafting
Pavement Management
Sign/Street Light Inventory/Mapping
Subdivision Plat/Site Plan Review
Work Order Management
Road Maintenance History Tracking
Traffic Volume/Accident Analysis
Transportation Modeling
Route Analysis
Drainage Analysis
Building Inspection Support
Wastewater Facilities Map Generation/Update
Network Tracking
Pressure Analysis
Flow Modeling
Wastewater Facilities Inspection/Maintenance
Infiltration/Inflow Analysis
Treatment Facility Control
Load Forecasting
Engineering Analysis
Dispatch/Routing Analysis

APPENDIX C
SURVEY FORM

APPENDIX C SURVEY FORM

Project Name/Code _____

Date/Time _____

Interviewee _____

QUESTIONS FOR TELEPHONE INTERVIEW

1. CHARACTERISTICS

General

1.1 Is the information in the Project Profile correct?

1.2 If not, please indicate corrections and/or modifications.

Organizational

1.3 What department or divisions of the participating agencies are involved in the project?

1.4 Describe the major events leading to a multi-organizational project.

Organizational (continued)

- 1.5 Describe the organizational structure under which the system functions in terms of roles and responsibilities.

Overview: Lead Agency _____ Committees _____
 Project Staff _____

- 1.6 How are technical, financial, administrative, and policy decisions made, and who makes and/or approves these decisions?

HOW

WHO

- 1.7 How are the "shared functions" of the system staffed and managed (if not answered above)?

Staffed

Managed

Project Code _____

Financial

1.8 How much is the system estimated to cost? \$ _____

1.9 What is included in this cost estimate?

_____	Hardware/Software	Other: _____	_____
_____	Database	_____	_____
_____	Maintenance	_____	_____
_____	Operation	_____	_____

1.10 How is the system financed (revenue source or sources)?

Bonds _____ Operating Revenues _____

Sell of Products and Services _____

Other: _____

Comments:

1.11 How is the system cost allocated to participating agencies?

2 . BENEFITS**2.1 Which of the following are benefits of your system?**

Yes	Important (Very, Moderately, Slightly)	
_____	_____	Improved timeliness of data
_____	_____	Improved data availability
_____	_____	Improved data accuracy
_____	_____	Increased productivity
_____	_____	Improved geoprocessing capabilities
_____	_____	Improved mapping capabilities
_____	_____	Eliminated duplication of data collection
_____	_____	Eliminated duplication of data storage
_____	_____	Eliminated duplication of data maintenance
_____	_____	Reduced difficulty in integrating data
_____	_____	Cost savings
_____	_____	Cost sharing

Comments:

2.2 Can you identify other benefits?

_____	_____
_____	_____
_____	_____
_____	_____

Comments:

2.3 Of your system's benefits, which are very important, moderately important, or slightly important?

3. BARRIERS**3.1 Which of the following barriers are or were relevant to your system?**

Relevant	Significant (Very, Moderate, Slight)	
_____	_____	B1 Gaining support for the project
_____	_____	B2 Maintaining support for the project
_____	_____	B3 Local constraints on multi-organizational projects
		Legal Policy Political Procedural
_____	_____	B4 Meeting multi-agency requirements
		Database Design/Implementation Application Design/Implementation Hardware/Software Capability Scheduling
_____	_____	B5 Staffing project with experienced personnel
		Attracting Training Existing Turnover Overall Shortage
_____	_____	B6 Managing a multi-organizational project
_____	_____	B7 Conflicts with existing workload
_____	_____	B8 Modifying organizational structure
_____	_____	B9 Reassigning or consolidating responsibilities
_____	_____	B10 Mistrust in data integrity
_____	_____	B11 Mistrust between participants
_____	_____	B12 Poor communication between participants
_____	_____	B13 Financing the system
_____	_____	B14 Allocating system cost
_____	_____	B15 Collecting allocated cost

Project Code _____

3. BARRIERS (continued)

3.5 Describe how each was resolved.

Barrier Number _____

Description:

Barrier Number _____

Description:

3. BARRIERS (continued)

3.6 For the remaining barriers/issues, what solutions have been or are being tried?

Barrier Number _____

Comments:

Barrier Number _____

Comments:

VITA

Anna L. Metcalf was born in Bardstown, Kentucky, on May 9, 1960. She attended elementary schools in New Haven, Kentucky, and was graduated from Nelson County High School in June 1978. Later that month, she entered Western Kentucky University. Ms. Metcalf received a Bachelor of Science in Geography in December 1982.

After completing a nine month internship with the Green River Area Development District, she entered the Graduate School of Planning of the University of Tennessee, Knoxville, in September 1983. She accepted a Graduate Assistantship for one year with the Graduate School of Planning and an Assistantship with the University of Tennessee Transportation Research Center for one year.

Ms. Metcalf accepted a position with PlanGraphics, Inc., a Frankfort, Kentucky, Geographic Information System consultant. She received the degree of Master of Science in Planning in May 1989.