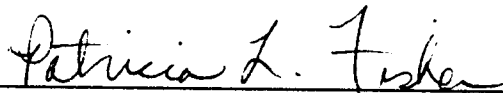


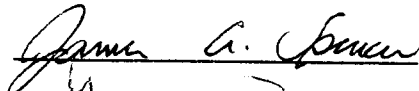
To the Graduate Council:

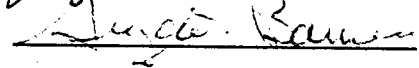
I am submitting herewith a thesis written by Muiruri K. Muchane entitled "Implementing A Geographic Information System: Guidelines For Local Governments." I have examined the final copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science in Planning.



Patricia L. Fisher, Major Professor

We have read this thesis
and recommend its acceptance





Accepted for the Council:



Vice Provost
and the Dean of The Graduate School

**Implementing A Geographic Information System:
Guidelines for Local Governments**

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

**Muiruri K. Muchane
December, 1990.**

This thesis is dedicated
to my parents,
Kagwe and Ruth Muchane,
for their never ending support,
encouragement and love.

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TABLE OF CONTENTS

CHAPTER	PAGE
I. INTRODUCTION	
Overview	1
Information Systems and Local Government Systems	2
Information Management Problems	6
Information Management	9
Problem Statement	10
Purpose	12
Organization of Thesis	12
II. OVERVIEW OF SPATIALLY CAPABLE SYSTEMS	
Automated Mapping/Computer Assisted Mapping (AM/CAM)	14
Computer Aided Drafting and Design (CADD)	16
Land Information System (LIS)	17
Geoprocessing	18
Geographic Information Systems/Automated Mapping-Facilities Management (GIS/AM-FM)	19
Database	24
Applications	26
III. RESEARCH METHODOLOGY	
Case Studies	35
Interviews	37
Limitations	37
IV ANALYSIS AND EVALUATION OF FINDINGS	
Introduction	39
Knoxville/Knox County/Knoxville Utility Board (KGIS)	39
Johnson City Geographic Information System	41
Eight Points For Consideration In GIS Implementation	41
V SUMMARY AND CONCLUSIONS	
Summary	72
GIS Definition	75
Database	76
Conclusions	77
Suggestions For Further Research	80
BIBLIOGRAPHY	82
APPENDICES	
A. SITE PROFILES	89
B. INTERVIEW FORM	91
VITA	102

LIST OF TABLES

TABLE		PAGE
1.	Typical Local Government GIS Data/Feature Layers	33
2.	Departmental Meetings To Determine Needs	42
3.	Detailed Database	43
4.	Johnson City GIS Database	56

LIST OF FIGURES

FIGURES	PAGE
1. Thematic Mapping Using Atlas Mapmaker	15
2. Plot Plan Using CADD	16
3. GIS Components	21
4. Information Integration	27
5. Layers of Geographic Information	28
6. KGIS Organizational Structure	64
7. KGIS System Configuration	65
8. Johnson City System Configuration	66

CHAPTER I

INTRODUCTION

Overview

In the past two decades, local governments have undergone significant changes in the use of the computer as a tool for the storage and analysis of information. Since local governments are in the business of "handling" information, the computer has enabled local governments to analyze information in new ways that were not possible before the computer age. The type of analysis that is now possible with the computer has the potential to enable local governments to foresee problems before they arise and to plan for their prevention and/or resolution.¹

The collection, storage and analysis of information is a large part of the function of local government agencies. Data collected by the various agencies is assembled by planning departments and used in the planning process. The typical planning department will collect or have access to information about population demographics (age, sex, race, disposable income, education level); educational facilities; water and sewage resources; health and medical resources; law enforcement; fire protection; recreational facilities; transportation services; landfill resources; infrastructure conditions; commercial and industrial resources; and zoning districts.

¹Berkman H.G. (1988). "Urban Planning Information Systems and Electronic Data Processing". Unpublished Manuscript. p.173.

Information Systems and Local Government Functions

Martin Myerson in his book titled "Building the Middle Bridge For Comprehensive Planning" identifies the five generic information intensive activities of local government:

- * Central Intelligence function - To facilitate market operations for housing commerce, industry and other community activities.
- * Pulse-taking function - To keep the community informed of the economic, population, physical and other changes.
- * Policy clarification function - To help frame, regulate and revise development objections of local governments.
- * Detailed development plan function - To phase private and public programs as part of a comprehensive course of action.
- * Feedback and review function - To analyze through research and projections the consequences of present action.

Central Intelligence Function

The central intelligence function requires the amassing and analysis of all data from the various agencies of local government. In the pre-automation era, all the data from the various agencies was compiled manually by the assembly of hard-copy material. This manual method meant that planners exerted most of their time and energy organizing the material rather than analyzing the data.² This difficult task of manually integrating all the databases from the various departments, and other bodies that might have useful information, was further compounded by the fact that the various departments

²Horwood, E. (1980). "Planning Information Systems: Functional Approaches, Evolution, and Pitfalls. Pennsaken, NJ: Auberbach Publishers. p.3.

would collect information in formats and scales that were not consistent across the board.

Today, database integration is a less ominous task. Freed from the task of reorganizing information data, urban planners can, with the help of computers, devote their attention to fulfilling the role of central intelligence to local governments.

Pulse-taking Function

The pulse-taking function of local government calls for planners to keep citizens constantly appraised of developments within the community. According to Myerson advance information allows local governments sufficient time to study and analyze situations before they arise hence keeping away from crisis management. When the pulse-taking role of local government is not accomplished, a "fire fighting" atmosphere pervades local government action i.e the local governments reacts to instead of being proactive to events. The increasing use of computers by local governments make it possible for planners to improve the pulse-taking function. Computer data analysis is now much easier through the use of such computer packages as the Statistical Package for Social Sciences (SPSS). SPSS along with numerous other packages such as dbase allow the urban planner to query data and analyze information for distribution, variance, skewness and many other statistical measures not possible in the pre-automation days.

Policy Clarification Function

According to Myerson the policy clarification function of local government necessitates the development of a host of policy alternatives. Each policy is studied and evaluated against the alternative policy and within the context of stated objectives. Since planners tend to be skeptical of easy answers to problems, they tend to demand large amounts of data before making decisions. Unfortunately, the presence of an abundance of data does not guarantee that a planner is therefore "information rich".

Automation has enabled planners to convert data into information through analysis. For instance, a planner might receive several requests for a fire station from several neighborhoods all with compelling reasons. Without using the computer the planner might seemingly have all the data to make a decision on the optimum location of a new fire station. With the computer, the planner has the far more advanced capability of an "intelligent" street network system possibly tied in with U.S. Bureau of Census Dime (Dual Independent Map Encoding) files that would allow the planner to calculate distances between addresses and proposed sites for the identification of the most appropriate site for a fire station.

Detailed Development Plan Formulation

Local governments, and more specifically planners, are perhaps best known for the development of plans. Planning theory literature identifies three reasons to support the need for plans.

The market failure argument is perhaps the most quoted reason for planning. The

argument states that in the absence of planning the free market fails to allocate the "real" costs or benefits to society. For example, if a neighbor suddenly decides to prospect for oil in his backyard the benefits and costs of such an activity would undoubtedly affect the entire neighborhood. On the cost side, the value of homes may depreciate if the area become a less desirable place to live. On the benefit side, the value of land might appreciate if oil were found to be present. The high cost of social goods is another reason used to justify plans. Social goods are defined as those goods that are impossible for the individual to provide for themselves due to excessive costs, or those goods that once provided universal consumption cannot be practically limited. Governments are thus in the business of providing the public with such social goods as defense, roads, sewers, parks, police and fire protection collectively. Efficiency and rational action is a third argument commonly used to justify planning. Paul Davidoff and Thomas Renier in their article "A Choice Theory of Planning" contend that planning is undertaken to assure the optimum use of resources in a world of scarcities.

Regardless of the argument, the development of plans begins with the amassing of spatial information (maps). Various mapped features are typically overlaid on a base map to determine relationships and project future scenarios. In the pre-automation era this analysis task was very difficult because all maps first had to be redrawn to a consistent scale before analysis could begin. The use of the spatial analysis capabilities of computer software bypasses the tedious time-consuming process of traditional overlay analysis.

Feedback and Review Function

Although the word "plan" conjures images of a linear or sequential operation, planning is a never-ending process of monitoring and sending feedback to ensure that static plans remain flexible, adaptable and relevant to the changing circumstances of the community. In essence the feedback and review function of local governments deals with the flow of information from the community back into the administrative offices. Improving the flow of information is one of the capabilities of a centralized information system.

Unfortunately, local governments tend to dedicate few resources to the review and feedback function and as a result planners can often be heard asking hindsight questions, such as "what went wrong with the plan ?". As spatial information systems become more widely implemented, the feedback and review functions will more than likely be better satisfied.

Information Management Problems

The five generic information intensive activities of local governments cannot in this highly complex day and age be effectively executed without the use of technology. Unfortunately, the rapidly changing technology has by far outstripped the ability of local governments to utilize new technology to their benefit. In many places, data collection in local government is still reminiscent of the pre-automation era. By and large, data collection among the various agencies of local government remains "unintegrated". As a result the separate agencies of local government still tend to operate as "information

islands" unto themselves.³ This approach to information collection and analysis is no longer acceptable as the world today, unlike that of yester-year, is highly interdependent. The problems of today demand an integrated approach in analysis and resolution because of their multi-dimensional nature. Older methods of data collection and storage tend to result in many discrete databases whose general usefulness is severely limited by duplication, inaccessibility and the lack of integration.

Duplication

Duplication of record keeping activities by different agencies within the same government causes a number of problems. First, duplication is expensive and inefficient. Duplication occurs as a result of the jurisdictional boundaries that have historically defined the functions of separate agencies within local government. Each agency has tended to collect information that is useful only within the narrowly defined concerns of that agency. Second, the thinking patterns of professionals in the different agencies tends to exacerbate the problem of duplication. Professionals in the various agencies tend to be oriented to "protecting" what they consider to be their turf. This orientation results in the duplication of resources.⁴

³Bayer, F. (1982). Computing in the City of Milwaukee: The Data-based Geographical Information System. Computers, Environment and Urban Systems, Vol. 7 p. 83-88.

⁴Berkman, H (1988) "Urban Planning Information Systems and Electronic Data Processing" Unpublished Manuscript p.173.

Inaccessibility

Once information is collected and stored it is useless unless it can be readily located and retrieved. The traditional approach to information collection in local governments tends to create the situation where one agency collects information it needs without regard for its potential value to other agencies. Even if other units were aware that the data existed it probably would not be in a readily useable form. For one thing, differing agencies have differing scale requirements. Some local government agencies, such as property assessors, require land use information on a small scale map, whereas the same land use information might be needed on a larger scale map by another agency.

Information can also be inaccessible from agency to agency due to manual methods of information storage. Manual methods of information storage, such as filing cabinets and map libraries, are not only space-consuming but also time-consuming when the need to retrieve the necessary information arises.

Lack of Integration

Though it often appears as if there are large gaps in the available information in planning related databases, the problem today is more commonly one of the inability to cross-reference the information of one agency with information collected by another agency due to conflicts in hardware and software, scale and format. In addition to conflicts in hardware and software, procedural and jurisdictional barriers continue to be

hindrances to information sharing.⁵

Information Management

Solutions to the problems of duplication, inaccessibility and the lack of integration actually have existed for years. Database Management Systems (DBMS's) have long been used in the private sector to organize, manipulate and share large centralized databases. DBMS's are powerful computer programs that have the ability to unite and manage "islands of information" into system-wide operations.

Despite the fact that DBMS's have existed for years and have been widely used in the private sector, local governments have generally resisted adopting DBMS technology to solve their information handling problems. This opposition to integrated data systems has accelerated the proliferation of heterogenous computing environments among the different agencies of local governments. The negative view of local governments towards DBMS capabilities can be largely attributed to the fact that while DBMS's can solve many information sharing problems, they cannot handle spatial information. Although local governments have in the past been criticized for resisting DBMS's, this criticism probably has no real validity as studies show that 70% - 80% of the information activities with which local government are concerned are location

⁵Wilson P.M. (1984) "Multi Purpose Geographic Information Systems. Selected Papers from URISA Conference in 1984, p. 137.

(spatial) related.⁶

The fact that Geographic Information Systems (GISs) can handle the spatial needs of local governments explains the stampede of local governments rushing to embrace GIS technology. As in any free-market economy, the demand has caused the private sector to respond quickly to the information-handling problems of spatial information users by providing a variety of systems available under a variety of labels and capabilities. Some of the common categories of such software are:

- (A) Automated Mapping/Computer Assisted Mapping (AM/CAM)
- (B) Computer Aided Drafting & Design (CADD)
- (C) Land Information Systems (LIS)
- (D) Geographic Information Systems (GIS)
- (E) Automated Mapping/Facilities Management (AM/FM)

Problem Statement

Although local governments and urban planners have been quite enthusiastic about the potential of GIS, relatively few such systems actually exist due to the extreme difficulty usually encountered in the process of developing and supporting GIS. Difficulties experienced by local governments during the recent proliferation of GIS's can be largely attributed to the early resistance of local governments to adopt DBMS

⁶Somers, Rebecca (1987) "Geographic Information Systems in Local Government: A Commentary", Photogrammetric Engineering and Remote Sensing, Vol. 53 No. 10, p. 1379-1382.

technology as well as the complex GIS implementation process that requires a great deal of advance planning and a rigorous and detailed needs assessment.

Local governments resisted DBMS's because they did not address their spatial information needs. Ironically, this resistance, even though based on sound reasons, has seriously handicapped local governments in the GIS implementation process. Had local governments gone ahead and implemented DBMS's for their non-spatial data, they would already have unified the separate databases of the various agencies and stemmed the rising tide of heterogenous computing environments. However, as local governments now try to implement GIS technology the process is complicated by the fact the "islands of information" must be unified in what is already a complex process. Even without the problems of discrete and incompatible databases, local governments are still struggling with the GIS implementation process with little guidance. Very little documentation exists about the complex GIS implementation process. The difficulties of implementation are further exacerbated by the fact that there are no generally accepted definitions and standards in this new field, making it difficult to assess the respective capabilities of different systems. Various systems available on the commercial market are designed to meet different needs. Decisions about the selection of hardware, software, cost and financing, staffing and database conversion have to be undertaken with extreme care.

Because implementing a GIS is such an expensive undertaking, local governments must strive to do it right the first time, since reversing bad decisions is extremely difficult with this high-priced technology.

Purpose

The purpose of this thesis is to develop guidelines and gather information that could increase the likelihood of successful GIS implementation. The GIS implementation process is a highly complicated procedure that remains poorly documented. It is the researcher's hope that this study will substantially add to the limited body of knowledge that currently exists.

One of the main problems that local governments have in developing useful information is the inability to ask vendors and consultants the appropriate questions. This study will attempt to ask all the "right" questions to acquire information on: a) key participants b) role of key participants c) organizational structures d) selection of system components. Readers should note that the purpose of this study does not include identification and clarification of the many technical issues related to the integration of hardware, software and data conversion. While technical issues are of vital importance and should not be overlooked when implementing a GIS, the issues are site specific in nature, require specialized knowledge and would be of limited value under a generic study.

Organization of Thesis

The thesis will be organized into five chapters. Chapters I and II will provide introductory and background material critical to understanding the concepts and establishing a common vocabulary for the later chapters. Chapter III will describe the methodology used in conducting the case studies. Chapter IV will present an analysis

of the findings from the case studies, papers and reports. Chapter V will conclude the research with a summary of the findings and suggestions for future research.

CHAPTER II

OVERVIEW OF SPATIALLY CAPABLE SYSTEMS

The last decade has seen dramatic improvement and growth of computer hardware and software, principally at the personal computer (desktop) level. Numerous software packages such as, AutoCad, VersaCad Map, Info and Architext, offer desktop mapping capabilities to local governments and utility companies to monitor land-use information - -- tax parcels, zoning, route planning for emergency services among many others uses. While these packages provide much needed spatial analysis to local governments and regional agencies, the proliferation of these packages has added fuel to the raging debate of what really constitutes a "GIS".

As implied earlier, the difficulties of GIS implementation are exacerbated by the lack of commonly accepted definitions and standards to define the respective capabilities of the numerous software categories. In the interest of minimizing the confusion and the ambiguous use of terms, an attempt has been made here at clarifying the non-technical differences between the various software categories.

Automated Mapping/Computer Assisted Mapping (AM/CAM)

The terms AM/CAM are descriptive of a class of software that essentially automates cartography. Instead of using the traditional map drawing tools, pens, t-squares, templates and zip-a-tone, a digitizer is used. A digitizer is an electronic tablet that is used to assign x,y coordinates to digital maps. The main benefit of use AM/CAM

software is the ease and efficiencies realized from the maintenance of digital maps. Computer maps are much easier to create, store, retrieve, analyze and update. Beyond producing thematic maps, automated mapping is quite limited as the graphic elements are not intelligent and therefore limited in their information processing capabilities. Thematic maps are, however, still useful to local government agencies and are frequently used to display planning related data such as average income by census tract, population densities, crime regions, flood plains and vegetation patterns among many other uses. For example, thematic maps created with Atlas Mapmaker are currently being used by the Tennessee Department of Health and Environment (DHE) to map counties requiring intervention in regards to teenage pregnancy (figure 1), cancer control and general administration of health care⁷

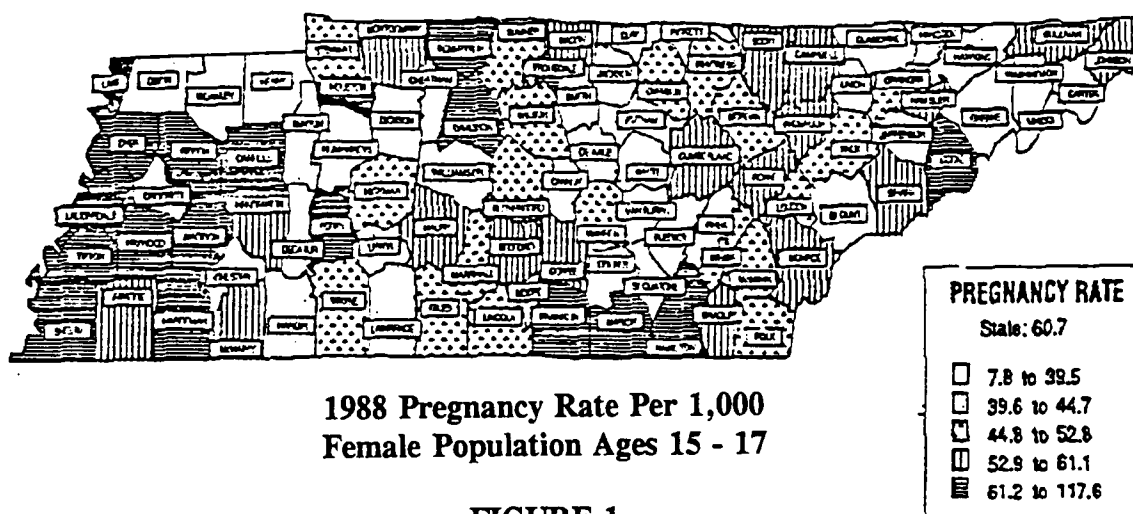


FIGURE 1
Thematic Mapping Using Atlas Mapmaker

Derived from (Government Technology, June 1990, Vol.3, No.6. p.21).

⁷Krizek, J. (1990). "Mapping the Road to Health in Tennessee" Government Technology Vol. 3 No. 6. p. 21.

Computer Aided Drafting and Design (CADD)

The once common sight of draftspeople sitting on tall stools around large drawing tables in rooms stacked with large flat storage cabinets and racks has all but disappeared. Today, design and drafting is usually done on the computer. As the name suggests, CADD systems are not true mapping systems although they can be used to produce maps. CADD systems automate the design of elements that require high technical specification --- bridges, roads, buildings, detailed site plans and sewer systems (Figure 2). Before the age of computer aided design, draftspeople spent many tedious hours redrawing maps necessitated by slight changes such as in zoning or land use. The use of the computer for design has made the business of design more efficient and cheaper and updating and revising drawings has become a trivial task rather than a labor intensive burden.

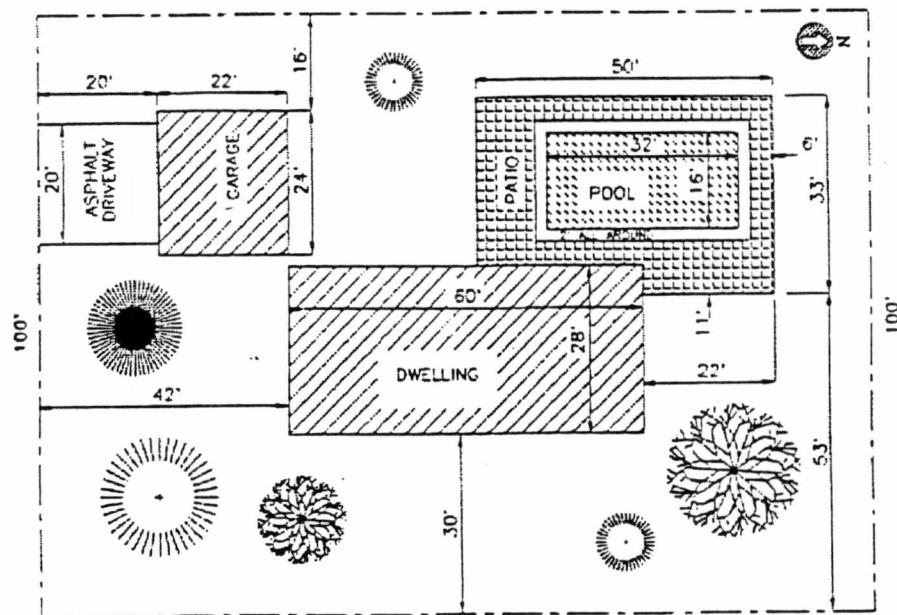


FIGURE 2

Plot Plan Using CADD

Derived from (Dix, 1989, p.201).

Massachusetts Water Resources Authority (MWRA) is currently using a CADD system to design the replacement of 5000 miles of aging pipes that carry waste water into the Boston harbor⁸ Because GIS's do not meet the needs of engineering and drafting departments, other local governments, such as Knoxville, have acquired CADD packages that easily interface with the main GIS package for technical drawings.

Land Information Systems (LIS)

The term LIS is somewhat misleading as it implies one large integrated system for land use management. In reality, LIS refers to the conglomeration of pieces of equipment and processes used to record, store, analyze and update land use activity. The entire process need not be, and most frequently is not, automated.

An LIS is the sum total of all the textural and pictorial documentation pertinent to the process of analyzing/establishing/operating/maintaining facilities, resources and/or activities within a geographic area. It also includes the underlying information management infrastructure required to access, apply, update and archive it. The definition applies whether this process is done entirely manually or with the aid of computers⁹

Outside of the United States, the government of Hong Kong is implementing one of the largest LIS's in existence. In it's final form, the "system" will be used by the

⁸Hanson, W. (1989). "CADD: Boston Harbor Cleanup Tool". Government Technology, Vol. 2 No. 2. p. 11.

⁹Klein, D. (1989). "Automated Polygon Processing Utility For Use Within A Desktop CADD System". Unpublished Manuscript p. 1-5.

Town Planning, Surveying and Mapping, Lands Administration, Building Ordinance and Administration departments. The LIS will consist of variety of tools designed to function together. Environmental and Scientific Research Institute's (ESRI) ARC product interfaced with an ORACLE DBMS will be used for spatial and attribute data management. AutoCad will be used for engineering and drafting. FORTRAN, COBOL, and C languages will be used for programming. The system configuration will consist of a network of SUN workstations and personal computers.¹⁰

Within the U.S., the Bureau of Land Management (BLM) operates the largest LIS that is used in the management of 275 million surface acres and 300 million acres of mineral rights. The system tracks land parcels for ownership, land uses, land status (leases, permits, licenses, right-of-ways, rentals, property assessment etc.). In addition the system is used for land use planning and environmental impact assessments.¹¹

Geoprocessing

Geoprocessing is the process used to assign geographic codes from a bank of codes to data records. Typically, geoprocessing systems will not have mapping capabilities.

This is typically a map-oriented system, though it is a geographic system and

¹⁰ARC NEWS, A Publication of ESRI, Vol. 11 No.2 p. 1-2.

¹¹Sonnenburg, D.(1988). "The Role Of The Legal Land Parcel In Land Information Systems/Land Information Management". GIS/LIS '88 Conference Proceedings. Vol. 1 p. 152-158.

might include mapping capabilities. This class is used primarily to assign geographic identifiers, or geocodes, from a reference file to individual data records. The most common application being the assignment of planning, census or statistical area identifiers to data records containing addresses, using a geographic reference file such as a DIME file. Geoprocessing systems may also include capabilities to perform network or district aggregation or analysis using geocode data.¹²

Geographic Information Systems/Automated Mapping-Facilities Management (GIS/AM-FM)

These two terms, GIS/AM-FM, are often used interchangeably because the system capabilities are closely matched. Not many real distinctions can be made between GIS's and AM/FM systems. AM/FM systems were developed earlier and tended to be aimed at automating mapping and the management of facilities. GIS's have since evolved not only improving the automation and management side, but also providing for complex analysis. GIS/AM-FM systems represent the best of two worlds --- the merger between spatial databases (AM) and text or attribute data. The benefits of this merger result in a powerful tool of analysis.

The systems have a combination of graphic and what is termed "attribute" processing capabilities. This class may have similar or identical graphic image handling capabilities to the automated mapping class. It also has the ability to store and link nongraphic attribute or geographically referenced data with the graphic map features to allow a wide range of information processing and display operations. The focus is on the geographic analysis rather than mere displaying"¹³

¹²Kevany, Michael J. (1987). "A Tutorial On Automated Mapping and Geographic Information Systems", Selected Papers from PlanGraphics, Inc. p.4.

¹³Ibid

As the name implies, a GIS has two key components to it --- geographic and information. The geographic part of the system refers to the system ability to keep track of geographic data in three ways. 1) Polygons --- building footprints, zoning districts, census tracts, political districts. 2) Lines and curves --- utility lines, streams, street center lines. 3) Points and symbols --- street lights, fire hydrants, water and sewage mains. The information part of the system refers to the system ability to keep track of data in three ways. 1) Numeric --- traffic volumes, depth, heights, costs. 2) Character --- building names, street names, pavement type. 3) Date --- date installed, expiration date, maintenance needed date. A complete package of hardware and software designed to operate as one unit is commonly referred to in the industry as a turnkey system.

GIS Components

Before any system can become functional several key components must be linked together to interface correctly (Figure 3). The components will vary, in brand name, from one installation to the next; the generic components will be found at any installation.

- (A) Central Processing Unit
- (B) Input Devices (keyboards, digitizers, scanners)
- (C) Output Devices (monitors, plotters, graphic printers)
- (D) Storage Medium (floppies, hard disks, compact discs)
- (E) Software

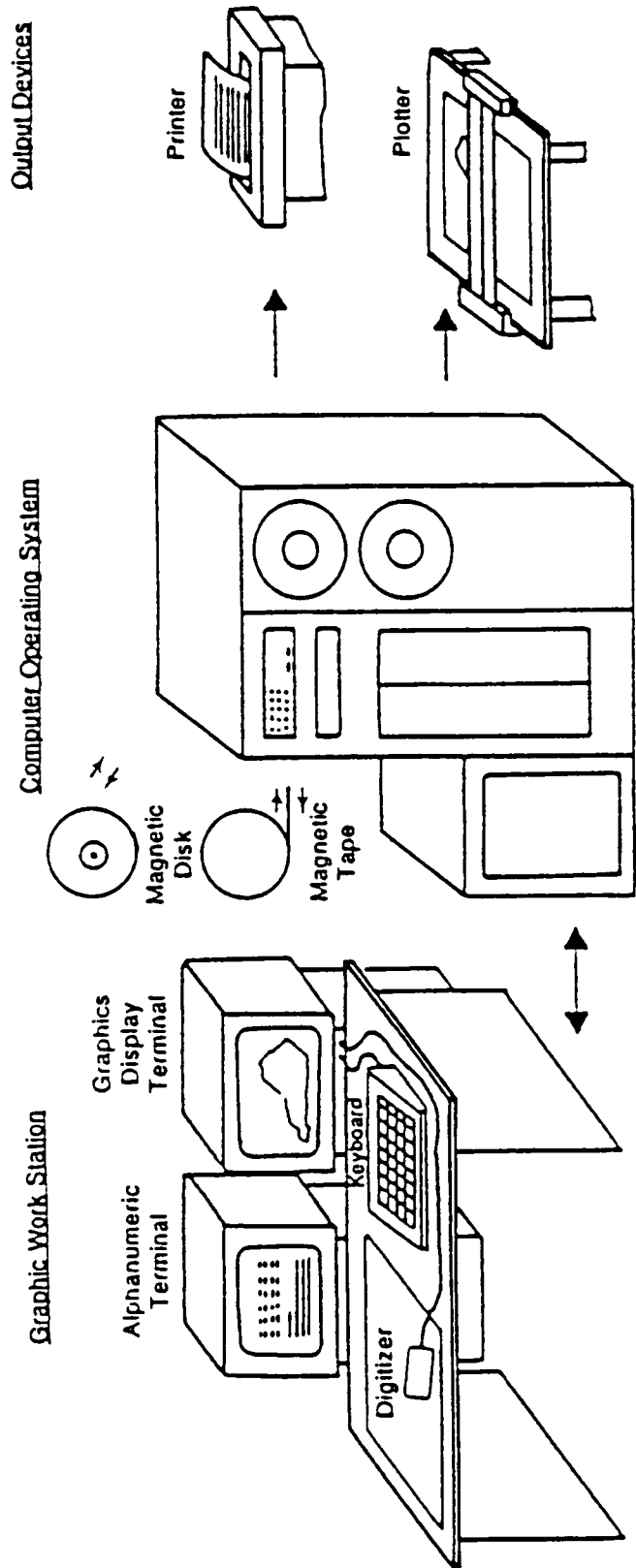


FIGURE 3
GIS COMPONENTS

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

Central Processing Unit. The central processing unit (CPU) is composed of three parts, memory, logic unit and control unit. The CPU is the most important component of the computer. A wide range of processors are available starting from the smaller personal processors to the larger mini and mainframe processors. The processor controls all file handling operations.

Input Devices. The typical input devices for a GIS are keyboards and digitizers. The keyboard allows the user to input data directly into memory. The standard keyboard will have a numeric keypad which is essential for applications that require large amounts of numeric information. Also present on the keyboard are the function keys for quick access for frequently operations. The digitizer inputs and transforms graphic data (maps) into the CPU in a manner that the CPU can understand, X,Y coordinates. The process of digitizing maps is slow and tedious; however, a number of devices have been developed to make inputting data much faster. Scanners are optical devices that can be used to rapidly transform maps into digital form. Unfortunately, scanners however do not totally automate the process. The common experience with scanners has been that the 30 - 40% of the digitizing effort still has to be done manually.

Output Devices. Monitors, or cathode ray tubes CRT's, temporarily display the results of processing. Today's computer monitors represent significant progress as they can provide the video-like clarity for graphics and digitized images.

A variety of plotters are available with a variety of abilities. On the low end, the

desktop pen plotter has the ability to produce color plots, but is severely limited by speed and size of plots. On the high end of the scale, electrostatic plotters are quicker than pen plotters and produce higher quality maps than penplotters. The better pen and electrostatic plotters will print on transparent material.

Graphics capable laser and dotmatrix printers are useful to produce black and white output. These printers are really more useful for small installations. Local governments should plan to invest in large plotters.

Storage. A variety of storage mediums are available. The most popular and well known are flexible diskettes, usually known as floppies. As the storage of floppies progresses (360K - 720K - 1.44MB), they will become even more popular. Although the floppies cannot currently hold the typically large space requirements of GIS files, they are still a cheap and safe method of storing and transferring data. As noted above, spatial data requires a large amount of storage space. Currently the most widely used mass storage devices are hard disks. Hard disks, typically a rigid irremovable platter, have improved rapidly in the last decade both in storage capacity and data transfer rates (speed). Direct-access storage devices have moved from the 50,000 bytes-per-second transfer rate of enhanced small device interface hard drives (ESDI drives) to over 1.25 million bytes per second of the small computer system interface drives (SCSI drives).¹⁴

The future of mass data storage will be compact disc. The use of laser discs is

¹⁴IBM Personal Systems Technical Journal (1989). p. 1-130.

expected to grow rapidly as the technology improves beyond the "write-once, read-many" capability. Recent studies by the Association of Information and Image Management (AIIM) reveals that today 95% of all government records are still on paper. Laser technology has the potential of transforming government offices into paperless offices in the near future. Today, up to 40,000 pages can be captured via scanners and stored on one single "write-once, read-many" (WORM) optical disk. According to AIIM, state and local governments are expected to purchase 102 new optical imaging systems worth \$39.6 million in 1990. In 1993, that figure is expected to grow to 281 new systems worth \$132.6 million.¹⁵

Database

The spatial and attribute database is central to the powerful capabilities of a GIS. The fact that a GIS database is integrated explains in it's wide appeal throughout the various branches of local government. The planners, for instance, see the ability to easily cross-reference data from the various departments for the development of comprehensive plans. The cartographers see the capability to easily produce high quality maps. School Boards may find an objective means of selecting school locations. Emergency Services see a way to clearly identify and label streets and parcels. These are a few examples to illustrate how a spatial and attribute database is universally

¹⁵Newcomb, T. (1990). "Public Sector Counts on Optical Technology for the 90s". Government Technology, Vol. 3 No. 4. p. 1 - 6.

appealing across the departmental jurisdictions of local government.¹⁶

Data in the GIS database is organized in three ways:

- (A) Graphic Features
- (B) Attribute Data
- (C) Geographically Referenced Data

Graphic Features. Graphic features, also known as polygons and points, include all digitized elements found on a map. The graphic elements are stored as layers in the database. Each layer stores the information that is functionally related to the other elements on the layer, e.g. the utilities layer would show electric, water and sewage features. Each layer is linked to the other layers by geographic coordinates (see layering concept figure 5). Points are also graphic elements representing a feature at a specific location, e.g. a fire hydrants, sewer manholes, electric substations etc.

Attribute Information. Nongraphic attribute information is stored in the text portion of the database. Attribute data provides descriptive data associated with a particular graphic feature/s on a particular layer. The attribute information is linked to the graphic features by a common index. For example, the electrical grid graphic features would be linked to attribute information on load demand, cables, substations, transformers etc.

Geographically Referenced Data. Geographically referenced data is not directly associated with graphic features on a map. Geographically referenced data is information

¹⁶Dangermond, Jack (1990). "The Organizational Impacts of GIS Technology" ARC NEWS, p. 25.

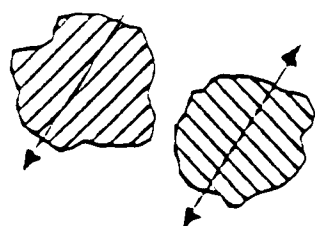
about a specific location or event. For example, records kept by the tax assessors on individual parcels (value, dimensions, location, taxes).

Applications

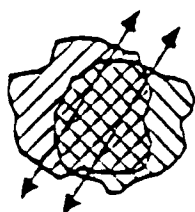
Once a GIS is in place and the database has been developed, the limits of its real and potential applications to local government functions are limited only by the bounds of imagination. The following illustrates how GIS technology can be applied to a wide variety of local government and other functions:

Mapping. Each department within local government has historically kept up with new changes by updating the "departmental" base map. As a result new changes occurring in a city have not been initially available centrally. With GIS's, each department is responsible for a particular layer of information which is then shared with other departments electronically. GIS provide for timely and efficient updating of all maps without duplication of work.

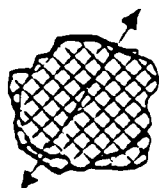
Planning. Because a GIS has the capability of manipulating data quickly and easily, it substantially improves the information available to planners. For example, computer overlay analysis can be used in a variety of ways. If a local government planner wants to identify areas suitable for new development, the system can be queried to produce maps of areas meeting the planner's specified variables of soil, terrain and infrastructure. Weights can be attached to each variable so that the resulting output indicates the degree of suitability. This type of analysis vastly improves such planning



Our Dicipines Sometimes
See Reality Like This

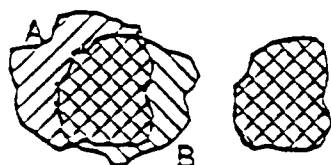


Sometimes Like This



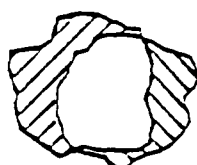
But Almost Never Like This

About closely related subject we sometimes have
redundant data



Redundant Data

Where they are different we have disparate data and
inconsistent data



Disparate
Data



Inconsistent
Data



Shared
Database

FIGURE 4

INFORMATION INTEGRATION

Derived from (ARC NEWS, 1989, p.25).

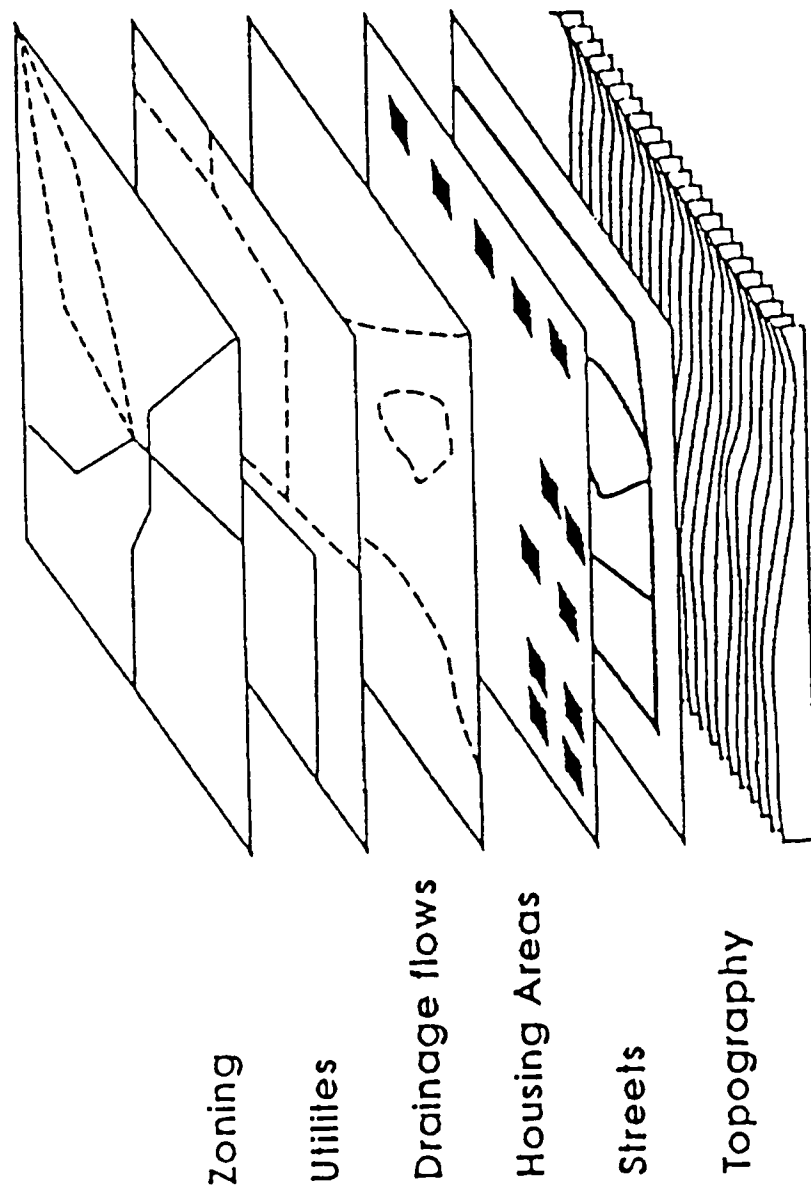


FIGURE 5

LAYERS OF GEOGRAPHIC INFORMATION

Derived from (Introduction and Overview Of GIS by Morrey and Co. n.d. p.2).

functions as comprehensive planning, growth management and day-to-day current planning.

Routing/Scheduling. With an intelligent street network system, local government functions such as, traffic and emergency services routing, road maintenance and code enforcement amongst many others, can be executed with much greater ease and efficiency. Rotterdam, the major exit point for all goods exported from the European Economic Community (EEC), is using an intelligent street network system for analysis and traffic routing.¹⁷

Land Use Management. Zoning has been the primary tool for land use control since the Supreme Court upheld it in the case of Village of Euclid v. Ambler Realty Company. GIS's can revolutionize land use management. By using all the data available in the spatial and attribute databases, a GIS, through modelling, can be used to "suggest" appropriate zoning.

Political Administration. One of the key issues that will be addressed in the coming years both at the federal and local level is redistricting. GIS capabilities tied in with U.S. Census Dime Files are being used to analyze and redraw congressional boundaries, track voter registration and produce the thematic mapping associated with political administration.

National Defense. Even though local governments are not concerned with national defense, GIS capabilities are being utilized by the U.S. armed forces for digital

¹⁷ Garcia, J. (1990). "Information Systems Key to Holland's Lifeline". Government Technology Vol. 3. No.7. p.26-27.

terrain modelling and nautical and aeronautical charting. On the local government level, police are linking the thematic mapping capabilities of a GIS with existing records of criminal activity to analyze patterns of criminal activity.

Educational Administration. School boards and others involved in the administration of schools can use GIS capabilities for demographic analysis, enrollment projections, school location planning, student transportation studies and the statistical graphing and thematic mapping associated with educational administration.

Public Health Administration. Local government officials concerned with the tracking of diseases and other public health threats such as hazardous waste can use GIS capabilities to track animal permits, building health inspections, environmental impact and to produce the appropriate mapping.

Economic Development. Various groups specifically concerned with the economic vitality of a community, chambers of commerce, merchant associations, downtown organizations, banks among others, may use GIS capabilities for such economic development activities as demographic analysis, intelligent site selection, demographic analysis, market research and infrastructure analysis.

Environmental Resource Management. The environment and resource conservation management will among the major issues of the decades ahead. Increasingly GIS capabilities are being used by conservationists and other groups to manage water, fish, wildlife, forests and other natural resources. Research is currently underway at Munich University of Technology on GIS modelling of ecological

relationships in time and space. The models being developed are being tested in Austria and West Germany.¹⁸

Logistics and Distribution Management. Companies involved in the distribution and circulation of goods and services, especially the high speed overnight services, can make use of GIS capabilities in route selection and optimization, mapping, site planning, tracking and monitoring of goods.

Modeling. Local governments are in the business of trying to shape the future. The odds of shaping the future can be increased if the future were predictable. GIS technology is being used to model "the future" in New York; the computer information services group (CISG) of New York City Planning Department is using a GIS to model future scenarios based on present growth trends in the city.¹⁹

Real Estate Management. GIS applications in Real Estate represent a future high growth area. Those involved in the sale, marketing and management of property recognize that GIS's could be applied to the areas of mapping, parcel tracking (deeds, value, dimensions etc.) demographic analysis and market research.

Teaching. Graduate Schools of Planning, Geography and Forestry have taken the lead in adopting GIS for practical and academic research. Scholars are also testing the limits of GIS software as well as developing new GIS applications.

¹⁸ ARC News (1989). "GIS and Dynamic Feedback Modeling: Integrating Time and Space To Help Model Complex Ecosystem Behavior". Vol. 11 No.1 p.1.

¹⁹Yapp, Russ (1990). "The Big Apple Maps Future With GIS" Government Technology. Vol.3. No.1 p.27.

These are a few of the major categories of current GIS application. A summary of typical local government GIS applications can be extrapolated by looking at Table 1.

TABLE 1**TYPICAL LOCAL GOVERNMENT GIS DATA/FEATURE LAYERS**

Geodetic/Survey Control	Electric Facilities
Reference Grid	Poles
Street Pavement (Air Photo)	Lines
Planimetric Features (e.g. fences)	Underground
Street Right of Way	Facilities (e.g. switches)
Street Names	Facilities (e.g. transformers)
Water Bodies	Facilities (e.g. substations)
	Street Lights
Railroad	Water Facilities
Parcel Boundaries	Lines
Parcel Center and Automation	Valves
Easements	Hydrants
Easements Annotation	Facilities
Subdivision	Gas Facilities
Buildings	Lines
City/County Boundaries	Facilities (e.g. valves)
Zoning	Telephone Facilities
Tax Areas	Facilities (e.g. lines)
Traffic Zones	Land Use (Actual)
Census Tracts	Land Use (Planned)
Election Districts	Bus Routes (K-TRANS)
School Districts	School Bus Routes
Fire Districts	Bikeways
Police Sectors/Beats	Soil Types
Water Areas	Land Cover
Electric Areas	Locations (e.g. schools, fire stations)
Gas Areas	Sanitary Facilities
Curb/Gutter/Sidewalk	
Flood Plain, Floodway	
Traffic Control Devices	

Derived from (Plangraphics Inc., n.d., 1985, p. 2-10).

CHAPTER III

RESEARCH METHODOLOGY

As noted in chapter one, local governments are very poorly equipped with the tools that can guarantee successful GIS implementation. A good way to provide local governments with tools of implementation is to study existing installations to discover, first hand, the types of issues that local governments need to take into consideration during the implementation process. With this in mind, the objective of this research was to do an indepth analysis of the experiences of local governments that have already implemented a GIS. The research began with a thorough investigation of existing material in the form of books and papers. Not much was available in the form of books, so the researcher had to rely on professional papers presented at GIS conferences. Although the absence of books made it difficult to easily gather material on the implementation process, one has to remember that the GIS industry is moving so rapidly that a few years is a whole lifetime in this business, moreover professional papers tend to present "cutting edge" material. The following sources were identified as major sources of material:

- 1) URISA conference proceedings 1985-1989;
- 2) conference proceedings from ESRI, a leading GIS software vendor,
1985-1989;
- 3) selected papers from PlanGraphics, a leading GIS consultant;

- 4) status reports periodically published by local governments currently in the process of GIS implementation;
- 5) the publication Government Technology which publishes GIS events in government;
- 6) ARC NEWS published by ESRI. This publication documents experiences of ARC/INFO users around the world;
- 7) publications of various GIS interest groups that have mushroomed all over the country, some of which communicate electronically through the various networks.

These sources yielded good base material for the description of the issues and concepts related to the implementation of GIS's.

Case Studies

Two case studies were conducted with the objective of doing a rigorous post implementation analysis of GIS installations. The case studies gathered data that was in most respects unpublished and undocumented. The decision to conduct case studies instead of a survey of more GIS installations was made after careful thought on how to achieve the objective of the study. The objective of developing guidelines was thought to be best satisfied by indepth study rather than a broad survey of GIS installations. The two case studies are: 1) Knoxville/Knox County/Knoxville Utility Board (KGIS). 2) Johnson City GIS. The two sites were selected based on the following criteria:

Knoxville/Knox County/Knoxville Utility Board GIS

The Knoxville/Knox County/Knoxville Utility Board GIS was identified as one of the most appropriate installations for a case study for a variety of reasons:

- 1) Knoxville/Knox GIS is a cooperative effort between City of Knoxville and Knox County. As cooperative effort, the issues pertaining to advance planning, coordination and resolution of data sharing conflicts between the three separate agencies were immense and as such made for an excellent case study.
- 2) According to PlanGraphics, one of the leading GIS consulting firms, KGIS is writing the book on the multi-organizational GISs.
- 3) KGIS was easily accessible to the researcher so repeated trips to conduct interviews and research were possible on a very limited student budget.

Johnson City GIS

The Johnson City GIS was identified as another appropriate GIS for a case study.

- 1) Unlike the multi-organizational KGIS, Johnson City's GIS was the initiative of Johnson City alone lending balance to this study.
- 2) Johnson City's GIS was a low budget initiative as the system was established using a federal grant. The system was developed using

inexpensive student labor from East Tennessee State University (ETSU).

Information on this funding and system development arrangement was deemed potentially very valuable to other local governments without much money.

- 3) Again within a very limited student budget, the Johnson City GIS was more accessible to the researcher.

Interviews

Interview questions were developed to collect information from GIS managers. The interview questions were designed to collection information on how a GIS can be successfully implemented by local governments. Specifically, the questions addressed the following issues: (a) the key participants (b) the role of the key participants (c) benefits of GIS (d) cost of GIS (d) financing a GIS (e) organization structures that increase the likelihood of a successful installation (f) issues related to database conversion. Appointments to interview GIS managers were scheduled by phone. During the phone conversion the objective of the study was explained. The characteristics of each GIS installation is summarized in the site profile data sheet (see Appendix).

Limitations

As the title states, the research is directed at the implementation of GISs in local governments. This study is limited to the investigation of the non-technical issues that

affect the successful implementation of a GIS. There are many technical issues related to the integration of hardware, software and data conversion that will not be addressed. While the technical issues involved in the operation of a GIS are very important, the issues are site specific in nature and require specialized knowledge. Furthermore, this study is not a review of GIS hardware and software. The only constant aspect of the computer industry is change. A review of rapidly changing technology would be of limited value to local governments as it would soon be dated.

CHAPTER IV

ANALYSIS AND EVALUATION OF FINDINGS

Introduction

This chapter presents the information collected through the post implementation study of the Knoxville/Knox County/Knoxville Utility Board (KGIS), Johnson City's GIS and an analysis of pertinent documents. The objective here is to provide a brief synopsis on how two local governments went about the process of implementing their GIS's and then focus on the common lessons from their experiences. Although the process used by each local government is remarkably different from the other, there are a number of common issues that yield valuable information to other local governments. These issues have remained, until now, either unpublished or not well documented. The readers are encouraged to study the tables as they contain valuable information not necessarily discussed in the text.

Knoxville/Knox County/Knoxville Utility Board (KGIS)

According to John Lutz, Director of KGIS, KGIS was initiated by discussions in the Metropolitan Planning Commission (MPC). Over the years MPC often lamented on how the city suffered because of the lack adequate maps. Back then, it seemed that maps became obsolete just as fast as they were updated. The only reliable maps that MPC staff had were the USGS topographical maps with the 20ft contours. It was then that casual discussions began on how computers could keep maps up-to-date. John Lutz and

Sue Adams approach the Mayor of Knoxville, the Knox County Executive and Knoxville Utility Board (KUB) Assistant General Manager and secured their support to conduct a benefit/cost study for a GIS. Each of three agencies contributed \$8,000 to fund the study. So, with \$24,000 PlanGraphics, a GIS consulting firm, was hired to conduct the benefit/cost analysis. PlanGraphics conducted the study and presented the results of their study to a group comprised of the City, Knox County and KUB. The group was so impressed with the potential benefits that a decision was made to commence implementing a GIS.

A GIS policy committee was formed that consisted of John Lutz of MPC, David Reece of KUB, Hollis McPhetridge of Knox County, Bob Bowers of the City of Knoxville, Dick Moran of Knox County Computer Center, John Whitehead of Knox County Property Assessment and Charlie Smart of Tennessee Valley Authority. The group positioned itself strategically by involving the Mayor of Knoxville, the Knox County Executive and the General Manager of KUB. The policy group then hired PlanGraphics to consult on the implementation process. The process that PlanGraphics followed had started with a benefit/cost study. A benefit/cost study is a method of comparing two ways of doing business. In this case, the benefits of automating business were found to be more than not automating. After the benefit/cost study, PlanGraphics conducted a series of interviews with the departments of the three participating agencies. The meetings were used to educate potential user departments on the benefits of GIS as well as determine the spatial and attribute data needs of the departments (see table 2 for list of departmental meetings). Once the data needs of the various departments had been

determined, the consultant in a series of other meetings with designated officials began resolving the data sharing conflicts between the departments and agencies. By resolving data sharing conflicts in this manner, KGIS avoided the inter-departmental rivalries that can slow down the implementation of a GIS. The consultant then compiled an inventory of geographically based information. This inventory was used to create the detailed database design shown in table 3.

After the database was designed, a data conversion vendor was retained on a contractual basis. The vendor was responsible for aerial photography and the conversion of aerial photographs and existing maps into digital format. A number of software and hardware vendors were then invited to submit proposals on how their system could meet the specified needs. In the interest of development time, a decision was made to go ahead with a turn key system. An Integraph system was selected to run on Digital Equipment Corporation's (DEC) Microvax II with 16 terminals and 3 personal computers on the network. After the hardware and software was acquired, the portions of the database that were ready from the conversion vendor began to be loaded on the system.

Johnson City Geographic Information System

Johnson City's approach to GIS implementation was very different from that used in Knoxville. In Knoxville, as with many other places, the system was essentially designed and implemented by an outside consultant; the database portion of the system was developed largely by use of a third party conversion vendor responsible for the converting photographs and existing maps into digital format.

TABLE 2
DEPARTMENTAL MEETINGS TO DETERMINE NEEDS

DEPARTMENT	AGENCY
Planning Commission	City of Knoxville
Service Department	
Waste Water	
City Schools	
Recreation	
Fire Department	
Police Department	
Information Systems	
Emergency Management	
Public Service - Inspections	
Public Service - Community Development	
K-TRANS	Knox County
Highway	
Code Administration	
Computer Center	
Property Assessor	
Register of Deeds	
Sheriffs Office	
Health Department	Others
KUB	
South-Central Bell	
Tennessee Technology Foundation	

Derived from (PlanGraphics Final Report for KGIS p. 1-2).

TABLE 3

DETAILED DATABASE

Feature	Lines	Symbols	Annotation	Attributes
Survey Control	monument	monument number	monument number	monument number, owner, date, order
Reference Grid	grid lines		cell number	
Street Pavement	pavement edges	bridges	street name	segment no. width, type date paved, condition of pavement, sub base
Planimetric features	fences, ridges driveways		feature name, elev.	
Street Right	right of way, edge		street name width	segment number, width, source
Water Bodies	water body, edge stream line		water body name	lake area
Contour Lines	contours		elevation	
Railroads	railroads		railroad name	
Parcel Boundaries	parcel boundaries	parcel center	parcel no., lot no., address, dimensions subdivision name, block no.	parcel ID no., bloc ID lot no., address, deed no. area use, plat book no., water serv. no., in flood plain zoning, owner name

TABLE 3 (continued)

Feature	Lines	Symbols	Annotation	Attributes
Easements	easement edge		easement ID	easement ID, holder
Subdiv. Boundary	subdiv. boundaries		subdiv. name	subdiv. name, no.
Buildings	buildings outline	building type	bldg. no. bldg. type, area	
City/County boundaries	city/county boundaries		city/county name	
Zoning	zoning area bound.		zoning class	zoning class, area
Tax Areas	tax area bound.		tax area no.	tax area, no., area
Traffic Zones	traffic zone bound.		traffic zone no.	traffic zone no., area
Census tracts	census tract bound.		census tract no.	census tract no., area
Election Dist.	commission, congress, district boundaries		commission, cong. district number	commission, cong. dist. no.,
Block	block boundaries			
School Districts	school dist. bound.	school	sch. dist., name/no.	school district, name/number
Fire Districts	fire dist. bound.	fire station	fire district, no.	fire district number
Police Sectors/ beat boundaries beats			police sect/beat no.	police sector/beat number

TABLE 3 (continued)

Feature	Lines	Symbols	Annotation	Attributes
Water Nur. Areas	water area bound.		water area number	water area number
Booster Repump area	booster repump area boundaries		booster repump area area ID	booster repump area no.
Power Areas	boundary lines		area ID	
Streetlight circuit area	boundary lines		area ID	
Electric Coding division	boundary lines		area ID	
Gas Pressure Dist.	boundary lines		area ID	
Wards	boundary lines		ward no.	
Council Dist.	boundary lines		district ID	
Precinct	boundaries lines		precinct number	
EMS Response area	boundary lines		area number	
Land Use Area	boundary lines		land use code	
Sector	boundary lines		sector number	

TABLE 3 (continued)

Feature	Lines	Symbols	Annotation	Attributes
Utility Service areas	boundary lines		area ID	
Community	boundary lines		community ID	
Sanitary Sewer zone	boundary lines		zone number	
Wrecker Zone	boundary lines		zone number	
GBF	street segments	nodes	node number	segment no., node no., address ranges, area IDs
Traffic Control		control devices	device number	device characteristics, meter type
	pavement marking	parking meter traffic inced. traffic count pt.	marking type	incident characteristics traffic counts
Bus Routes	routes	transfer points stops, ticket sales, park and ride sites		routes
School Bus Routes	routes	stops		
Bikeways	bikeways			
Bridges		bridges		bridge characteristics

TABLE 3 (continued)

Feature	Lines	Symbols	Annotation	Attributes
Soil Types	boundary lines		soil type	type characteristics
Flood Zones	floodway, flood plain, flood hazard zone, flood fringe, flood insurance			rate data
Flood Cross Sec.	flood lines			
Wooded Areas	boundary lines		name	area
Geology	geology types		geologic conditions	area characteristics
Point elevation	point	elevation	elevation	
Subdivision Plan work area	parcel boundaries		dimensions, parcel number	area
Parcel center		center point		register deeds, sale data, parking spaces, building permit no.
		school symbol	school name	school data, student data
		fire station park/rec. fac.	station name facility name	station data facility characteristics
		social service fac. historic sites	facility name site name	facility characteristics site characteristics

TABLE 3 (continued)

Feature	Lines	Symbols	Annotation	Attributes
Street lights	circuits cables, conduits, lines	churches	church name	source characteristics
		hospitals	hospital name	
		cemeteries	cemetery name	
		air pollution	source ID	source characteristics
		source		
		control stat., street lights	light number	
		line type, splices	depth	
		switch	switch number	
		fuse	fuse number	
		breaker	breaker number	
		transformer	transformer number	
		ser. disconnect		
		cut out	cut out number	
Electric Facilities		vault	vault number	facility characteristics trans. files, cuts out/in log disconnect maps facility characteristics vault files
		capacitors		
		meters	meter number	
		red tag meters	meter number	
		cable terminal		
		recloser	recloser number	
		regulator	regulator number	
		control point	control point number	
		poles/risers	pole and riser no.	
		guy anchor		
				vault files, large custm. files vault files
				vault files vault files vault files vault files

TABLE 3 (continued)

Feature	Lines	Symbols	Annotation	Attributes
Electric General attribute files		substation	substation number load demand	substation files, transformer
		oil circuit		
		reclosures		
		manholes	manhole number	manhole service book
Water lines	water mains lines			CARES database
				DPA database
				feeder file
				conductor file
				section file
				node file
				map file
				intermediate point file
				protective device file
				switch file
Water Facilities				completed jobs file
				PAN number book
			line name size type	size, name, size type, main material date installed, curb elevation
		valves gate box	valve number	valve size, number valve turns, valve status, gate box/manhole valve card data
		wyes tees risers	facility number	facility characteristics

TABLE 3 (continued)

Feature	Lines	Symbols	Annotation	Attributes
Water Service	plant lines	hydrants	hydrants number	hydrant number, fire flow data
		pump	station ID	hydrant pressure readings
		reservoir	reservoir ID	station characteristics reservoir capacity plant characteristics
Plans	plan/profiles sketch diagram work sketch book construction field book	service connect	service number	customer name, service data service book
				sheet number
				sheet number
				book number
				book number
General Water attribute files				work book index cards, blow off cards, engineer field book, foreman log and report, field book, transmission field book
Gas Lines	gas lines mains		size	date installed line characteristics
Gas Facilities		valves	valve number	valve characteristics valve manual

TABLE 3 (continued)

Feature	Lines	Symbols	Annotation	Attributes
General Gas attribute files		regulators	regulator number	regulator characteristics
		test stations	station number	station data, service cards
		meters	meter number	meter data
				field book, service cards
				service potential, overline
				survey, corrosion inspection,
				casing file, insulator
				inspection, atmospheric
				corrosion inspection, leak
				report, reservoir capacity
Gas Plans	plan/profile		specifications sheet number	sheet number
Sanitary Sewer lines, mains lines	force mains		line size	line characteristics
Storm Sewer	Lines	lines, mains	line size	line characteristics
Sewer Facilities		wye/tee manhole sumphole	manhole number sumphole	characteristics measurements characteristics measurements characteristics
Waterwater Plans	plan/profiles	specifications sheet number	sheet number	

TABLE 3 (continued)

Feature	Lines	Symbols	Annotation	Attributes
Cable TV	lines	facilities	line ID	line characteristics facility characteristics
KUB Communication cable	line	terminals	line ID	line characteristics
Civil Engineer design drawings designs			specifications drawing number	specifications
Surveys	survey lines	monuments	survey ID, measure.	specifications
Telephone Lines	lines		line ID	characteristics
Telephone		wire center	wire center ID	characteristics
Facilities		telephone fac.	facility ID	facility characteristics

The reasons for the development of Johnson City GIS are not any different from any other GIS --- the automation of spatially related data for City departments. The idea came about when those concerned with mapping were exposed to a GIS at a vendor exhibition. Those exposed to GIS managed to sell the idea to the City and City applied for a grant from the Federal Urban Mass Transit Administration. The grant was awarded so the initial capital costs to the city were much less than is typically the case elsewhere. According to Don Kiel, GIS Director, this allowed Johnson City GIS to develop much faster than it would have normally been possible because the City was not immediately burdened with servicing a debt. The low capital costs also meant that it did not cost the user departments much to be part of the GIS initiative. Enthusiasm for this seemingly "free" resource rapidly developed and user departments became willingly to allocate personnel to work on the GIS.

Johnson City's GIS was low budget initiative and as such the City could not afford to hire an outside consultant or a database conversion vendor. Determined that cost not be allowed to interfere with the development of the system, an alliance was sought with East Tennessee State University. The alliance meant that a system was now in place to recruit low-cost students to develop the database. In the selection of software and hardware costs, once again, played a part in narrowing the choices for Johnson City. A decision was made to go the GIS software package AUTOGIS produced by Autometeric, Incorporated. The decision to go with Autogis was based on the fact that Autogis was a comprehensive GIS software package available as shareware on

government projects. Autogis was developed in the early 1980's for large government users --- Bureau of Land Management (BLM), U.S. Fish and Wildlife Service, U.S. Forest Service among many others. The package is fairly powerful and well documented. Autogis is composed of three essential parts: the data entry package, for the conversion of map information to digital format; the analysis package for statistical, mathematical and geographic manipulations; and the output package, for the output to hardcopy. An additional benefit of the software was that it ran on the existing Data General MV 10,000 platform that City already had. Autometric's contract with the City also provided for on-site training sessions. Four City employees underwent the training sessions. After the training was completed, work began on database development. ETSU students began manual digitizing and data entry and by February of 1985, the tax map layer had been completed. The tax map formed the basis for several other future map layers. Over the next few years, the system gradually evolved with greater ETSU participation. By August 1986, ETSU students had completed several database development projects that were of immense benefit to the City. Table 4 shows the current status of the database.

Eight Points For Consideration In GIS Implementation

As is evident from the experiences of Johnson City and Knoxville, GISs can be implemented using different methods. Regardless of the implementation method

employed, there are a series of common lessons that emerge that apply to any situation. By analyzing the experiences of both Knoxville and Johnson City and others found in the limited literature available, the researcher developed important information on eight critical points that will give local governments an idea of the complexities involved and a feel for some of the issues that must be taken into consideration when making decisions on GIS implementation.

- (1) Sell the Idea
- (2) Perform needs assessment
- (3) Establish communication
- (4) Improve the organizational Structure
- (5) Undertake financial planning
- (6) Develop the database
- (7) Define staffing needs
- (8) Select hardware and software

Selling The Idea

Gaining support for GIS organization-wide is the is one of the keys to success. The support of key individuals in decision making capacities will make it easier to secure funding as well as personnel from various departments to develop the GIS. In the case of KGIS gaining support of the various user department meant first educating them on the benefits of the a GIS. In Knoxville the process was systematic. An outside

TABLE 4
JOHNSON CITY GIS DATABASE

Coverage	Area	Databases
Property Parcels	Johnson City Washington Co. (Part) (28,500 parcels)	Tax-related
USGS Digital Line Graphs Includes: Roads Railroads Pipelines Rivers, Streams, Lakes Power Lines Airports	N.E. Tennessee (9 maps)	Attributes
USGS Digital Elevation Models Northeast Tennessee (32 maps)		----
U.S. Census Bureau TIGER/Line Files Includes: Streets Street Address Ranges Misc. Cultural Features	Carter Co. Washington Co.	Attributes
Soils	Washington Co.	Attributes

TABLE 4 (continued)

Coverage	Area	Databases
Hazardous Materials Locations	Johnson City	----
Police Patrol Zones	Johnson City	----
Land Use 1982-83 Historical	Johnson City	Attributes
Flood Zones	Johnson City	Attributes
City Limits	Johnson City Bristol	----
U.S. Census Blocks/Tracks	Johnson City Bristol Washington Co. Carter Co. Sullivan Co. (part)	Attributes
Schools/School Zones	Johnson City	----
School Bus Routes	Johnson City	----
Transit System Routes	Johnson City	Ridership
Tax Map Indexes	Johnson City Bristol Carter Co. & Washington Co.	----

TABLE 4 (continued)

Coverage	Area	Databases
Major Thoroughfare	Johnson City	Attributes
Zoning	Johnson City	Attributes
Water Lines	Johnson City	Attributes
Hydrants	Wash Co. (part)	
Valves		
Reducers		
Sidewalks	Johnson City	Condition
Street Names	Johnson City	----
	Bristol	
	Washington Co. (part)	
Traffic Zones	MPO Region	Attributes
Federal-Aid Road System	Johnson City	Attributes
	Bristol	
Dilapidated Structures	Johnson City	----
City-Owned Property	Johnson City	Many fields
Annexations	Johnson City	Dates

Derived from (Johnson City Prospectus, 1990, n.d., p 2-3).

consultant was hired to educate the departments. The initial GIS committee also sought strategic alliances with the heads of each of three participating agencies. Early support from the upper levels cleared the path at the lower tiers. Since Johnson City's GIS developed incrementally the issue of city-wide support was not as critical. The system, however, rapidly gained an interested audience because no contributions were asked of the departments to develop the system and secondly, the GIS administrators were able to quickly deliver very useful products to interested departments.

Perform Needs Assessment

Successful GIS implementation is a very complicated and money consuming endeavor. Throughout the implementation and development of the GIS, local governments should expect problems. There will be major disagreements between departments, conflicts of hardware and software, software manuals that may be difficult to read among many other problems. One of the best ways of minimizing problems is to do a thorough needs assessments. Not many GIS administrators would recommend that the needs assessment process be skipped or be done by internal staff. Although hiring an outside consultant is expensive, the money is well spent in the long run. Outside consultants are more likely to be viewed as objective by "turf oriented" departments. Consequently, consultant recommendations are more likely to gain acceptance among the various departments.

Establish Communication

Because the development of GIS is so complex, a great deal of communication is required between project leaders and potential user departments. There are numerous issues, such as conflicts in scale and format, that need be resolved by communication. In Knoxville communication was fostered by designating one individual from the three participating agencies to be contact person with associated departments. With a system of communication in place, problems were resolved quickly and effectively.

Implementing a GIS requires consensus on a number of issues by as many of the potential users as possible. Decisions on database accuracy, content, updating procedures and access privileges must be decided upon before implementation. If the people designing the database do not take into account the needs of the people who will be using the system on a daily basis, they won't use it... this requires communication.²⁰

Improve the Organizational Structure

Since GISs are still a relatively new phenomena, there is no time tested organizational structure that has been "proven". Even with the relatively little experience, organizational structures have emerged as one of the key components to

²⁰Parent, Phil (1990). "10 Points for Planning a GIS" Government Technology. Vol. 3. No. 2. p. 26-31.

ensuring a successful GIS. Michael Kevany in his paper titled "A Review of Experiences With Automated Mapping and Geographic Information Systems" recognizes the conflicts that are likely to occur.

Responsibility for the automated system varies from place to place and has sometimes resulted in turf battles. As a computer system, the data processing department may have or demand control. On the other hand, as dedicated mapping system ... the Public Works, Planning departments may want control... In some cases disputes have arisen when multiple organizations want control over map updating and maintenance.²¹

Based on the evaluation of the experiences of Knoxville, Johnson City as well as papers presented at the Urban and Regional Information System Association conferences, a well defined GIS organizational structure is of utmost importance if a GIS is to be successful. A fairly autonomous structure seems to work well. In Knoxville, the GIS group does not directly report to any of the three participating agencies (City of Knoxville, Knox County and KUB). Instead, the group reports to a GIS policy group composed of the Mayor of Knoxville, the Knox County Executive and the General Manager of KUB (see Table 5 for KGIS organizational structure). A GIS user committee also exists and meets frequently to keep the flow of information between GIS administrators and users departments open. Clint Brown in his paper titled

²¹Kevany, M (1987). "A Review of Experiences With Automated Mapping and Geographic Information Systems". Selected Papers from PlanGraphics Inc. p.6.

"Implementing a Geographic Information System: What Makes a New Site A Success ?"

suggests that the GIS organizational structure should at the very least have the following people:

Manager. Has a broad general knowledge of GIS applications, capabilities, and database requirements of the organization. The manager should be experienced in personnel management and is skillful at keeping staff motivated, loyal and working at capacity. The manager leads coordination with the user community... The manager knows how to estimate resources and costs and knows how to get money and commitment to support the facility.

GIS Analyst. Has specific knowledge of the GIS and its use. The analyst can design databases as well as analytical procedures required for users' applications. The analyst should be a strong communicator who can listen to user requests and translate them into methods and procedures for generating GIS products. The analyst knows how to plan production steps for GIS applications.

Database Manager. Has a knowledge of GIS database design and experience with data used in GIS applications pertinent to the organization. The manager knows and understands mapping principles. The manager organizes data sets into layers and descriptive fields, chooses the data sources, levels of resolution, coordinates systems and mapping procedures to be used. The manager should know how to design attribute databases and associate this descriptive data with map features. The manager should also know how to develop automated map libraries and data dictionaries and can ensure quality control.

Senior Processor. Has knowledge of using the GIS to produce products outlined and specified by the GIS analyst. He/She knows how to use the software, hardware and data to generate products. The processor designs day-to-day product generation tasks. He manages simple computer tasks performed by lower level processors.

Cartographer. Has experience and working knowledge of map drafting/cartographic principles. He/She provides support at two

critical phases of GIS operation: 1) data entry and 2) map display. For data entry, the cartographer compiles and integrates map data from many sources for automation including existing maps, aerial photography, and satellite imagery. For map display, the cartographer designs output maps to be produced by the system.

Digitizer/Key Operator. Has experience in general GIS operation and/or key entry. The operator has responsibility for data entry operations - digitizing, map editing and key entry of descriptive data.

Computer System Administrator. Has knowledge and experience in maintaining a computer system, including all hardware, software, peripherals and supplies. The administrator keeps the facility going.

Programmer. Has experience with using a GIS system and is proficient at programming in FORTRAN, COBOL or similar languages. The programmer is the developer of site specific applications. The programmer may also develop and maintain macros to allow system access to less experienced users. In this way, the programmer brings the system closer to end users.

End Users. Have a general knowledge of the functions and capabilities of GIS and how GIS can be applied to meet their needs. Users make requests of the GIS facility to produce a specific set of well defined products. The users have basic knowledge of the system capabilities and of the resources which are required to produce typical products. Users provide support and funding for GIS organizations. Their needs are the needs the GIS must address. They are the ones to keep happy. They are also the ones who typically require a lot of education.²²

²²Brown, Clint (1986). "Implementing a Geographic Information System: What Makes a New Site a Success ?". Proceedings of the ASPRS Geographic Information System Workshop. p. 12 - 19.

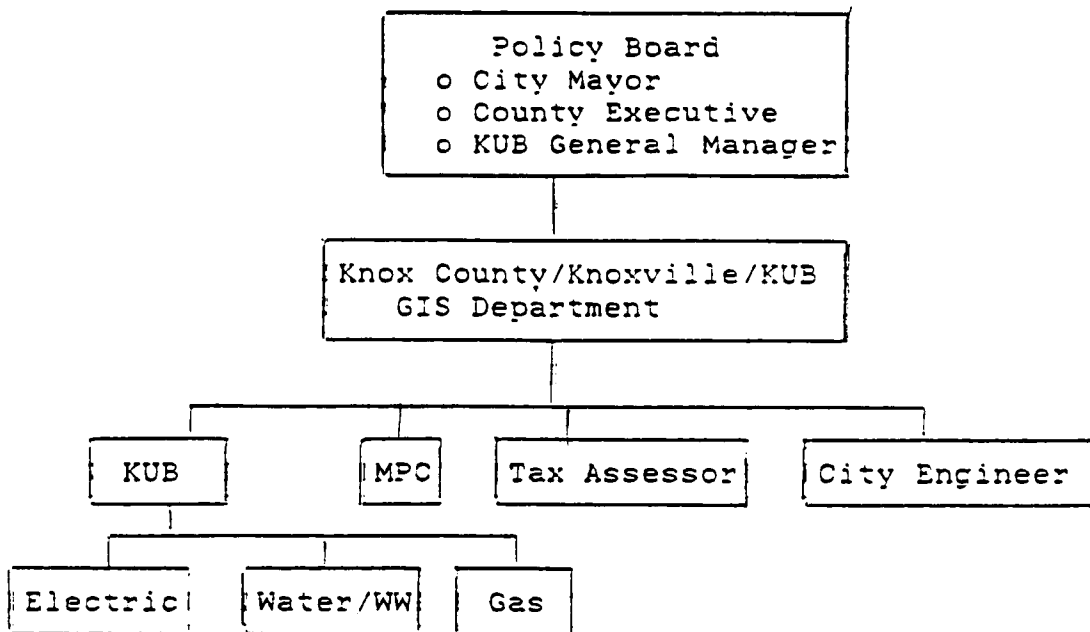


FIGURE 6

KGIS ORGANIZATIONAL STRUCTURE

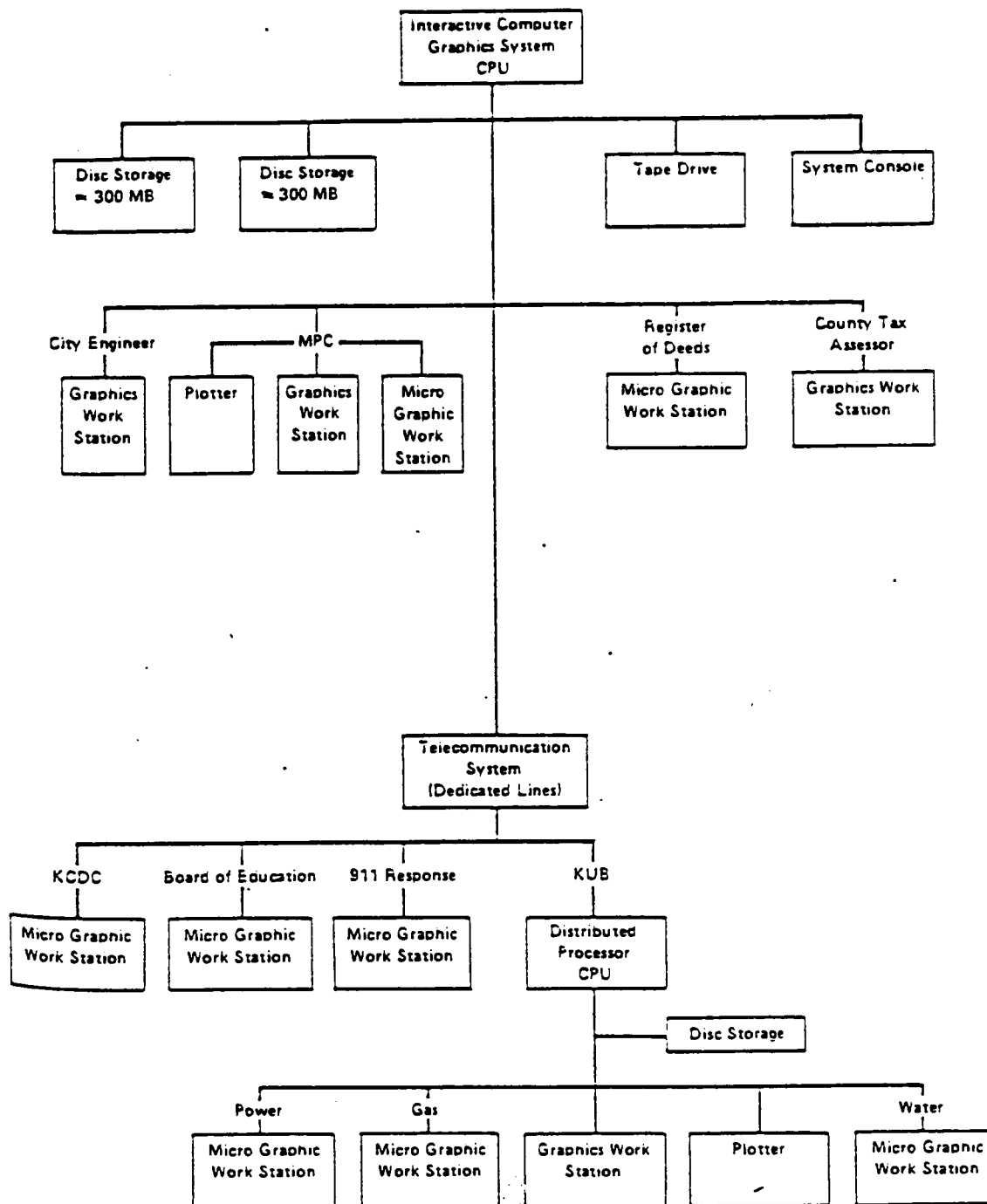


FIGURE 7

KGIS SYSTEM CONFIGURATION

Derived from (PlanGraphics Final Report for KGIS, 1985, p. 3-5).

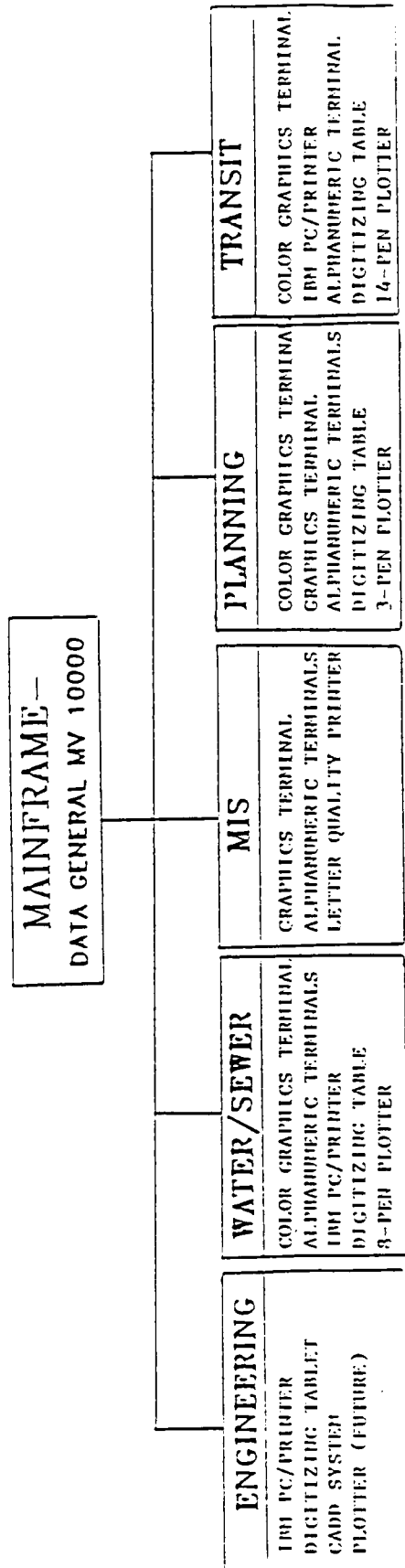


FIGURE 8
JOHNSON CITY SYSTEM CONFIGURATION

Derived from (Johnson City GIS Five Year Plan, 1988, p.23).

Undertake Financial Planning

Perhaps the largest consideration for local governments wanting to implement a GIS, particularly the smaller ones, are funding questions. How the initial capital cost and recurring operating expenses are met affects the success of a GIS. After talking to GIS administrators and reviewing GIS literature, the researcher has come to the conclusion that there is no commonly accepted "best" way of financing a GIS. This is because the financial circumstances of each local government is vastly differs. GIS administrators, therefore, have to work with "their" particular set of financial circumstances.

Even though there is no best financing method of securing funding, KGIS is recognized as having one of the firmest funding situations in the United States. Because the developers had enough foresight to realize that the system should not be subject to the budgetary whims of politicians in the Knoxville and Knox County or the budget director at KUB, the system was funded by a \$5.5 million dollar bond issue. In addition, the three agencies signed a cost allocation contract agreement that underwrote, by one-third each, the cost of developing the system. According to Michael Kevany, Vice President PlanGraphics, this financial security is clearly partially responsible for the steady progress that KGIS has made. The cost of depreciating the system is offset by distributing it to the users department. This method of cost allocation ensures that there will be enough money to replace and upgrade the system when it becomes obsolete. Additional funding is obtained through contract work done for Tennessee Valley

Authority (TVA). KGIS administrators have also targeted the University of Tennessee, Oak Ridge National Laboratories (ORNL) and Tennessee Technology Foundation (TTF) as future potential clients.

Johnson City's GIS on the other hand was initiated with relatively small local government investment as a federal grant had been obtained to cover most of the capital costs. In addition, the GIS software Autogis, more commonly known as MOSS, was available at the time as a public domain package. As most local governments know, the days of substantial federal assistance are long gone. Still, in the opinion of the researcher, local governments can obtain federal monies to finance a GIS if local governments are creative. In the decades ahead, most federal money is likely to be directed at national concerns --- environment, drugs and crime, health care, education among others. Local governments should adjust how they write proposals to include how a GIS can help address the national concerns at the local level.

Develop the Database

Contrary to the views of some, hardware, software and staffing expenses do not constitute the bulk of initial expenses. Building the database is the most money consuming expense. According to Phil Plant, a GIS Planner/Consultant with BSI Consultants Inc., 60% or more of the cost of implementing a GIS program is building the database. Building the database includes the design of the database, aerial photography, the labor intensive conversion of photographs to digital format as well as

inputting data into the attribute database. In essence, database development is an on-going process that never ends as the database has to be constantly updated with new changes.

Define Staffing Needs

The specifics of required GIS personnel have been covered in the organizational section of this chapter. Local governments, however, need to be aware that it is extremely difficult to attract and retain qualified GIS personnel. Precisely put, the demand for qualified GIS personnel far outweighs the supply. As in any free market, this bids up the salaries and other perks that must be offered to entice personnel. According to the PlanGraphics publication BENCHMARKS, a salary range of \$50,000 to \$60,000 is not uncommon for GIS managers of large municipalities and utility systems and a range of \$40,000 to \$50,000 for smaller organizations. Another staffing problem that plagues local governments is the difficulty in retaining the best employees. While success of a GIS partially depends on the quality of personnel developing it, local governments have found it very difficult to retain skilled staff because of the more lucrative offers from the private sector. Local governments should plan to compensate GIS staff at their full market value.

Revision of local government recruiting practices goes hand-in-hand with trying to recruit the best staff. Local government personnel offices have been known to be bureaucratic messes. In most places of employment job seekers apply for jobs by

sending in a resume, followed by an interview conducted by the division/department hiring. In many local governments this relatively straight forward process is mired in standardized forms, inappropriate for documentation of GIS skills, submitted to "faceless" individuals who often know little of the special nature of GIS positions be filled. With such hiring practices, local governments cannot expect to employ top-notch individuals.

Select the Software and Hardware

The selection of GIS software and hardware should be as careful a process as possible. Software and hardware is expensive and reversing a bad decision is nearly impossible. Most leading GIS software packages are platform independent (run on a variety of machines), and that makes the selection of software more important. Selection of hardware, however, still remains an important issue as certain software packages may not be fully compatible with certain platforms.

When selecting software and hardware, local governments should be very specific about the functions that the software and hardware is expected to perform. Once a comprehensive list of software and hardware expectations has been compiled, the list should be submitted to several vendors that are then invited to demonstrate how their systems meet the specified needs. The researcher has developed the following set of questions that should used a guide in the software and hardware selection process:

- 1) Is the product well developed, easy to use and well documented ?
- 2) What other local governments are using the product and how do they evaluate the product ?
- 3) Who will provide service, maintenance and support after installation ?
- 4) What service warranties are provided ?
- 5) How long has the company been in business and it is stable ?
- 6) What are the visible and hidden costs ?
- 7) What kinds of training arrangements does the company provide ?
- 8) Does the product meet the needs of all the users ?
- 9) Does the product provide room for expansion and growth ?
- 10) Does the product interface easily with other products on the market ?

In conclusion, local governments wanting to implement a GIS system should remember that one of the best and most inexpensive ways of learning more about GIS and the complexity of issues involved is by visiting existing installations. Find out about jurisdictions that seem to be similar to yours. Study what they did right and wrong and learn from them. Finally, join one of the GIS professional associations such as the Urban and Regional Information System Association (URISA). A wealth of information is available in the form of annual conferences and publications of such associations.

CHAPTER IV

SUMMARY AND CONCLUSIONS

Summary

The impacts of using outdated data and data management methods affects everyone everyday. Society feels it when it approaches local governments with routine requests. Take for instance, the case of the developer who requests the deed history on a parcel of property for development consideration. The local government that cannot respond to such routine requests quickly imposes costs on society. The developer incurs higher costs in terms of lost productivity. Society, in general, also incurs the increased cost of funding an efficient data management system. As the pressure on local governments to modernize record keeping systems increases, more and more local governments will be trying to implement GISs. The immense benefits of a GIS have been mentioned previously. To recap, the benefits generally fall in four broad categories:

- 1) Efficiency gains - increased productivity as the problems of duplication, inaccessibility and the lack of integration are eliminated. Duplication is the result of multiple record keeping by different departments of the same organization. Inaccessibility is caused when otherwise useful information cannot be readily located and retrieved due the method of storage. Lack of integration is closely related to inaccessibility and occurs due to conflicts in

hardware, software, procedural and jurisdictional barriers.

- 2) Additional capabilities - new types of advanced analysis that can now be accomplished that were impossible without the GIS. For instance, the planner who wants to identify areas suitable for new development can query the system to produce maps of the areas meeting the specified variables of soil, terrain and infrastructure. Weights can be attached to each variable so that the resulting output indicates the degree of suitability. This type of analysis was not possible before the GIS age and improves such planning functions as comprehensive planning, growth management and day-to-day current planning.
- 3) Increased responsiveness - local are the first in line of those designated to respond to natural and man-made emergencies that are life and property threatening. The police, fire, emergency medical and hospitals can make use of such GIS capabilities as tracking, route selection, mapping among many others to improve emergency responsiveness.
- 4) Intangibles - those types of benefits that are not really quantifiable in dollar terms. They include higher quality maps, improved ability to respond to client requests among many others.

Unfortunately, the rush by local governments to embrace GIS technology at times tends to overshadow some of the disadvantages. Many local governments do not realize that GIS software is a very complex and takes a number of years to learn thoroughly.

It has been estimated that ESRI's ARC/INFO product takes at least two years of full time effort to learn well. Because GIS software is so complex there is the growing concern that as the software develops it may eventually become so complicated that it will become inaccessible to the average user. Secondly, there is the concern of over reliance on GISs. Because the GIS provides so much information, users may tend to forget that the system is still a static snap shot of reality and does not reflect recent reality on the ground. Local government Planners making plans based on system information need to be keenly aware of this fact and make the necessary field trips to check on new developments. There is also the age old concern that about computer systems in general ---- "garbage in, garbage out". In the days before database integration (DBMSs), this problem did not cause that great of a concern as any "garbage" would only affect one or two departments at most. With GISs, like all integrated systems, the system resources are available to the entire organization. A seemingly small error, therefore, has the potential to affect entire organizations. Finally, there are some very serious legal questions involved in the operation of a GIS. It is a well known fact today that the entire computer industry has tended to outgrow the laws that govern most aspects of life. Although the cases that seem to get the most of the media attention are espionage and computer hackers spreading "viruses", there are many other cases that go unnoticed that already suggest that local governments expose themselves to great liability in the operation of a GIS. Some of the reported cases include:

- * Computer improperly disconnecting public utilities for non-payment.
- * Allegation of misleading financial information provided to subscriber of computerized database service.
- * Failure to renew patent due to error in not entering registration of patent on computerized follow-up system.
- * Margin call made due to inaccurate information in computer customer account.
- * Inaccurate information in consumer-credit reporting database giving rise to liability due to failure to use reasonable skill and care in design of system to ensure data accuracy.
- * Human or computer error leading to failure to make municipal assessment.
- * Computer controlled traffic signals malfunctioning causing green lights to be displayed in both directions.²³

The pros and cons of GIS aside, implementing a GIS requires a great deal of planning and coordination. The implementation plans must address a wide variety of topics including financing, database design, organizational structure, staffing among many others, and the purpose here has been to develop information on the issues that local governments should take into consideration before implementing a GIS.

GIS Definition

The term GIS is quite misused in the industry because the technology is still relatively new and the industry does not yet have commonly accepted definitions and

²³Sookman, Barry (1990). "liability of Information Providers". 1989 URISA Conference Proceedings. Vol. 4 p.256-276.

standards. As a result there are numerous software packages out there that are being marketed as GIS capable. A true GIS has two essential components to it --- geographic and information. The geographic part of the system refers to the system's ability to handle spatial data. The information part of the system refers to the system ability to link attribute data to special location or event. A complete package of hardware and software designed to operate as a unit is commonly referred to in the industry as a turnkey system. The essential ingredients of a GIS are therefore three --- software, hardware and the database.

Database

The database is the most important portion of the GIS. The database stores the graphic and attribute information. The fact that all the spatial and attribute information is available to the user departments explains its powerful impact throughout the various departments of local government. The database is the most money-consuming portion of a GIS as it very expensive to build and must be continually updated if is to remain useful. The data in the database is stored in three ways --- as graphic features, attribute data and geographically referenced data. Graphic elements are stored as layers in the database. Each layer stores information that is functionally related to the other elements in the layer. Each layer is linked to other layers by geographic coordinates. Attribute information is nongraphic information stored in the text portion of the database and provides descriptive data associated with a particular graphic feature/s on a particular

layer. Geographically referenced data is data about a specific location or event but not associated with a specific feature on a map.

Conclusions

The GIS implementation process is a very complicated and involved procedure and local governments wanting to implement a GIS should take the following list of guidelines into consideration. The importance here is on the points and not the order. This is because many of the steps can occur simultaneously or sequentially or be interwoven throughout the implementation process:

- (A) Sell the idea
- (B) Perform needs assessment
- (C) Undertake financial planning
- (D) Develop the database
- (E) Establish communication
- (F) Improve the organizational structure
- (G) Define staffing needs
- (F) Select hardware and software

Sell The Idea. Selling the idea of GIS throughout the organization is critical to gaining support for the GIS. The GIS must be carefully marketed at the upper levels of

management where decisions are made. Promotional materials in the form of video presentations and literature are available from vendors at little or no charge and should be used.

Perform Needs Assessment. An objective and realistic analysis is absolutely essential for database design and implementation. The assessment involves the identification of all the information needs, both spatial and attribute, of the entire organization. The process is technical in parts and requires experience, typically that of a consultant. In addition, the process is used to take inventory of existing graphic and attribute data.

Undertake Financial Planning. Decisions on the capital and operating costs funding are very important to the success of the GIS. The funding arrangement needs to be worked out in advance between the participating agencies. Financing a GIS through bond issue is one way of securing stable funding for the long term. Funding just through normal operating funds tends to leave the GIS open to the erratic cycles of the budgetary process. A third method of funding is a cost-sharing arrangement between the users. Cost sharing alone may discourage some potential departments from agreeing to be part of the system, so it may be prudent to seek other funding sources. The cost-sharing agreement needs to be worked in advance and signed by all participating departments.

Develop the Database. The development of database will be the most money-consuming aspect of the GIS implementation. Plan to spend substantial amounts on aerial photography and the conversion of the photographs into digital format. Aerial

photography has to be repeated periodically so that the system continues to reflect the reality on the ground. The facilities to do aerial photography will not exist in-house and a conversion vendor needs to be hired for this. The conversion process is extremely expensive and costs may run five to ten times the cost of the hardware and software.

Establish Communication. A system of communication is essential for every stage of the implementation process. The whole process requires a great deal of coordination that is only possible through well established channels of communication.

Improve the Organizational Structure. Develop a clear and well established organizational structure that allows the GIS department to serve all the user departments without the interference of turf wars that might otherwise creep in. An autonomous GIS department, in most instances, seems to work well. A policy body responsible for setting the general directions of the GIS should oversee the GIS department.

Define Staffing Needs. Hiring qualified staff is of utmost importance. According to PlanGraphics most systems that have failed have failed because of inadequate staffing. The market for GIS professionals is very tight and local governments should plan to compensate GIS staff at their full market value.

Select Software and Hardware. Use the list of specific expectations to select the software and hardware. Also use the ten guideline questions in chapter 4 in the selection process.

Suggestions For Further Research

It is clear that the future of GIS in local government is poised for a great takeoff although not much information is not currently available to local governments on how to go about implementing a GIS. This research contributes to removing the information vacuum that currently exists in the GIS implementation process. There are still areas, however, that require further research. Suggestions for further research include:

- 1) Creative and innovative ways for local governments to obtain funding for GISs.
- 2) Legal issues involved in the implementation of a GIS.
- 3) Organizational structures that are conducive to effective GIS administration.
- 4) Techniques for marketing GIS within the organization.
- 5) Techniques for enhancing communication and coordination.
- 6) New GIS applications for enhancement of local government functions.

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APPENDICES

APPENDIX A
SITE PROFILES

GEOGRAPHIC INFORMATION SYSTEM - SITE PROFILE

Location: Knoxville/Knox County, Tennessee

Contact Person: John Lutz

Participating Agencies/Departments:

- (1) City Engineer
- (2) Knoxville Police
- (3) Knox County Property Assessor
- (4) Knoxville Public Works
- (5) Knox County Engineering Department
- (6) Metropolitan Planning Commission
- (7) Knoxville Emergency 911
- (8) Knox County Highway Department
- (9) Knoxville Utility Board
- (10)

GIS Software: Intergraph

Hardware Platform: Micro Vax II

GEOGRAPHIC INFORMATION SYSTEM - SITE PROFILE

Location: Johnson City, Tennessee

Contact Person: Don Kiel

Participating Agencies:

- (1) Johnson City Planning Department
- (2) City Engineering Department
- (3) Johnson City Transit
- (4) East Tennessee State University
- (5) Johnson City Water/Sewer Departments
- (6)
- (7)
- (8)
- (9)
- (10)

GIS Software: Autogis/ARC INFO

Hardware Platform: Data General MV 10,000

APPENDIX B
INTERVIEW QUESTIONS

INTERVIEW QUESTIONS

PART I: GENERAL

1. Provide a comprehensive recap of the events that lead up to the development of your GIS. Please include information on the project initiator, selling of the concept to various agencies, specific essential activities, plans of action etc.

PART II: ORGANIZATIONAL STRUCTURE

1. Please provide a brief historical recap of how the current GIS organizational structure was developed and the specific occurrences that resulted in this structure.

2. How effective is the organizational structure in the administration of your GIS ?

4. Detail any changes that you think should be made to the organizational structure to improve GIS services.

5. What is the title and responsibilities of the individual ultimately responsible for the GIS?

6. To whom does this individual report ?

7. Please detail the relationship of the GIS to the rest of your local government.

8. Comment on the future direction of your GIS. How were these plans formulated ?

PART III: BENEFITS

1. What benefits have been realized by the implementation of your GIS ?

- a. Reduced duplication of data collection ☐
- b. Reduced duplication of data storage ☐
- c. Increased accessibility of data ☐
- d. Increased data sharing ☐
- e. Improved analytical capabilities ☐
- f. Cost savings ☐
- g. ☐
- h. ☐

2. What are some of the more preferred features of your system?

PART IV: FINANCIAL CONSIDERATIONS

1. How much did your system cost ?

2. What does this cost figure include ?

- | | |
|----------------------|--------------------------|
| a. Hardware | ☐ |
| b. Software | ☐ |
| c. Technical Support | ☐ |
| d. Training | ☐ |

3. How did you finance your GIS ?

- | | |
|--------------------|--------------------------|
| a. Operating Funds | ☐ |
| b. Grants | ☐ |
| c. Bonds | ☐ |

4. Do you have any other sources of funding ?

5. How was the cost of the system shared between the various agencies ?

PART V: SELECTION OF COMPONENTS

1. Comprehensively recap the process used to select the system components

PART VI: DATABASE CONVERSION

1. Detail comprehensively the issues that need to be addressed in database conversion.

PART VII: HINDRANCES TO EFFECTIVE OPERATION OF YOUR GIS

1. What have been the major stumbling blocks to the effective operation of your GIS ?

COMMENTS

- | | |
|--|-----|
| a. Cost sharing | [] |
| b. Jurisdictional and procedural battles | [] |
| c. Support for the project | [] |
| d. Resolution of the different requirements of each participating agency | [] |
| e. Management of the project | [] |
| f. Inadequate organizational structure | [] |
| g. Lack of qualified personnel | [] |
| h. Inability of software to meet needs | [] |

VITA

Muiruri K. Muchane was born in Nairobi, Kenya on January 11, 1962. He attended Hospital Hill Primary School and Saint Mary's School, Nairobi. In the fall of 1983, he joined Warren Wilson College, NC. In May 1987, he received the Bachelor of Arts Degree in Economics and Business Administration. He was also awarded the Alton Pfaff Cup, the College's highest honor.

In the fall of 1988, he accepted an assistantship at the Graduate School of Planning at the University of Tennessee, where he was presented with the school's Professional Promise and Outstanding Contributions to the Graduate School awards. He received in the master of science degree in planning in December 1990.

The author has worked for the University in the GIS and general computer fields. He hopes to pursue a career in this or a related area.