2003

Development of GIS as an information management system: a case study for the Burden Center

Zhitao Su

Louisiana State University and Agricultural and Mechanical College

DEVELOPMENT OF GIS AS AN INFORMATION MANAGEMENT SYSTEM: A CASE STUDY FOR THE BURDEN CENTER

A Thesis

Submitted to the Graduate Faculty of the
Louisiana State University and
Agricultural and Mechanical College
in partial fulfillment of the
requirements for the degree of
Master of Architecture

in

The School of Architecture

by
Zhitao Su
B. S., Tongji University, 1988
August 2003

ACKNOWLEDGMENTS

In the accomplishment of this thesis I would like thank the School of Architecture, and extend sincere appreciation to my patient and cooperative committee members, Dr. C. Barrett Kennedy, Professor William R. Brockway, and Sadik Artunc, for their guidance through my research. I would also like to thank Mr. Farrell W. Jones for his great help during this project.

In addition, I particularly want to thank the students who were especially generous with their help in this study. Whatever I asked for, they were always willing to help me get what I needed.

Finally, to my wife, my parents, my sister, and my brother, I own much gratitude for their unending support. Thanks to you all.

TABLE OF CONTENTS

LIST OF FIGURES

ABSTRACT

For a park site, it is very important and necessary to let the local planning authorities realize and understand the important aspects and benefits of the site and to establish the long-range development strategies for the location. In order to succeed during the planning process, the communication and information that flow among all the participants must be well organized. In this situation, a project-wide Geographic Information System (GIS) would be a good solution.

The goal of this project is to explore the possibilities for administrative authorities to implement a GIS database system to support the site planning and management of a park site.

The research is based on three parts:

The first involves components related to the field of park planning and GIS technology. It provides an outline of the park planning and management process, GIS techniques, and GIS-based strategies that have been developed for use in park planning and design.

The second part provides a method of developing a GIS database prototype for park planning and management. An inventory of existing assets and options for future development can be integrated in a GIS database. Then this provides a platform for the gradual development of a comprehensive park management system.

The third part involves the development of a prototypical GIS database design for an existing park site. It represents a practical implementation of a GIS system for the Burden Center, an historical and agricultural research center in Baton Rouge, Louisiana. This system will give quality information about the Burden Center site and will serve as a foundation to facilitate park planning, decision-making, facility management, future development, and resource interpretation for educational purposes.

CHAPTER 1 INTRODUCTION

1.1 Background

In our world, parks and open space are positive elements of the urban space that add economic, social, historic, and aesthetic value to our cities and environment. Well-planned open space can promote community investment, educate citizens about the environment, contribute to a city's unique character, and link surrounding buildings to create a sense of place.

Unfortunately, not all parks and open space achieve their goals. As Leonard Phillips noted in his book Parks: Design and Management, most American parks are "of low to moderate attendance, ordinary aesthetic value, and average maintenance." By Phillips's assessment, only one percent of parks are outstanding—beautiful, attractive, and valuable. The success of these parks is attributed to successful PPM -- park planning and management.

Because many people work together and generate a large stream of information in the process of park planning and management, working coordination and information exchange play an important role in successful PPM. Although most products are currently being produced with the computer, it is not in general practice to exchange information (data) digitally. Drawings and reports are mostly dispersed on paper. The latest developments of GIS technology can offer many opportunities to create a more efficient and more open stream of information in the PPM process.

The public is demanding more transparency in general and more specifically to participate in park planning. Governments are searching for methods and tools to provide more openness. More and more cities and counties are setting up electronic systems in their planning and management. So, the flow of information during the planning and building

process should be easily accessible, more up to date and faster to search and retrieve. GIS technology provides possibilities to structure, integrate, and present information. However, when implementing a GIS database during the PPM process, some common problems emerge. This paper intends to search some solutions or methods of implementing a GIS database for PPM.

1.2 Problem Statement

The development of digital computing technologies has had a significant impact on both architecture and urban planning. Many computing applications have been used to facilitate the process of architectural design and urban planning. As Michael Batty et al. described in 2000, architecture has been influenced by computer-aided design (CAD). Also, urban planning employs the geographic information system (GIS) for spatial analyzing and representing.

CAD technology developed AutoDesk Architectural Desktop and MicroStation software packages particularly for architectural drawing and visualizing. However, there is no software specially developed with respect to the processes of park planning.

In the past, some tools have been dramatically developed for visualization and information representation in the process of urban planning, particularly through GIS technology with software packages such as ArcView and GeoMedia. However, they are largely concerned with supporting the design stage, rather than providing a template for carrying out and managing the whole planning process. Due to the complexity of data types, the variety of participants, and the need to synthesize data in the PPM process, this problem is more obvious.

Some of the problems in designing a GIS system for PPM (park planning and management) include:

- Unlike the traditional process of PPM in which paper played a large role in information exchange, GIS technologies manage and manipulate the information in digital format. Data must be captured and integrated efficiently and seamlessly, and users must be assured of access to the most current data during the process of PPM.
- At present, the explosion of new and various data types from a variety of sources can contribute to success, but a great volume of data means that system developers must be selective, and gathering, selecting and exchanging these data are still big challenges.

1.3 Objectives

The purpose of GIS design in PPM is, using the GIS "off the shelf" tool kit, to develop a method of setting up a geographic database prototype for organizing digital data, to facilitate information management, visualization and illustration, decision-making, and project organization in the process of park planning and management. This GIS database will benefit all the participants in the process of PPM, including administrative authorities, professionals, and the public. Based on a real project, Chapter Six will provide more detail about the benefits of the GIS database for PPM.

The goals and objectives of this research are to:

- Select appropriate and cost-effective GIS-based tools
- Design GIS data models for PPM
- Make a template of GIS database for PPM

This thesis will provide answers to the following questions:

- Which GIS-based tools are available? What can these tools do? What developments can be expected in the future?

- How can GIS techniques be involved the process of PPM?
- What are the benefits and limitations of a GIS database for PPM?
- How can a prototypical GIS database for PPM be assembled?

As a key outcome component of this research, a geographical database prototype for PPM for the Burden Center (Baton Rouge, Louisiana) was assembled to illustrate current capabilities of GIS-based tools and a strategy for the GIS database system implementation for PPM.

1.4 Scope

The scope of this thesis is involved in a park and recreation area at the city and region scale rather than the home or neighborhood scale and placed at the urban and suburban level rather than at the wilderness level, although the method developed in this research can be extended to a larger scale and a higher level, such as the national or global scale and the rural or natural level. (Fig. 1.1 shows the park site scope in this paper.)

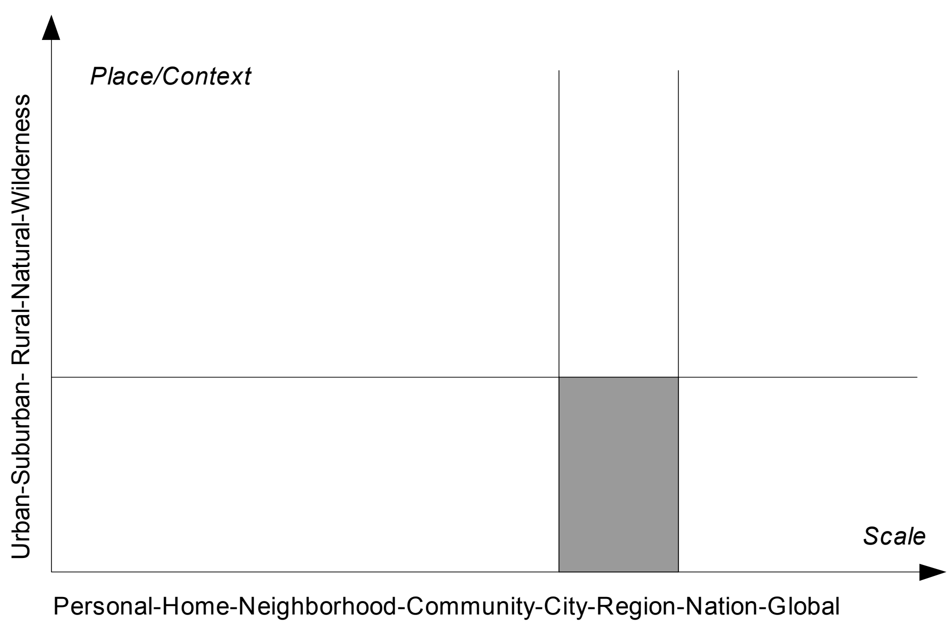


Fig. 1.1: Park Site Scope

This research concentrates on a conceptual model or prototype design of a GIS database for PPM. Several fundamental considerations determine the area of research as follows:

- The research aims for a conceptual and logical model that fully takes into account the critical aspects of a GIS database design in aiding PPM, i.e., GIS data model, data relationship, topology, map visualization, and data conversion.
- This research does not propose to develop a new GIS tool. Rather, it is intended to help users select the proper GIS software packages as tools in GIS database design.
- The research focus is on the beginning of the GIS database design. It is to set up a foundation or prototype for further development.

Emphasis is given to the organization of parameters and characteristics needed for graphic data and non-graphic data assemblage and interaction within the GIS database. The various advantages (integration of the data model, real-time navigation possibilities and ability to interactively manipulate objects) of GIS technology that facilitate the manipulation and exploration of data are to be employed for a GIS database. Several aspects of an intended integration of GIS and visualization concepts are explored, i.e. formulations of spatial queries graphically, visualization of data through media (graphics, hypertext links, panorama), editing of data on a database level. The database organization of data supporting extended exploration of the data model is investigated.

The thesis is about how to set up a GIS database prototype in aiding PPM rather than how to use GIS technology to conduct a PPM project. This research does not intend to inventory all the data needed in an operational GIS database, and also not to develop a GIS database on the Web, since these are not considered feasible for the time schedule of one research project such as this one. These tasks will be left for further development in the

future. The thesis aims at the development of concepts and their validation by prototyping key aspects.

1.5 Structure of the Thesis

This thesis has seven chapters that concentrate on how to set up a GIS database system for aiding park planning and management from a practical perspective. It could make it more efficient and feasible that the participants in the complex process of PPM will benefit from the functionality of GIS. The seven chapters are Introduction, PPM, GIS, GIS technology and PPM, Methodology, Application: PPM System at Burden Center, Baton Rouge, Louisiana, and Conclusions.

Chapter One, Introduction, begins with a general discussion of the background of the program area in PPM. In the meanwhile, it reviews the problems in design of GIS for PPM and the goals and objectives of this thesis.

Chapters Two and Three involve an outline of the GIS and park planning background. They set up definitions of a park and GIS. Chapter Two discusses the process and classifications of PPM, and reviews the traditional approaches of urban design and park planning. Chapter Three outlines GIS applications in various fields, and also discusses some terms of GIS and some basic concepts of GIS data and metadata.

Chapter Four is about GIS technology and PPM. It describes five main GIS techniques used in urban design, site planning and park planning, and also discusses techniques involved in the process of PPM.

In Chapter Five, the method to develop a GIS database for PPM is presented. It outlines the software and hardware for GIS and describes the development of a GIS database model for PPM. In Chapter Five, data collection and data assemblage are discussed, including what

data is needed, and where and how to collect and input the data into the GIS database. A case study is used to illustrate how professionals utilize GIS technology in a real project.

The main idea of Chapter Six is to develop a prototype, a foundation GIS database for a real project of Burden Center in Baton Rouge, Louisiana. It introduces the background and describes the objectives of the site, and also discusses the benefits of the GIS system for Burden Center. Here, I discuss data collection and analysis for the GIS database design based on established background and goals. I describe the design of a GIS database and data models for the Burden Center. GIS implementation of the database system is discussed thoroughly in Chapter Six, including software and hardware selection, data converting, data digitizing and modification, mapping and illustration, and staff train.

Chapter Seven summarizes advances and some critical factors when GIS technologies are used in the process of PPM. It also discusses lessons received from the GIS database design and implementation of the Burden Center project.

CHAPTER 2 PARK PLANNING AND MANAGEMENT

2.1 Park Definition

A park is "a tract of land often including lawns, woodland, and pasture attached to a country house and used as a game preserve and for recreation, a piece of ground in or near a city or town kept for ornament and recreation, and an area maintained in its natural state as a public property" (Webster). Parks serve people by providing preservation and protection of natural and cultural resources and providing opportunities for recreational use of resources and for leisure, outdoor recreation and outdoor living in natural surroundings. Parks are invaluable elements of our environment and landscape.

A park is any space and site for outdoor recreational purposes. PPM is a process to create a park "using human and physical resources and support services" by many people or teams "who could make valuable contributions."

2.2 Classifications of Park Planning

Monty Christiansen, in his book "Park Planning Handbook," defined six main types of park planning: organizational planning, financial planning, physical planning, program planning, functional planning, and general planning. Each type is concerned with different aspects and controls. Financial planning, for instance, concerns budget; physical planning concerns facilities, etc. General planning, a combination of the other five types, includes a group of roles and actions to realize the outdoor recreational purposes, from design, construction, and maintenance, to interpretation, use, management, and development.

PPM is more like the "general planning." Beginning in 1975, the National Park Service began to use the term "General Management Plan." In this research, the term PPM-park

planning and management is used because it will be discussed, focusing on park design, interpretation, and management.

2.3 Process of PPM

Park planning and management could be classified as two levels. One is at the state and federal level, with an emphasis on natural resource management (e.g., state park), and another is at the urban level, focused on local recreational programming near or within urban areas (e.g., urban open space). Spreiregen, in his book Urban Design: The Architecture of Towns and Cities, stated that urban space is generally represented by three broad categories: the street, the square, and the park (open) space. (Spreiregen, 1965, p. 184)

One urban design process and one park planning process are reviewed here, for the purpose of exemplifying and clarifying the processes of PPM.

Cutler developed a new process with eight tasks emphasizing environmental assessment.

- Task 1: Data Base Inventory—general description of the project.
- Task 2: Community Participation and Reaction
- Task 3: Establishing Existing Conditions and Analyzing Impacts of Projected Conditions
- Task 4: Establishing of Priorities through Value Facts in Order to Evaluate Alternatives
- Task 5: Design Alternatives, Schemes/Projects Alternatives—presenting, comparing, and evaluating alternative schemes
- Task 6: Stating Impacts & Developing Means to Minimize Adverse or Maximize Beneficial Effects
- Task 7: Adjustments and Alternatives to Establish a Final Action Plan

- Task 8: Review and Feedback

  (Cutler, 1982, p. 57).

Monty Christiansen developed four phases of the park planning process: predesign, design, development and actualization.

The predesign phase is the basis for the next two phases. In this phase, the design program is prepared as a direction to all the participants of the park planning process. The program includes determining the activities, preparing the activity analysis and synthesis, and compilation.

The design phase is also called physical planning; it "is the process of conceiving and structuring the physical arrangement of recreational areas and facilities and their necessary functional support elements." Some of the functions to be completed in this phase are: design objectives, site analysis, concept plans, evaluation of alternatives, and preparation of development.

The development phase is the construction phase. All works focus on construction, from construction drawings and specifications and competitive-bid construction contracting to actual project construction and management.

Monty considered that, for the park, the real importance is "to provide opportunities for quality recreational experiences, not just the facilities." So the actualization phase is to control and assume that "the proposed recreation experiences be carefully prepared, coordinated, implemented, evaluated, and revised as need." Unlike the three preceding phases, it is not procedurally or chronologically ordered, while it runs through the whole park planning process and interlinks every phase together.

Cutler's eight tasks focus on the design stage, while Monty's four-phase process is based on the assumption that the basic goals and objectives exist (Monty, p. 8, 1977).

Fig. 2.1 shows five stages in the process of PPM: Management, Preparation, Design, Construction, and Implementation.

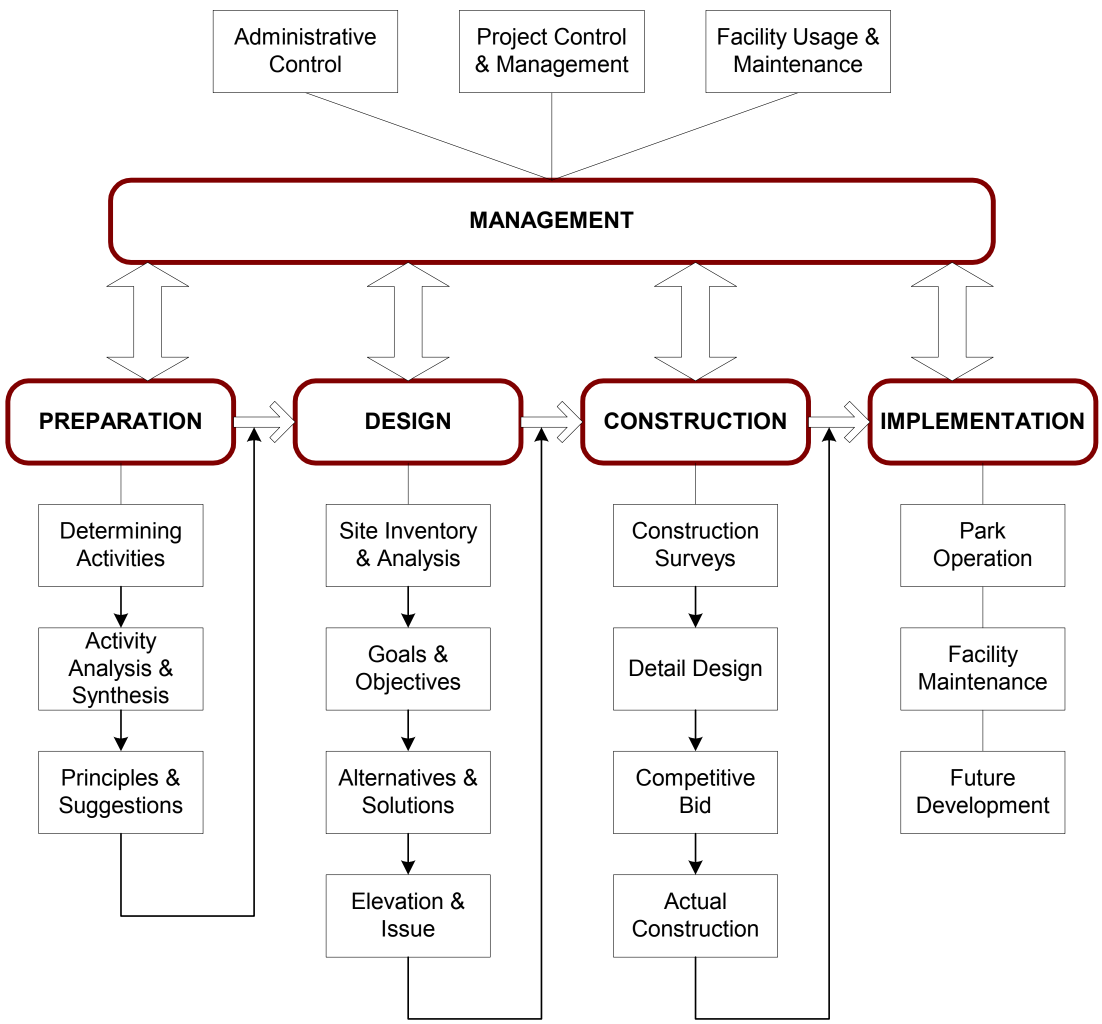


Fig. 2.1: PPM Process

2.4 Participants in Park Planning and Management

As mentioned before, the process of PPM is a continuous, complex system, not only because of its multi-functional stages and works, but also because of the participation of numerous authorities, groups and individuals. PPM, more than most other problem-solving

activities in policy-making, impacts a very wide sector of the population who has clear views as to what constitutes acceptable design. In addition, PPM is concerned with public participation and thus any process must always be open to a wider set of views than those of the designer.

Generally, there are three types of participants in PPM. The first is the administrative authorities, including governing authorities and executive committees. For instance, commissions govern cities. As a general rule, the executive committee performs all the management functions in the process of PPM. The second is the professionals, including consultants, designers, and engineers, etc. This group is a dominant force during the phases of preparation, design, and construction. Designers are involved in the entire process at the level of technical management and the project control. The third part is the public, including the social interest groups, users, citizens, etc. PPM is public-oriented. Active participation by the public can help make the park a better place.

CHAPTER 3 GEOGRAPHIC INFORMATION SYSTEM

3.1 GIS Definition

A Geographic Information System, or GIS, may have different means in different perspectives. Here are some definitions:

> "An information system that is designed to work with data referenced by spatial or geographic coordinates. In other words, a GIS is both a database system with specific capabilities for spatially-referenced data, as well as a set of operations for working with the data" (Star and Estes, 1990, p. 2).

> "A GIS is a group of procedures that provide data input, storage and retrieval, mapping and spatial analysis for both spatial and attribute data to support the decision-making activities of an organization" (Grimshaw, 1994).

In these definitions, GIS is seen as a toolbox for analyzing spatial data, or an information system for collecting, sifting, and rebuilding data to deliver answers for questions or queries.

GIS technologies include GPS (global positioning system), RS (remote sensing), and capabilities for input, storage, and manipulation (or analysis) and output of geographic information. GPS is a system of earth-orbiting satellites that can provide the precise location of an object on the earth's surface (in lat/long coordinates). RS is the use of satellites (and aircraft) to capture information about the earth's surface, for example, aerial photographs and satellite images.

3.2 The Applications of GIS Technology

The power of a GIS lies in the ability to integrate common database operations with visualization and analysis offered by a digital map interface. GIS technology, data structures, and analytical techniques are gradually being incorporated into a wide range of management and decision-making operations.

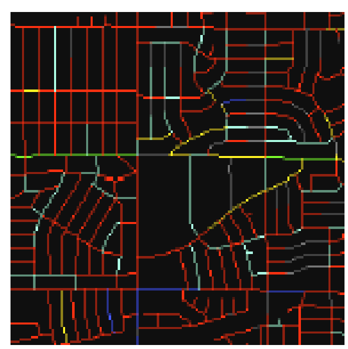
Dr. Francis L. Hanigan (1988) identified the following categories of GIS applications:

- Business
- Election administration and redistricting
- Infrastructure management
- Oil, gas, and mineral exploration
- Public health and safety
- Real estate information management
- Renewable resources management
- Surveying and mapping
- Transportation and logistics
- Urban and regional planning
- Research and education

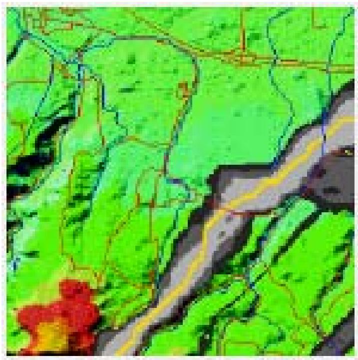
Here are some samples of GIS applications and what GIS can help to do:

An engineering department monitors the condition of roads and bridges and produces planning maps for natural disasters.

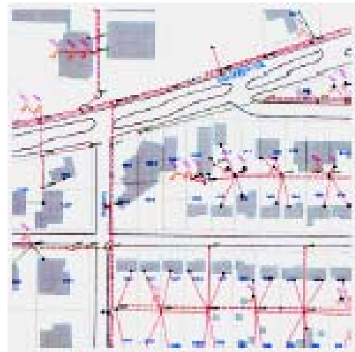
A tax assessor's office produces land use maps appraisers and planners.



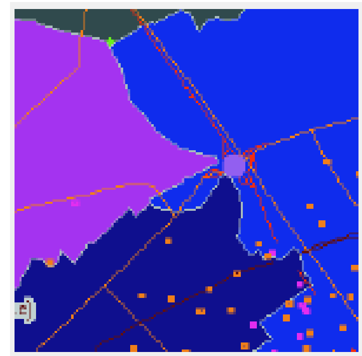
A wastewater department prioritizes areas for repairs after an earthquake.



A pipeline company finds the least-cost path for a new pipeline.



An electric utility models its circuits to minimize power loss and to plan the placement of new devices.



An emergency management agency plans relief facilities by modeling demand and accessibility.

Source: Bob Booth and Andy Mitchell, 2000, Getting Started with ArcGIS.

3.3 Data and Metadata

Data for GIS can be divided into two basic types: graphic and non-graphic. Graphic data, also called spatial data, including vector and raster, is made up of four elements: point, line, area (these three for vector), and pixel (this for raster). Graphic data includes coordinates, rules, and symbols that define features such as buildings, roads, or cities in a map. However, non-graphic data, often called tabular data or attributes, are representations and descriptions of features in the map. A building, for example, may be linked to name or size information about the building.

Metadata is data about data. It describes the attributes and contents of an original document or work, and can relieve potential data users of having to have full advance knowledge of a dataset's existence and characteristics. In other words, standard bibliographic information, summaries, indexing terms, and abstracts are all surrogates for the original material, hence metadata. The term is generally applied to electronic resources and refers to

"data" in the broadest sense--datasets, textual information, web pages, graphics, music, and anything else that is likely to appear electronically (Milstead and Feldman 1999).

Metadata describe different aspects of data, including:

- Identification -- What is the name of the data set? What geographic area does it cover? What themes of information does it include? How current is the data? Do restrictions exist for accessing or using the data?
- Data Quality -- How good is the data? Is information available that allows a user to decide if the data is suitable for his or her purpose? What is the positional and attribute accuracy? Is the data complete? Was the consistency of the data verified?
- Spatial Reference and Organization Information -- How is the data referenced to the real world (coordinate systems, datum)? How is the data organized (data models, topology)?
- Entity and Attribute Information -- What geographic information (roads, houses, elevation, temperature, etc.) is included? How is the information encoded? Were codes used? What do the codes mean?
- Distribution -- From whom can I obtain the data? What formats are available? What media are available? Is the data available online? What is the price of the data?"

CHAPTER 4 GIS TECHNOLOGY AND PARK PLANNING AND MANAGEMENT

4.1 GIS Technologies Involved in the Process of PPM

We have discussed five stages in the process of PPM: management, preparation, design, construction, and implementation. The process of each stage usually begins with some formal analysis of the problems in question based on good information, followed by systematic analysis of the options that might be designed to solve or alleviate these problems, and ending with the choice of a best option which is then implemented. This rational decision-based model is implied in various institutional structures that have been devised at various levels of methodological studies, although some factors (e.g., the uncertainty of definitive analyses) affected by planning somewhat dilute the model in practice.

Within the traditional process of PPM, the most effort is exerted to present the problems embodied in functional models of the park system. This perspective assumes that problems in PPM can be represented within functional models of the park and that formal planning processes enable such problems to be consistently resolved and their solutions tested using such models. In the previous two decades, the emphasis has changed within park planning from functional modeling towards systematic representation of the park system using various information technologies particularly GIS and CAD, and the formality of the rational-decision model has been diminished as the array of computer technologies for planning and management come to be used as a tool kit for enabling solutions to be generated and evaluated. The development of spatial decision support systems (Densham, 1991) has come from many more approaches to spatial problem-solving in those cases where the focus has been first on location models rather than on a systematic problem-solving process. Later,

planning support systems have been devised which have adopted the ideas of decision support with their emphasis mainly on information, representation, and modeling, fusing these with more formalized processes of planning based on the rational-decision model (Harris, 1989; Klosterman, 1997).

PPM was largely seen as being part of the wider structure of comprehensive planning, and there was and still remains an assumption that any formal methodologies which might be needed should take place on larger spatial scales where the functional structure of the park system was clearer. PPM, both its practice and description, has been dominated by an emphasis on solutions, with a strong focus on visual factors, but definitely not coupled with an emphasis on how good plans might be generated.

In developing computer technologies for park planning and management, a formal framework to display what and how computer technologies can facilitate the process of the PPM is needed so that the potential of the technologies can be exposed. Then, we will adopt a simple planning support system in which we identify various computer technologies (mainly GIS techniques) alongside a sequential process through which the participants of PPM might move in developing a PPM project, or set of alternative plans which might be chosen for further exploration.

Fig. 4.1 shows the framework that displays the relationships between the process of PPM and the computer technologies that might be used. In the practice of PPM, some of the five stages may be collapsed, eliminated, and/or elaborated, but the main process structure (five main stages) is still the same. It is simple to suggest that some variant (steps) of the process is implicit in park planning and management and that the use and adoption of GIS technologies must be seen accordingly.

Computer mapping systems are involved with GIS as visual representation in 2-D. Such mapping is best seen as part of multimedia, mainly visual, which enables various representations of the system to be captured without formalized analysis procedures.

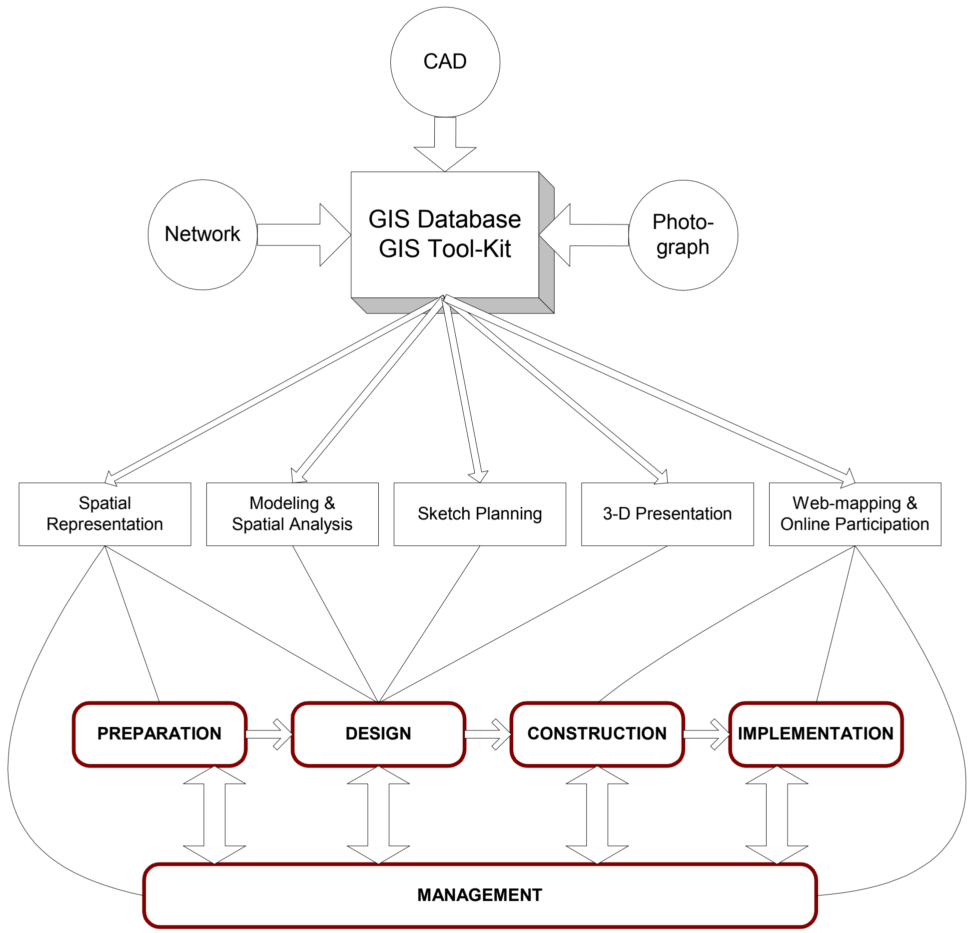


Fig. 4.1: Computer Technologies in the Process of PPM.

Fig. 4.1 shows some computer technologies connected within GIS to develop five aspects of digital tools that can be involved in the process of PPM. We will discuss in more detail the five aspects of GIS digital tools in the next section. Except in the design stage, the GIS tool-kit generally may facilitate other stages through the management stage that involves the entire process of PPM.

4.2 GIS-based Tools for PPM

With the rapid development of computer science, the pace of change in the GIS field is also quick. In this section, through an intensive search of the World Wide Web, some recent and useful GIS-based tools or technologies in PPM will be discussed.

Batty et al. (2000) stated, in his paper Visualizing the City: Communicating Urban Design to Planners and Decision-Makers, that neither Computer Aided Design (CAD) nor GIS are necessarily the only technologies relevant to urban design, but they represent the most widely developed and publicly available software in these areas.

The Center of Advanced Spatial Analysis (CASA) of the University College London did extension research that outlined the application of GIS and CAD in the process of urban design. Working Paper Series 3 and 21 of CASA discussed these technologies on one of these projects, the VENUE Project (Virtual Environments for Urban Environments). The Joint Information Systems Committee funded this project from October 1996 until March 1999. The basic idea of VENUE involves the development of digital tools from a foundation of geographic information system (GIS) software applied to urban design.

The VENUE developed two types of tool, namely functional analysis based on embedding models of movement in local environments into GIS based on ideas from the field of space syntax; and, secondly, fashioning these ideas in a wider digital context in which the entire range of GIS technologies was brought to bear at the local scale, which represents urban environments from about 1: 500 to around 1: 2500.

Five aspects have been identified within the VENUE project as the key aspects of the process where digital tools should be best developed in urban design:

- Representing the geographic form of the system, in terms of buildings, streets, land uses, etc., at different geographic-geometric scales, and using different types of media.
- Modeling relationships between the various components of the built environment.
- Enabling the designer to sketch different alternative designs which address the problem in question.
- Visualizing the 2D map geometry or geography in 3D at different scales.
- Tying together all this various software in a networked participatory digital environment - a virtual design studio - where various users might participate and collaborate in the process of design.

(Michael Batty, Martin Dodge, Bin Jiang, Andy Smith, 2000, "New Technologies for Urban Designers: The VENUE Project", p. 7)

Based on these five aspects, digital tools used in urban design, the development in the process of PPM will now be discussed.

4.2.1 Spatial Representation

The basic materials within the process of PPM are maps of land use, facilities, transportation, building types and forms, landscape details, topography, and other physical characteristics of the local environment. Starting in 2-D, GIS plays an important role for spatial representations, since most GIS software packages contain sophisticated cartographic tools.

The supply of digital data at a fine scale is increasing in many cities, and a full range of digital photographic data is becoming available at the local level, such as aerial photographs,

remote sensing photographs, etc. GIS software packages offer many tools to represent, integrate, and analyze this data in thematic maps.

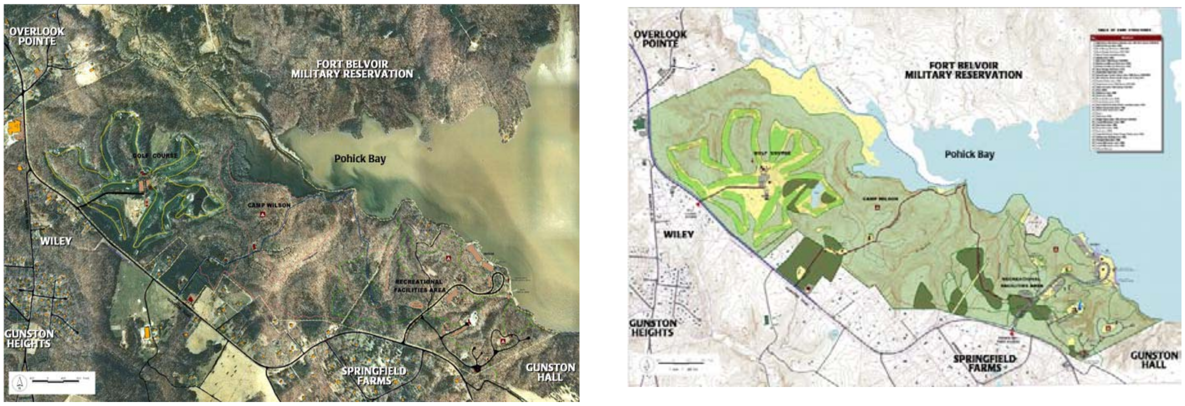
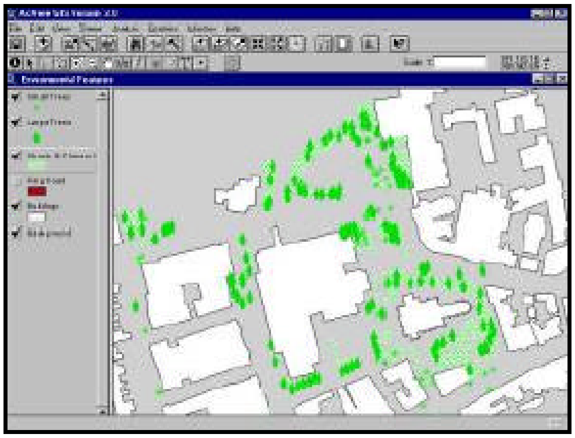
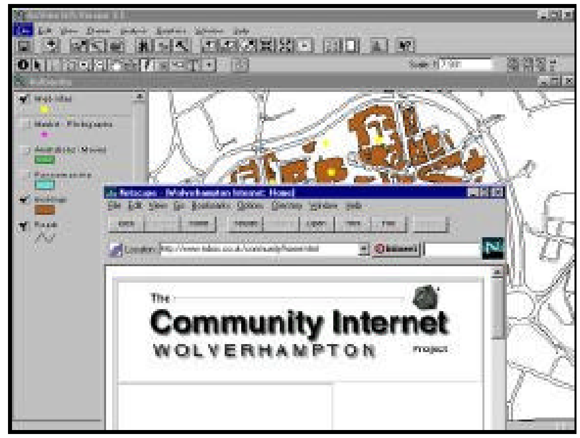


Fig. 4.2: Pohick Bay Regional Park, representing as thematic maps.
Left: Regional Map (aerial photograph). Right: Site Features Map.
http://www.nvrpa.org/pohick/index.html

The original work with VENUE was based on a detailed case study of Wolverhampton town center. In this project, embedding multimedia into GIS, another visualizing technology was used to drive the urban design. Still and animated pictures, such as photographs and videos, can be hot linked in from the GIS desktop to show the vivid condition of the site. An example from VENUE paper 21 is shown in Fig. 4.3.

Fig. 4.3: Types of Spatial Representation for Wolver Hampton Town Center.
Top Left: Still Imagery in GIS. Top Right: Dynamic Imagery in GIS.
Down Left: Landscaping Detail. Down Right: Linkage to other Internet.
Source: CASA VENUE work paper 21. http://www.casa.ucl.ac.uk/venue.pdf





(Fig. 4.3 Continued)

4.2.2 Modeling and Spatial Analysis

During the last decade, considerable efforts have been expended to give GIS more powerful modeling capabilities or rather developing ways in which modeling software can be linked to GIS.

Within VENUE Projects, Batty et al. (2000) argued that some formal methods have been developed embedded in GIS desktop. One of these methods, the Space Syntax approach, has been incorporated into GIS. Space syntax is a set of techniques that compute the accessibility of different locations at a fine scale by considering the connectivity of the road system.

In GeoMedia Professional and ArcGIS, the user loads an image of the building and site plan and then draws the axial lines directly on the screen. These are stored in a simple data structure, their intersections calculated, and the relevant graph computed. Various measures of access can then be computed and displayed on a standard color scale. This Extension that is configured as a simple addition to the standard ArcView interface is called Axwoman, and in GeoMedia it is a part of the functional components.

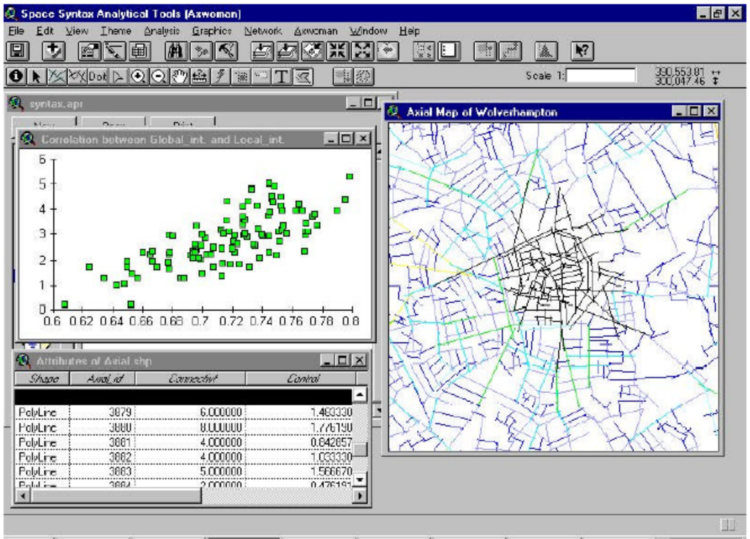


Fig. 4.4: Space Syntax within GIS.
Source: CASA work paper 3. http://www.casa.ucl.ac.uk/venue.pdf

Singh (1996) stated that one of the most important functions of GIS technologies should be the ability to find patterns and trends which otherwise might be missed because the pattern is too subtle or because it is based on the synthesis of many data sources.

The thematic map that can be considered as single variable is one of the most common GIS outputs. In the process of PPM, professionals and decision-makers want to know about the interaction of many different variables rather than how one variable varies across space. The new extensions and features developed in GIS software packages will play an important role in this type of analysis (combinations of spatial queries and overlays).

Some extensions and features of GIS will offer even more options for analysis:

- Spatial analysis of public space and open spaces
- Analysis of form and shape of the park site by decomposition details
- Thematic aspects such as the spatial distribution of particular functions
- Quantitative analysis of the spatial conditions by measures and numbers

- Repercussions and effects of different planning stages in their chronological order comparison of alternative plans.

4.2.3 Sketch Planning

In the early stages of PPM, participants, especially designers, always want to sketch and visualize plan and design ideas rapidly. Within GIS, the idea of sketching is one of being able to arrange and position new elements within different locations.

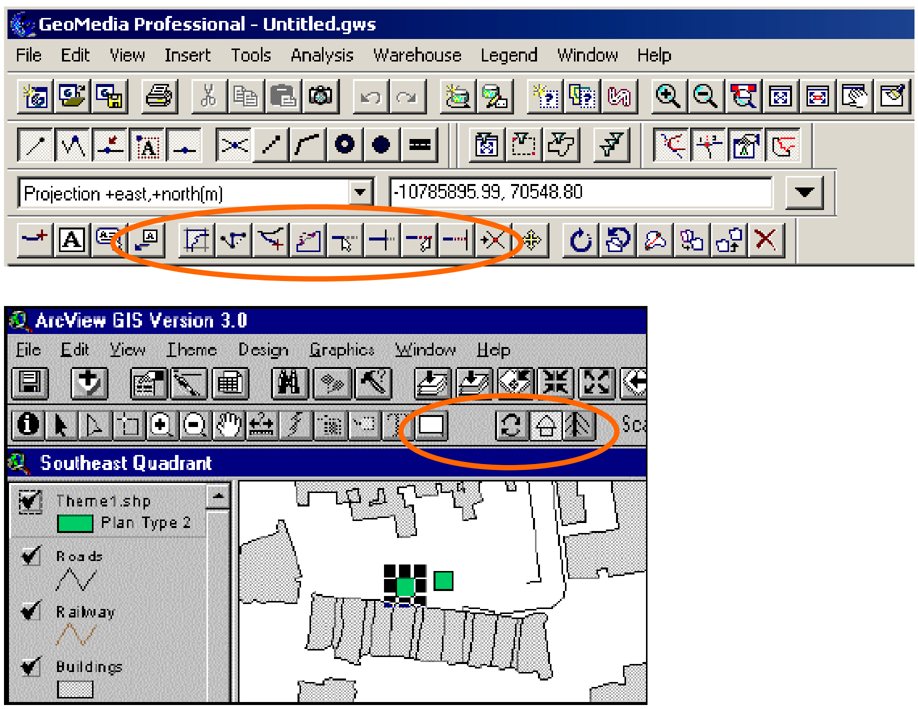


Fig. 4.5: Drawing tools of GeoMedia Professional and ArcView.

GeoMedia Professional and ArcGIS provide a powerful and intuitively attractive set of drawing tools which enable 2-d sketching of geographical features, as well as a rich set of map classification and symbolization options for visualizing sketch plans. These tools offer users of the software a standard menu of items that might be organized creatively in the manner of sketching on the screen. The users are able to create, edit, and modify buildings,

trees and any other more detailed natural or cultural built forms and landscape elements from a standard set of items.

Fig. 4.5 shows the sample drawing menu of GeoMedia Professional and ArcView.

4.2.4 Three Dimensional Representation

"Visualizing the future through simulation techniques is one of the most powerful tools for making informed design and planning decisions."—Environmental Simulation Center.

The term "3D representation" refers to the ability to make virtual worlds, using 3D computer models to give people a feeling of reality in the imaginary world. In the traditional design process, designers always use perspective renderings to express their design and planning ideas.

A variety of virtual reality (VR) technologies are being used to create 3D models. The most popular approach is VRML (Virtual Reality Modeling Language), a Web modeling language to construct basic objects in three dimensions on any scale. Another popular technique is TIN (Triangular Irregular Network), used to build an integrated polygonal mesh, which accurately represents the slope's terrain and elevation, the location of road networks, and location of shorelines.

The program called "ESRI 3D Analyst", an extension to ArcGIS, within GIS, was developed providing a seamless extension of the GIS to support fully interactive 3D visualization. The goal was to extend the GIS interface with a 3D view correlated with the 2D information presented in ArcGIS. Within this extension, the user is able to navigate in real-time the photo-realistic 3D database and interactively query information in both two and three dimensions. The key attributes of the extension are:

- The 3D view functions in parallel with the GIS tool (ArcGIS)

- The selection of features is fully correlated among all three data views – tabular, 2D, and 3D.
- 3D Analyst includes sophisticated tools for 3D modeling and analysis.
- Viewshed and line-of-sight analyses, spot height interpolation,
- Profiling, steepest path determination, contouring,
- Performing surface area and volumetric calculations, slope, aspect, hillshade,
- Interactive perspective viewing.

MultiGen-Paradigm provides other sophisticated real-time 3D simulation solutions for 3D GIS visualization—SiteBuilder 3D and ModelBuilder 3D.

SiteBuilder 3D is the breakthrough product for ArcGIS users that transforms 2D map data into highly realistic, fully interactive real-time 3D scenes. Once the 3D database is created, ArcView users can quickly conduct virtual fly-through while tracking their position simultaneously in 2D.

ModelBuilder 3D is a companion product to SiteBuilder 3D that allows users to quickly generate 3D models of real-world buildings, objects, and vegetation into an interactive display of 3D GIS data.

Charles Donley introduced some CommunityViz™ projects for visualizing Future Community Growth in the Town of South Kingstown (Rhode Island). One of these projects is a scenario prototype for a parks capacity study. SiteBuilder 3D™ is used to visualize the potential development within this prototype. The power of this 3D scene is that it is tied tightly to the 2D ArcView GIS themes. When buildings are changed in shape or position, the 3D scene gets changed without needing to re-extract data, as is the case with other 3D software. Having the 3D features tied to the 2D themes enables the planner to interact with

citizens' groups to make changes to the development and get immediate feedback of indicators as well as the landscape visualization.

Fig. 4.6: 3D visualization: Scenario Prototype for Tribune Housing parks.
http://gis.esri.com/library/userconf/proc02/pap0854/p0854.htm

The data used in the prototype is fairly simple. It is more helpful to have the ortho-photos and terrain for the 3D visualization of the results of the build-out.

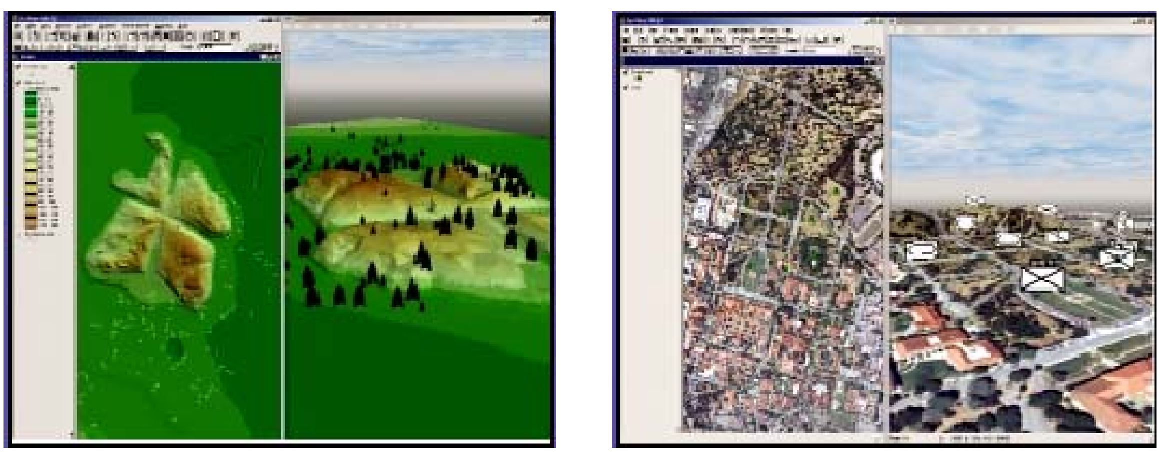


Fig. 4.7: Samples of SiteBuilder 3D.
Left: Extend terrain analysis applications with realtime 3D viewing.
Right: Side-by-side viewing for mission planning application.
Source: http://www.multigen.com/support/dc_files/SiteBuilder3D_brochure.pdf

4.2.5 Web-mapping and Online Participatory System—Future Development

Data distribution strategy will differ significantly from what it is now. With the development of wide area network (WAN) schema, more spatial data will be distributed through networks. Large networked spatial databases will be established in which the database management and updating tasks will be shared at different levels of the database hierarchy. Perhaps the greatest impact to GIS from the networked and distributed processing is handling shared large spatial databases. In this networked strategy, a number of database servers (some of them are also called SQL server) may be run on the network, and GIS applications may retrieve spatial information from these servers using a standard query language regardless of the computer platforms on which the servers are running.

As discussed before, the process of PPM is a continuous, multi-participant system. Sharing of information, communication, and interaction play an important role in the process of PPM. In a conventional PPM, professionals and designers work in one place and use hand drawings, boards, or CAD. At present, with the aiding of GIS and internet techniques, a professional group might be composed of people in various locations; communications in the PPM process are computer-mediated and computer-supported; information is handled in electronic forms; final documentation and presentation are also in digital format and can be displayed in multimedia, such as digital maps, video, audio, and computer animation, etc.

The main GIS desktop vendors, ESRI and Intergraph, provide extensions and functions for GIS in automated mapping and facilities management over the internet whereas WebMapping for GeoMedia Professional and ArcIMS for ArcGIS have evolved from the simple HTML image maps to sophisticated servelet-driven mapping services, while also keeping pace with the growing demand and progress in technology. With ArcIMS and

WebMapping, the use of GIS changed from merely an interactive visualization and query of the spatial databases to a platform for sharing remote spatial databases.

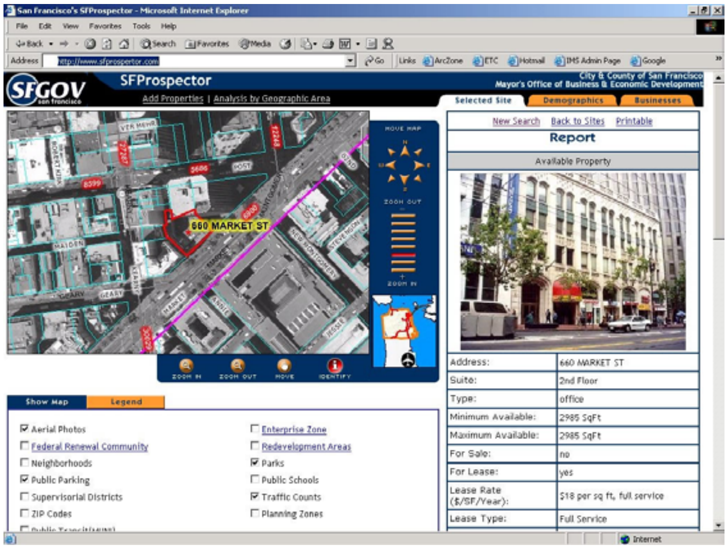


Fig. 4.8: ArcIMS sample

http://www.esri.com/software/arcims/graphics/prospector-lg.jpg

CHAPTER 5 METHODOLOGY—PROTOTYPE DEVELOPMENT FOR PPM WITH GIS

5.1 Goals and Objectives Definition

For park planning and management, definition and determining of goals and objectives for a park site are the basis for the whole process. They are described in the first stage of the PPM process.

The park site is a vital, living place; it includes a great deal of information or data. For a GIS database, it is impossible to record all the detailed features and attributes of the site. Therefore, it is very important to identify the information needed. The goals and objectives are critical in determining the data that will be recorded in the GIS database (in the professionals' judgment). For example, each proposed activity carefully analyzed determines what environmental conditions must be provided.

5.2 Standards

5.2.1 Software and Hardware

The software we discuss here refers to GIS application software that is provided in the form of software packages. These packages, consisting of multiple programs, are integrated to provide a variety of capabilities for mapping, management, and analysis of geographic data. There are four main components of GIS application software: geographic processing, DBMS (database management system), spatial analysis utilities, and graphic user interface (GUI).

Geographic processing capabilities allow users to enter, edit, display, and plot graphic features and maps. For instance, a user may import the shape of a water body from a CAD file, or create and edit it in the map. DBMS in GIS software packages allows users to store

and retrieve non-geographic data linked with graphic features. GIS software packages provide analytical tools used for independent or collaborative spatial analysis.

These tools, including query, buffer, and geocode, are used to create intelligent digital maps to analyze, query for more information, or print for presentation.

In the GIS application of PPM, two main GIS software packages, ArcGIS and GeoMedia, are selected as the core software. Both of them provide capabilities in geographic processing, DBMS, spatial analysis and GUI, and they also have several plugs or extensions that add and improve functionality to the package. In many projects, some users utilize other DBMS tools integrated within GIS software packages to create and manage the non-graphic database, such as Microsoft Access, SQL, and Oracle.

	Hardware	**Minimum**	**Recommendation**
Processing Unit	CPU	Pentium	Pentium III
	RAM	32+MB (For 3D GIS 256mb)	256+MB
Peripheral Unit	Hard drive	200+MB	1+GB
	Monitor	SVAG 800X600	Preferably Large
	Video Card	OpenGL compliant w/ 32mb (3D GIS)	64+ MB Video RAM
	CD-ROM drive		Preferably fast
	Scanner		Color
	Inkjet or Laser Printer		Preferably Color

Fig. 5.1: Basic hardware devices used in GIS application for PPM

Hardware is any physical device used as part of a computer system. Generally, the main hardware components include the processing unit and the peripheral unit. In GIS application

for PPM, the high speed CPUs, the large storage devices, and the fast graphic display devices are recommended in order to cut down on processing time.

Fig. 5.1 shows that higher hardware requirements are needed for efficient performance.

5.2.2 GIS Database Design

Database design addresses the contents, specifications, relationships, and sources of data to be incorporated into the GIS database. Generally, GIS database design starts with the data models as a design prototype that will help speed up and simplify the GIS implementation. The model design should be open, multipurpose, and standards based. Open GIS Consortium (OGC) and ISO are used as simple feature specifications in which the spatial data are managed in database management system (DBMS) tables.

Data is organized by layers, coverages or themes, with each theme representing common features. Layers or themes are related with precise geographic coordinates recorded for each theme. For instance, vegetation can be seen as a theme in a GIS map to represent different plants in a park site.

GIS has the ability to organize information into a series of layers or themes that can be integrated using geographic location. Each GIS database includes these thematic layers, and for each layer, specifications for the contents in the physical database are also described. These include how the geographic features are to be represented (e.g., point, line, polygon), how the data is organized into data warehouses, feature classes, attributes, relationships, and what the database integrity rules and GIS behaviors (e.g., topologies) are.

In a PPM GIS application system, about thirteen thematic layers are used to represent features of a park site. Fig. 5.2 shows the thematic layers of a park site.

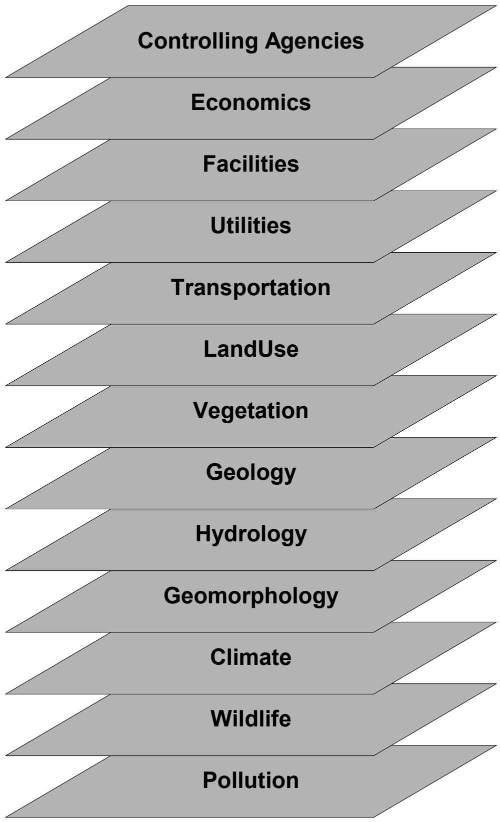


Fig. 5.2: The key thematic layers in GIS model for PPM.

As traditional database design procedures, object-oriented design tools are useful with the migration of GIS data management into a DBMS when used appropriately. And fundamental GIS design principles and methods still apply. Fig. 5.3 shows conceptive data models for thematic layers of PPM.

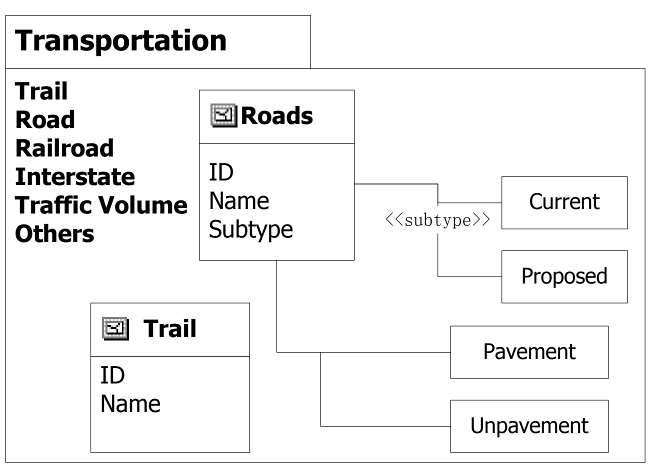
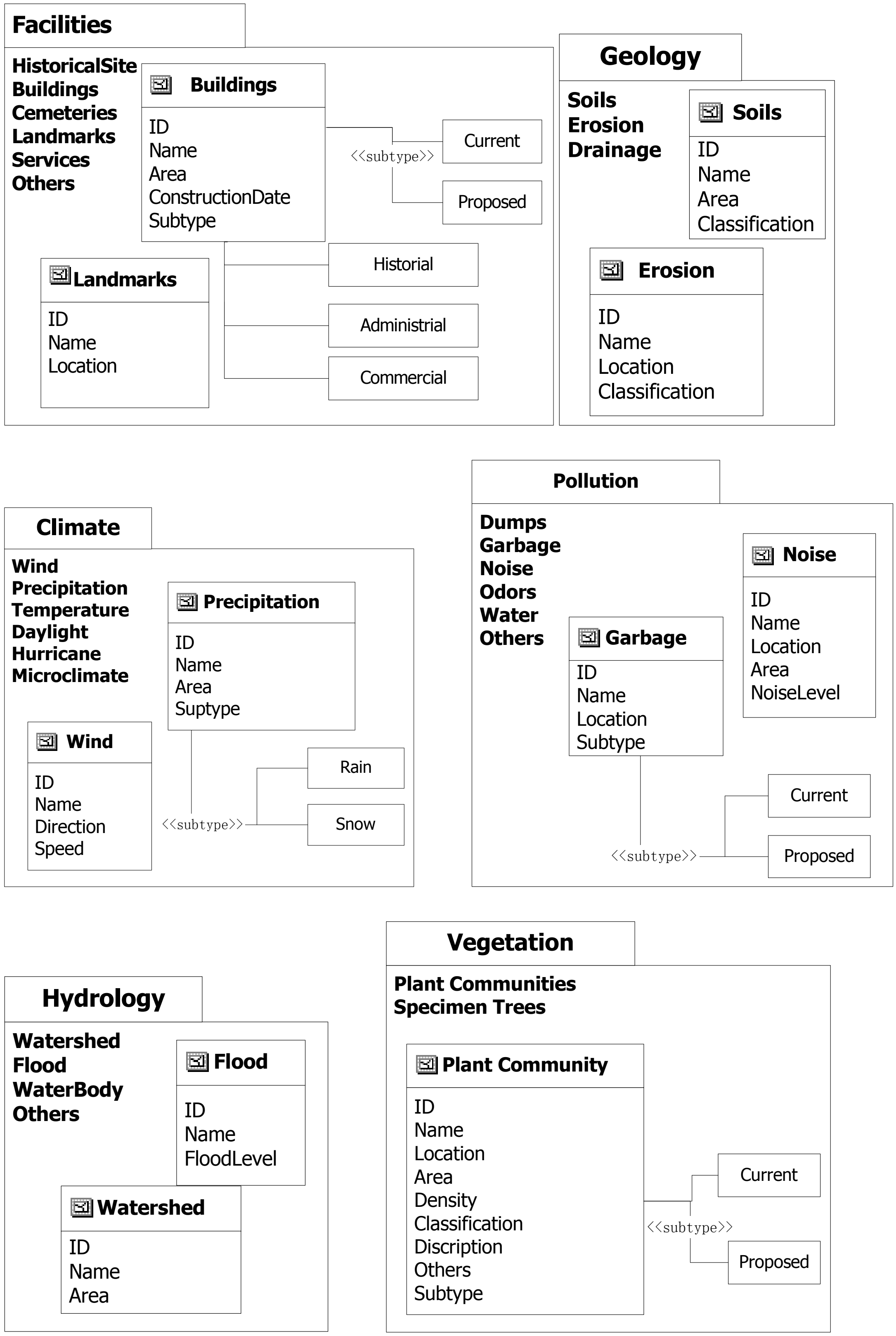
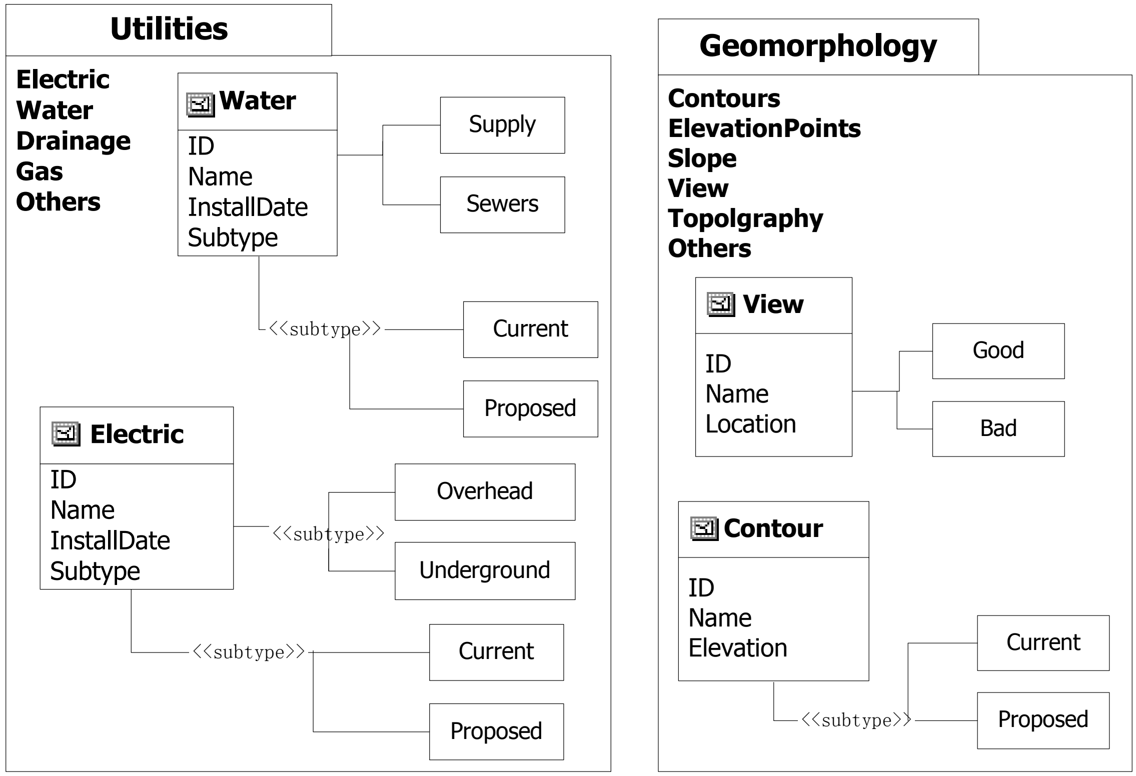


Fig. 5.3: The Data Models for thematic layers of PPM.



(Fig. 5.3 Continued)



(Fig. 5.3 Continued)

5.3 Data Collection and Assemblage

5.3.1 What Data Is Needed and Where/How to Collect It?

In a PPM GIS system, data collection is a process of several factors, including management requirements, goals of the park, project budget, and site conditions. However, not all the attributes are needed in a certain park. For different park sites, different data is collected. The goals and objectives of a project and the park site features will help determine which data should be collected.

The site's attributes are recorded and represented in the inventory maps that simply are used to describe various attributes of the site and surroundings. This process is called inventory mapping. For example, an inventory map of elevation shows the existing site

conditions for a single attribute—elevation. This map, like any other inventory map, is valid for any land use that might be considered for that site.

Category	***Warehouse***	**Feature Classes**
Physical	Geomorphology	Elevation
		Slope
		Aspect
	Hydrology	Watershed
		WaterBody
		Flood
		Aquifer recharge areas
	Geology	Soils
		Drainage
		Bearing capacity
		Depth to bedrock
		Erodibility
	Climate	Solar access
		Winds
	Wildlife	
	Vegetation	Plant communities
		Specimen trees
Cultural	Land use	Prior land use
		Land use on adjoining properties
	Transportation	Trails
		Roads
		Railroad
		Traffic Volume
	Utilities	Electric
		Gas
		Sewers
		Water
		Telecommunications
	Facilities	Buildings
		Historical Sites
		Landmarks
		Services
	Pollution	Dump
		Noise
		Odor
		Water
	Economics	Agriculture
		Commercial
		Tourism
	Administration	

Fig. 5.4: Data list used most often in PPM

Supplier	***Product Name***	**Metadata**
U.S. Geological Survey	Quad Maps (paper)	Contours, roads, rivers, lakes, ponds, some structures, forests, political boundaries 15° quads at a scale of 1:62500 7.5° quads at a scale of 1:24000
	Digital Line Graphs (DLGs)	Roads, rivers, shorelines, political boundaries Coverage for entire United States Derived from 1:100,000 maps
	Digital Elevation Models (DEMs)	Contours, spot heights (in grid cells) Coverage for entire United States Level one (hand processed); Level two (machine processed) Derived from 1:24,000 quads
	Digital Raster Graphics (DRGs)	Scanned from orthophoto quads at 1:24,000; 1:100,000
	Digital Orthophoto Quarter Quadrangle (DOQQ)	
Defense Mapping Agency	Digital Terrain Models	Contours Derived from 1:100,000 maps
National Resource Conservation Service (NRCS)		Soils Maps and reports available by county
Biological Resources Service (BRS)		Wildlife Habitats (based on State GAP projects). When files exist, coverages are statewide
U.S. Forest Service		Timber stand maps, classification, resolution. Coverages vary with each forest.
Bureau of the Census		Demographic data (STF) Roads, political boundaries (TIGER*)
Environmental Protection Agency (EPA)		Reach files: stream topology, flows

Fig. 5.5: Data Resources

Source: James A. LaGro, Jr., Site Analysis, p.35

Generally, the site data is organized into two components: physical (natural) and cultural. Fig. 5.4 shows the sample data most often used in PPM.

Traditionally, common data collection methods are interviews, surveys, document analysis, behavioral observation, visiting a state-of-the-art project, literature search, and others (Preiser, 1985, p. 11). For example, civil engineers or surveyors collect property boundaries, contours, and existing structures. Normally they need to stay in the site to collect the data.

Using GIS tools, many site features may be obtained by digital data. The data is in various formats. GPS tools help during the site survey phase to gather any position by Longitude/Latitude. Fig. 5.5 shows the resources of site information. Most of the data formats can be imported into GIS software packages, such as ArcView or GeoMedia. I will discuss this more in the next section.

5.3.2 Data Input and Conversion

Different kind of data, graphic, non-graphic, and existing digital data, is required to develop and reformat in the database. This is a process requiring a substantial investment of personnel, time, and financial resources. Fortunately, most GIS vendors provide mapping or data input and conversion tools with GIS application tools. Users can also develop a contract with a data input and conversion firm for the initial database development.

Peter L., in the book Geographic Information Systems: A Guide to the Technology, described four types of data entry and conversion in GIS database development:

- Photogrammetric compilation and digitizing using an analytical stereoplotter
- Automation of existing maps using a digitizer or scanner
- Key entry of data
- Transfer of existing digital data

The data in PPM can be classified as three ways to input and convert: converting the existing digital data, such as CAD drawings, DEM file; digitizing the aerial photograph; and entering the non-graphic data.

The main GIS application software packages, GeoMedia Professional and ArcGIS, provide the most operations of data input and conversion. These operations include graphic processing capabilities that allow users to digitize and edit maps or aerial photography, geodatabase management that includes capabilities to input and manage non-graphic data associated with map features, and conversion tools to transfer files with different formats. In GeoMedia Professional, for example, *Define CAD Server Schema File* is designed as a tool allows users to import CAD files dramatically.

Fig. 5.6 displays the data formats supported in ArcGIS and GeoMedia.

Supplier	***Product Name***	**File Types Support**
ESRI	ArcInfo ArcView ArcEdit ArcGIS 8.1	CAD (dwg, dgn...) MDB (Access) Text (txt,)
Intergraph	GeoMedia 5.0 GeoMedia Professional 5.1	ArcInfo Access ArcView (shp,) CAD (dwg, dgn...) MGE Mapinfo ODBC SQL Text (txt,)

Fig. 5.6: Data types supported in ArcGIS and GeoMedia.

5.4 Case Study—Recreation Master Plan, Chattanooga, Tennessee

This case is derived from chapter ten in the ESRI Press book GIS for Landscape Architects by Karen C. Hanna, 1999.

Chattanooga, Tennessee, is a picturesque city along the Tennessee River. In 1998, planning for new growth well into the next century, Chattanooga's Department of Parks and Recreation (DPR) undertook a ten-year update of its recreation master plan. The Philadelphia office of Wallace Roberts & Todd (WRT) was chosen to prepare the plan.

5.4.1 Goals and Objectives

After World War II, The National Recreation and Parks Association (NRPA) published standards representing the number of facilities required per person, with regional variations. The goals of the project, through supply comparison of existing recreation facilities against the NRPA's recommendation and standards set by nearby cities, are to identify recreation demand and deficiencies, develop fiscal and management recommendations, and prepare the final citywide master plan in Chattanooga.

5.4.2 Data Collection and Assemblage

WRT selected data according to the objectives. First, WRT converted CADD files provided by the Regional Planning Agency into ArcView GIS coverages to form a basemap of the city. Next WRT obtained parcel level information about every public park and recreational facility within Chattanooga and created GIS maps and a corresponding geographic database describing acreage, ownership, and specific facilities, such as baseball fields and tennis courts. This data was used to determine the shortages of different recreation amenities throughout the city.

WRT also used U.S. census data to plot population densities in the various communities throughout Chattanooga. These maps helped refine the plan's recommendations, so the right type of recreation facilities would be located near the appropriate age group.

From the initial sixteen community meetings, WRT recorded the comments in the report. Social services from health departments to housing authorities to real estate brokers tapped into the digital database to help in the decision-making process.

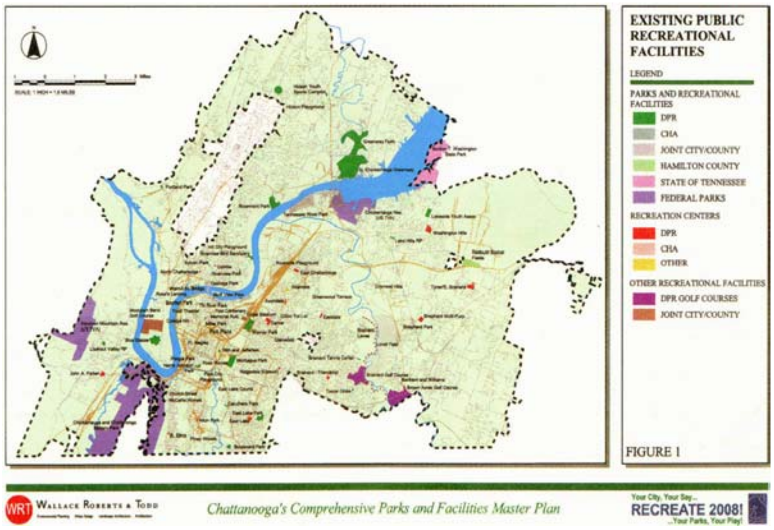


Fig. 5.7: The map of recreation facilities. (Source: Karen, GIS for Landscape Architects P.77).

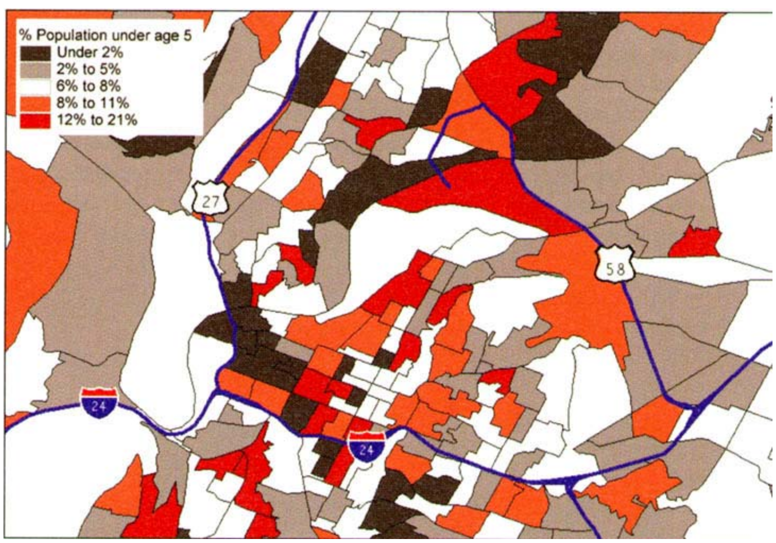


Fig. 5.8: The map of census data. (Source: Karen, GIS for Landscape Architects, P.79)

5.4.3 Analysis and Representation

Neighborhood parks were mapped surrounded by a 1-mile radius, which represents a realistic service area. These service area maps readily identified areas of the city that did not

have enough neighborhood parks. After mapping the needs, WRT addressed some recommendations to satisfy these needs, such as proposing DPR to consolidate or close some of the facilities and improve others, etc.

WRT also used these GIS maps and GIS measurement functions to provide valuable assistance in calculating capital improvements and in estimating the costs of operating and maintaining the parks.

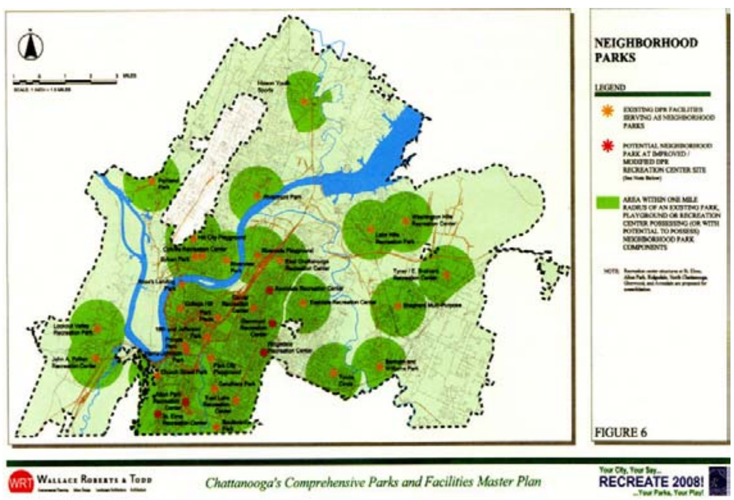


Fig. 5.9: The buffer analysis for service area of existing parks. (Source: Karen, GIS for Landscape Architects, P.80)

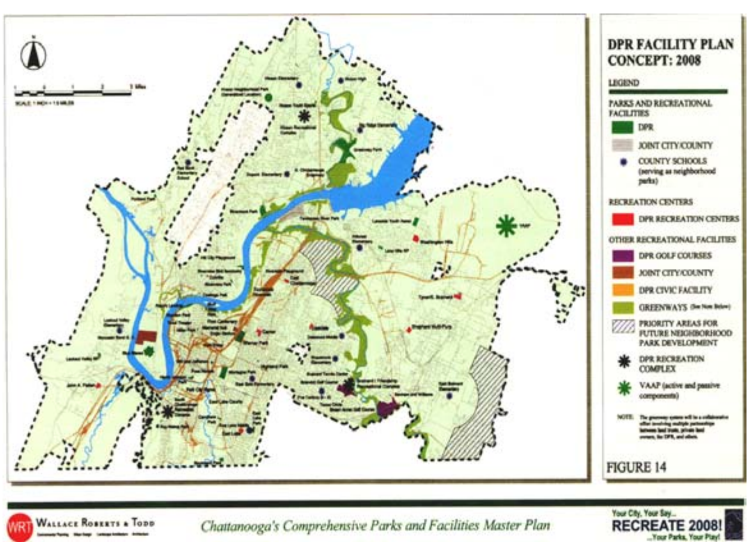


Fig. 5.10: The map of build-out park & recreation system. (Source: Karen, GIS for Landscape Architects, P.81)

Public participation through community meetings and cooperation with the DPR staff, the Citizens' Task Force and the Regional Planning Agency, and the city council were used throughout the process to make accurate conclusions.

All GIS maps and tables were generated in digital format and will be updated as portions of the master plan are implemented.

5.4.4 Conclusion

This is a relatively minor and simple project, but it clearly demonstrates some common advantages to most site planning projects conducted in GIS: it is efficient, inclusive, and graphically flexible. WRT completed the project in only eight months with the help of GIS tools (ESRI ArcView software). The GIS application could incorporate the objective ratings established by the public and the experts in its modeling operations, and it allows the decision-making process to continue as fine-tuning is needed.

CHAPTER 6 APPLICATION: PARK PLANNING AND MANAGEMENT SYSTEM AT BURDEN CENTER, BATON ROUGE, LOUISIANA

6.1 Introduction

In the previous chapters, we discussed GIS technologies aiding in the traditional process of PPM, efficient off-the-shelf GIS tools used in PPM, and methods of geographical database system design for PPM. In this chapter, we will utilize GIS techniques to carry out a real project, a prototype for the Burden Center in Baton Rouge, Louisiana. This prototype is a geodatabase foundation for Burden Center, to be used in facilitating the site planning and development. The prototype focuses on the public entrance to the LSU Burden Center site, the urban/public horticulture area.

6.2 Background

Burden Center, originally Windrush Plantation, was owned by the Burden family from the mid 1800s until the early 1990s when the final segment was donated to Louisiana State University (LSU). It is an historic rural and agricultural research center located on a 420-acre farm in the heart of Baton Rouge, Louisiana.

LSU began acquiring the property in 1966 with the donation of an initial 50-acre parcel. The donors were Mr. Steele Burden, former landscaper for the LSU Campus; his sister, Miss Ione Burden, former Assistant Dean of Women at LSU; and Mrs. Jeanette Burden, widow of their brother, Mr. Pike Burden. Additional parcels were donated annually until 1992, when the University acquired the final parcel.

Currently there are several parts inside; there are conservation/preservation, ornamental/turf research, rural life museum, Windrush Garden, horticulture and field crop

research, and urban/public horticulture, among others. The entire site is bisected by interstate 10 and can be accessed by eight miles of paths and roads.

The Burden family stipulated in the act of donation that the property be utilized for Horticultural and Agronomic research, development of the Rural Life Museum, and as a "green area," devoid of buildings extraneous to these purposes. Just prior to the donation of the final parcel of land, Mr. Steele Burden amended these stipulations to include the construction of a new LSU Art Museum and, possibly, a Museum of Natural Science on the property.

To secure the University's future adherence to these stipulations, the Ione Burden Foundation was formed to ensure basic compliance with the intent of the donation. This Foundation is composed of 12 to 14 prominent citizens who are interested in the appropriate use of this resource.

Currently, two LSU campuses are involved in the development of the property. The LSU Agriculture Center (AgCenter) is responsible for the overall maintenance and development of 413 of the total 420 acres. The Baton Rouge Campus is responsible for the development of the Rural Life Museum and the 7 acres of land that it occupies.

Adjoining Essen Lane, the urban horticulture center is in the southeast area of The Burden Center. It is an urban park of about 60 acres with special activities, and was designed as an entrance, a hub through which other sites are accessed. There are several land use areas inside, including the entry, Mr. Burden memorial, Burden administrative office, the LSU botanical garden, master gardeners, urban horticulture, woodland garden, and market. All these areas are designed as a synthetic entirety. The urban horticulture center is the first stop for visitors; therefore, many basic public activities should be placed here.

6.3 Goals and Objectives

In recent years, Burden Center has been working on updating the entire site planning and management. The following goals were identified:

- Based on the stipulations of the donation, maximize the contribution of the Burden Center to LSU and the public.
- Preserve and enhance the ecological and cultural resources of the Burden Research Center.
- Continue existing compatible uses and provide opportunities for additional compatible uses on site, including educational, recreational, and scientific activities.
- Provide a balance between financial resources, revenue-generating activities, and overall benefits.
- Enhance public visiting of resources, public awareness of conservation, and protection activities in the Burden Center.

Subordinate objectives include adjusting the entire site land use areas, developing an area security plan, redesigning the urban/public horticulture center, removing/adding greenhouses and shed houses, renovating some buildings, adding an EBR Parish Extension office, and making a new development of the Ornamental/Turf Research area.

Using these goals and objectives as directives, a prototype—geographical database system will be set up to inventory the site, focusing on the urban/public horticulture area, to facilitate Burden Center planning and management.

A retired landscaping architecture professor helped to formulate some of the objectives and also did a rough concept layout design for the site. The urban park design and development system will be set up based on the objectives and layout design.

6.4 Benefits of the System

The park planning and management system is set up to give the participants--designers (architects, landscaping architects, etc.), researchers, clients, and visitors--a clear and effective tool to help them understand the site, analyze the opportunities and constraints, make decisions, and get site illustrations, etc.

As a natural and historic site, The Burden Center is an excellent resource for researchers and visitors. A site inventory will provide a relatively comprehensive record of the site elements (attributes). In this project (system), natural and artificial features in the urban horticulture center will be collected, including topography, microclimate, buildings/structures, districts, shapes/patterns, routes, plants, landmarks/nodes, land usages/land coverings, and vistas/views, etc. This inventory will provide designers and researchers with some starting points, such as “What do we have here and its condition?” “What are the opportunities and constraints?” And then this will also help generate design or research questions such as “How do we organize the visit route?” “What do we need to keep or remove?” “Where and what do we need to build or improve?” or even “What or where do public visitors prefer to visit?”

GIS technology uses digitized files and databases to map and link the site inventory helping integrate many different formats of data and illustrate the data with maps. Furthermore, GIS technology provides many tools to help analyze and query the data (the site attributes). In the map, each group of components with the same characteristics, such as buildings or routes, is displayed in the same thematic layer, or feature class, and linked with a data table in which are recorded its attributes, such as the building size, type, and year built. Many thematic layers can be displayed at the same time. Using GIS technology, users can analyze and query the data, such as “What is the service range of a building?” or “Are there

any conflicts between the pedestrian routes and the vehicle roads?" All this information will be helpful in the design process and provides clients evidence to make decisions.

The Burden Center is on a heavily visited, abundant resource of nature and history. The GIS system can generate maps and illustrations that may be used to display to the general public and visitors, such things as the routes, a visiting map, and museum or memorial records.

In the future, this system could be expanded to all the other sites in the Burden Center, forming an entire site system benefiting site management, development, construction, and illustration. It also can be used to develop ASP web pages for display to the general public.

6.5 Data Collection and Analysis

As was discussed in the previous chapter, the general data in PPM can be organized into parts: natural and cultural. Keeping in mind the directives of the goals and objectives described before, thirteen basic thematic layers are assembled in the geodatabase. These layers include: vegetation, geology, land use, transportation, facilities, and utilities, etc. Each layer includes various features; for example, the transportation layer comprises road, sidewalk, path, trail, etc.

Because this is a prototype, I selected six thematic layers as examples in the database system: vegetation, geology, land use, transportation, facilities, and utilities.

DOQQ images can be downloaded from http://atlas.lsu.edu/rasterdown.htm. DOQQ, Digital Orthophoto Quarter Quadrangle, is a color photograph of a section of Louisiana made from an airplane. The DOQQ images' resolution is one meter, meaning each pixel on the photograph represents one meter square on the ground. In order to get more detail of the site, I gained one-foot resolution aerial photographs of the Burden Center from the CADGIS Lab, LSU. These are the highest resolution images available for free.

The LSU AgCenter provided electronic CAD files, including a property map and some building drawings. The property map is a site plan of the entire Burden center, recording property boundary, land use areas, roads, buildings, historic features, soil types, drainage, utilities, and plants.

In recent years, the entrance, roads, and paths were changed several times. In order to get the most current information, GPS devices were used to trace the latest roads and paths. The results were recorded in an ArcView shape file.

I conducted several field surveys and talked many times with the director of Burden Center, Dr. C. P. Hegwood, Jr., to receive the latest changes in the site. The property map (CAD File) was completed in 2002 and the aerial photographs were taken around 1995. Since then Burden Center has adjusted some land use areas, relocated some buildings, and dug two ponds. All these changes should be reflected in the prototype. Otherwise, I also took many pictures to record and display the site landmarks and I also made a panorama of Windrush Garden Lake view.

At the Burden Center, a retired professor of the LSU landscape architecture department works as a landscape architect for the site. He adjusted the entire site land use, redesigned the layout plan of the urban horticulture center, and made some sketches for conceptual design. In the urban horticulture center, some new gardens (e.g. the LSU botanical garden, the rose garden, and the master garden) will be added; some old buildings (greenhouse, lath) will be removed and replaced by newer buildings (new lath and office building); and the visiting route will be changed and more parking lots added.

All the data and information I received would be converted or imported into the GIS database. The data conversion and import will be discussed in detail in coming sections.

6.6 Database Design

As discussed in the previous section, each GIS database is composed of a series of thematic layers used to represent and answer questions about a particular problem set. The database is designed to define the specification for each component in the database.

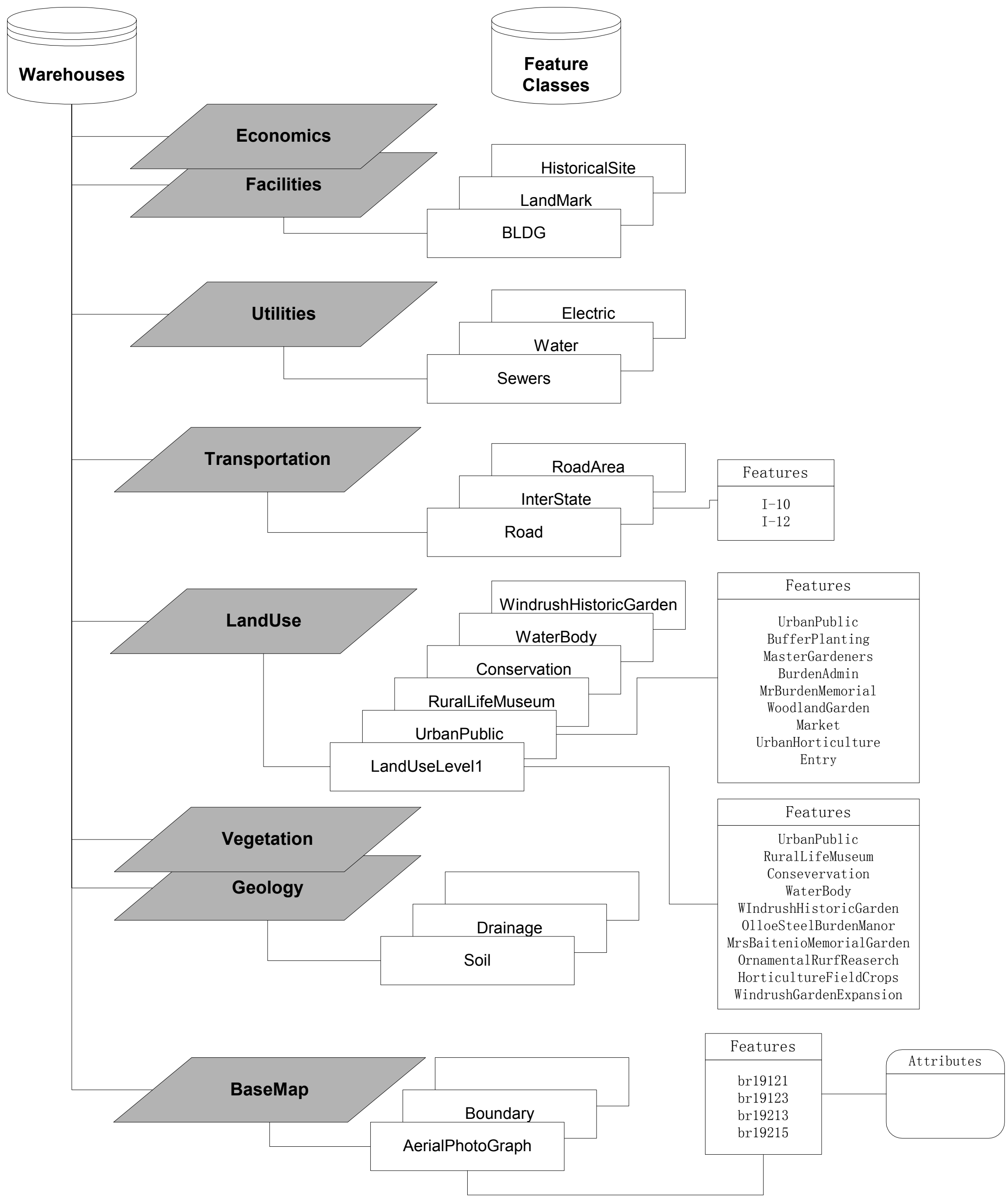


Fig. 6.1: GIS Database Structure Tree

ID	LandUseID	Name	Security
1		RuralLifeMuseum	General
2		Conservation	Accompanied
3		OllieSteeleBurdenManor	Accompanied
4		MrsBaitenioMemorialGarden	General
5		WindrushHistoricGarden	General
6		RuralLifeMuseumExtension	Accompanied
7		UrbanPublic	General
8		OrnamentalRurfReaserch	Accompanied
10		WaterBody	
11		WindrushGardenExpansion	General
12		HorticultureFieldCrops	Accompanied

Level1 LandUse Table

ID	LandUseID	Name	Security
1		BotanicalGarden	
2		UrbanPublic	
3		BufferPlanting	
4		MasterGardens	
5		BurdenAdmin	
6		MrBurdenMemorial	
7		WoodlandGarden	
8		Market	
9		UrbanHorticulture	

UrbanPublic (Level2) Table

ID	BldgID	Name	Security	Cost	BuiltDate	Function	FutureDevelop
3	94	ImpleBarn		$0.00			Remove
2	244	PrcStaffResi		$0.00			Renovate as market
6	267	ResiHorti		$0.00			Remove
9	386	GreenHouse		$0.00			Keep
10	387	ShedHse#1		$0.00			Keep
5	396	HeadHseLab		$0.00			Keep
8	397	ShadeHse#2		$0.00			Keep
1	415	ConferenceBldg		$0.00			Keep
7	426	GreenHouse		$0.00			Remove
4	434	TurfOrnLab		$0.00			Keep

Building Table for Feature Class 'BLDG'

Fig. 6.1 shows the specification and data structural tree for the GIS database. Based on the goals and objectives of the Burden Center, the GIS database includes eight warehouses (e.g., Facilities, LandUse, Basemap), and each warehouse includes a number of feature classes (graphic data), other tables (non-graphic data), and a series of relationships among the tables. Each feature class is managed as a single table.

As we know, a GIS database includes a large amount of spatial data (graphic) linked with relevant tabular data (non-graphic). The tables in page 52 are some samples linked to the relevant feature classes. We will examine more fully in the next section "System Implementation" table (non-graphic data) management and linkage between features (spatial graphic data) and table.

According to landuse classifications obtained from the American Planning Association Land Based Classification Standards (LBCS), the lands of the Burden Center are classified as two levels. Based on the site planning, the whole Burden Center is classified into eleven areas (e.g., Rural Life Museum, Water Body, Urban Horticulture Center) in level 1; level 2 classifies each level1 site into several sub-areas. The urban public horticulture center, for example, is classified into eight sub-areas (e.g., Botanical Garden, Urban Horticulture, Woodland Garden, etc.).

6.7 System Implementation

6.7.1 Software and Hardware

Getting the right software and hardware is essential for developing a GIS prototype for the Burden Center.

As the main desktop GIS application tools, both ArcGIS and GeoMedia Professional provide varies of capabilities of data management and analysis for PPM.

In the Burden Center project, I selected GeoMedia Professional 5.1 as the main GIS tool. GeoMedia Professional 5.1, one of Intergraph's GeoMedia product suite, is the latest release of desktop and web-enabled mapping visualization and analysis software tools that help users to integrate spatial data in many different formats to collect and maintain spatial data efficiently and easily. With its open architecture and live data integration, users can bring all the GIS data into a single environment and turn it into valuable information. Furthermore, GeoMedia Professional provides smart tools to capture and edit spatial data. Its flexibility, scalability, and open standards deliver productivity gains for collecting and modifying data and speeding implementation of GIS databases (www.intergraph.com/gis/gmpro/default.asp).

Another reason I selected GeoMedia Professional is that Intergraph supplied free temporary licenses to the CADGIS Lab of LSU, and the Burden Center, with each being able to use the license. The CADGIS Lab will also provide technical support in maintenance and future development of the prototype.

Hardware and software requirements for GeoMedia Professional 5.1 are:

- Pentium III or equivalent microprocessor - minimum
- 265 MB of free disk space
- 512 MB RAM recommended
- SVGA display required (Single monitor recommended). Minimum 800x600 resolution with 256 colors, recommend 1024x786 resolution and 16-bit color.
- Access to CD-ROM drive.
- Mouse or compatible digitizer for input.
- Compatible plotter or printer (optional).
- Sound card (optional).

- Software dependencies:

  Microsoft Windows NT 4.0 SP6a

  Microsoft Windows ME

  Microsoft Windows 2000 SP3

  Microsoft XP SP1

  Administrator privileges are required to install and uninstall GeoMedia Professional

  Microsoft Internet Explorer v. 3.02 or higher (needed for installation and runtime when working in the Layout Window environment).

Source: GeoMedia Professional Readme

I ran the software packages on a desktop PC from Dell, a Precision 530, with dual Intel Xeon 1.7-GHz processors, 1 GB of RAM, 40-GB hard drive, and ATI Fire GL2 Video with 64-MB memory. The operating system is Windows 2000 Professional.

6.7.2 Data Converting and Importing

GeoMedia Professional 5.1 provides different ways for different format data conversion. I gathered about five different formats of data concerning the Burden Center. Now, these data are being converted and imported into the GIS database.

To be able to better understand GeoMedia Professional, one must comprehend three basic terms in relation to the program—"warehouse," "feature," and "feature class." GeoMedia uses a warehouse to store different data. The warehouse is the source of geographic data for the software. Features in GeoMedia Professional are geographic entities represented on a map by geometry and defined by non-graphic attributes in the database. A

feature class is the classification to which each instance of a feature is assigned. Feature classes can contain point, linear, area, image, compound, and text features.

A warehouse named "Basemap" will be created to store the aerial photographs of the Burden Center. After starting GeoMedia Professional 5.1, command *New Warehouse* is used in *Warehouse* menu to create a new warehouse, and then a connection is made to that warehouse. Using *Insert Georeferenced Images* in *Insert* menu, the program will insert four aerial photographs of the Burden Center (br19121, br19123, br19213, and br19215) into the warehouse "Basemap," and create four feature classes in this warehouse to represent each image.

Fig. 6.2 shows the dialog box of inserting the images.

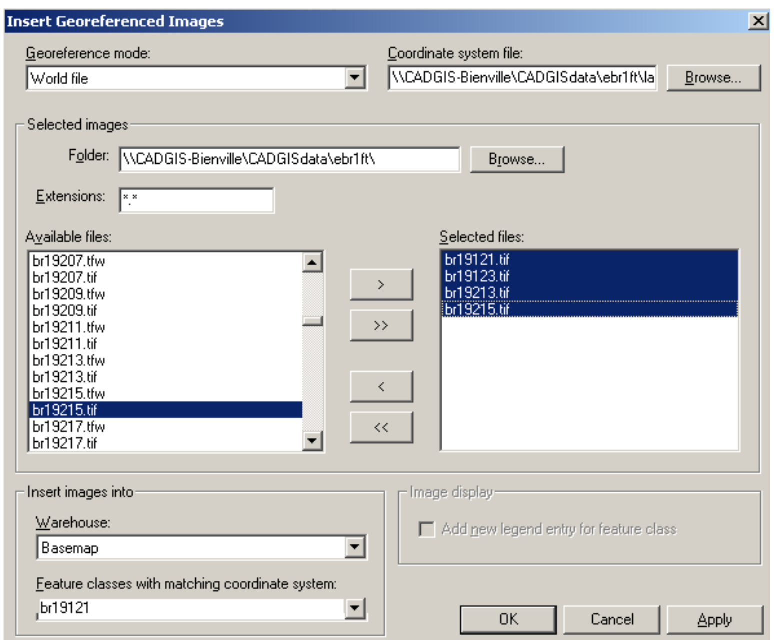


Fig. 6.2: Insert aerial photographs

CAD files I gained from the AgCenter contain a lot of information. To interpret this, I need to convert the property map into the GIS database. GeoMedia offers a tool named

DefCSD, *Define CAD Server Schema File*, which allows users to specify the parameters the software uses when creating connections with the CAD data server.

In order to convert the data needed in the Burden Center property map, the CAD file must be modified before starting the conversion. The *DefCSD* utility provides the capability of defining feature classes, allowing users to select the graphic attributes they want the CAD data server to use to determine whether a graphic element is a member of the feature class. These graphic attributes in AutoCAD include entity color, layer name, entity type, etc.; layer name is used to determine the graphic elements in the property map, which means all the graphic elements with the same layer name in the CAD file will be converted to a certain feature class. Because we need the data of land use, soil type, buildings, interstate highway, pipelines, and utilities, all these graphic elements in the property map are put in the relevant layer; elements representing the interstate highway, for example, are classified in the layer named "interstate."

After completing the modification of the CAD file, the actual conversion begins. Starting *Define CAD Server Schema File* from windows *Start>Utilities*, in the *Files* tab, the Burden Center property map and coordinate-system file that are to be used by the CAD server are selected. In the *Feature Definition* tab, the CAD server is specified to identify different features within the property map by relevant layers. Six feature classes are created named "Landcover," "InterState," "Bldg," "Pipeline," "UtWater," and "Soil," and layer name is selected as an exposed graphic attribute to define an instance of a graphic element from the property map as belonging to the relevant feature class (Fig. 6.3). This results in a CAD Schema Definition File named "Burden.csd," which will be used to connect the property map to display in the *MapWindow* of GeoMedia Professional later.

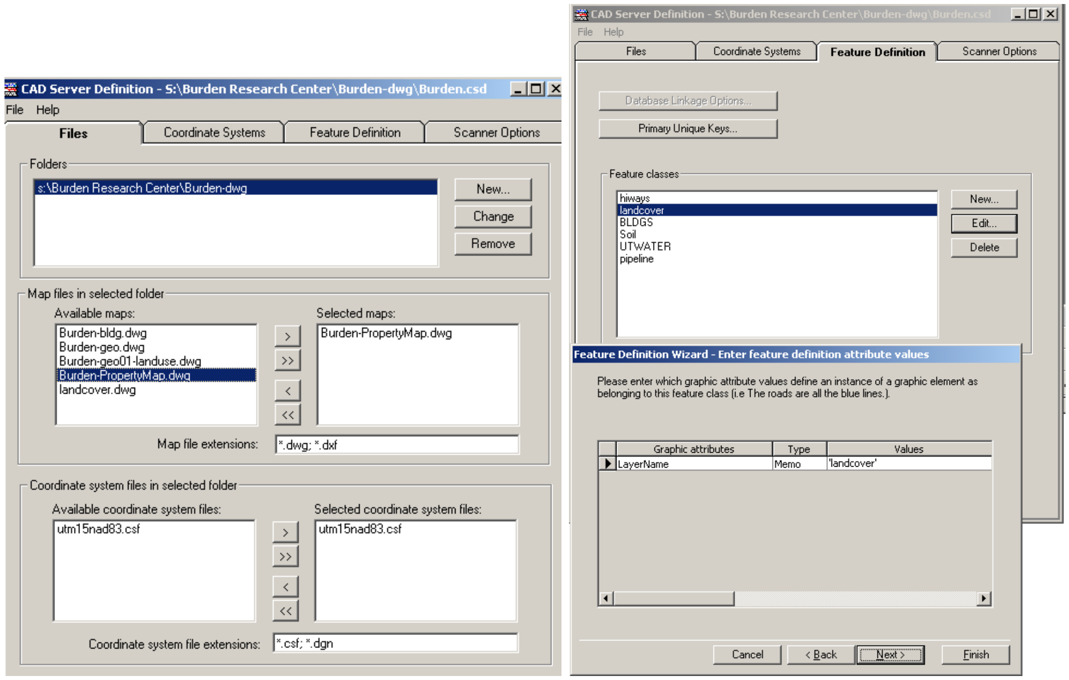


Fig. 6.3: DefCSD Dialog Box for CAD file connection.

The next step is to display the graphic element of the CAD file in GeoMedia. Starting GeoMedia Professional 5.1, a new *GeoWorkspace* which is a map window used to display the map is made and a new warehouse is created. Then a connection to that warehouse is made. The next step is to make a CAD connection to the "Burden.csf" I just made. Then using *Add Feature Class Entry* from *Legend* menu, all the feature classes created in the "Burden.csf" file to the map window are added. Fig. 6.4 shows the map of feature classes from CAD file.

When CAD files are created, there is no coordinate system defined. Therefore, the vector data in the CAD file is not always positioned correctly in relation to its real-world location on the ground when imported to GIS software packages, explaining why the features imported from the property map do not fit aerial images when displayed simultaneously (aerial images are imported from the sources where the coordinate system was defined but CAD files without the coordinate system). GeoMedia Professional offers a tool to solve this problem.

Vector Registration is used to fit incorrectly positioned vector data to its true position on the ground, and lets users define a new registration using control-point pairs that match locations on the inaccurate feature class to their correct locations on the ground. Users can choose to review the registration to ensure that the results of the registration are satisfactory and edit individual control points if necessary. Once users have an accurate registration, they can apply it to one or more feature classes or queries (one at a time) by choosing a feature class in which to save the output.

Before conducting registration, warehouses are created to store the data from the CAD file. Five warehouses, named “LandUse,” “Transportation,” “Facilities,” “Utilities,” and “Geology,” are needed to store the feature classes created in the process of *DefCSD*.

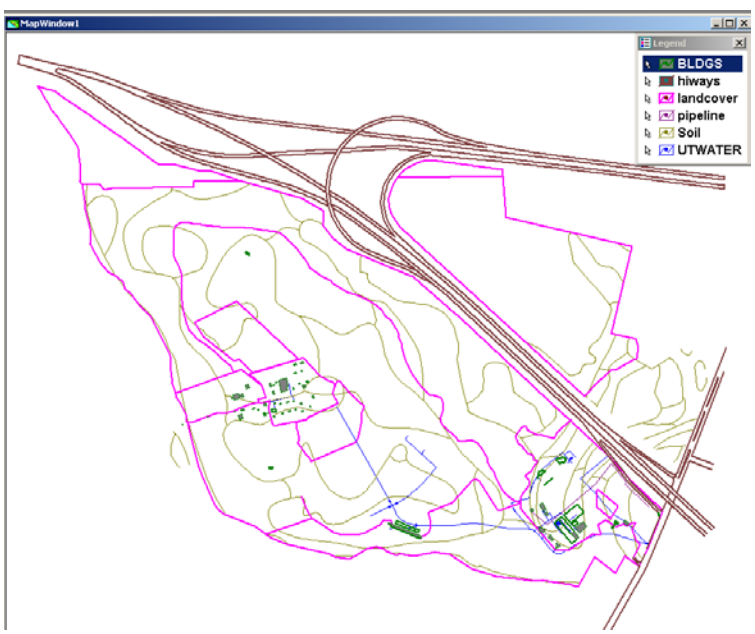


Fig. 6.4: Graphic elements from CAD file

The next step is to register the CAD vector data. In GeoMedia Professional, connections to warehouses of “Basemap” (aerial photographs) and “BurdenCenter” (CAD feature classes)

are made, and then two map windows are opened to display aerial photographs and CAD feature classes separately. The command *Vector Registration* is started from the menu *Tools*, and a new registration file is made. I select four control-point pairs (more pairs are more accurate, with at least three for Affine transformation) from the source and target (see Fig. 6.5), and click *Transform* to select the feature class "Interstate" output to the warehouse "Transportation," and then click *Apply*. I repeat the process to output "LandUse" to warehouse "LandUse," naming the feature class "LandUseLevel1," "Bldg" to warehouse "Facilities," "UtWater" and "Pipeline" to warehouse "Utilities", and "Soil" to warehouse "Geology." After these processes are finished, I have a map with the property map properly fitting the aerial images. Fig. 6.6 shows the map after CAD file registration.

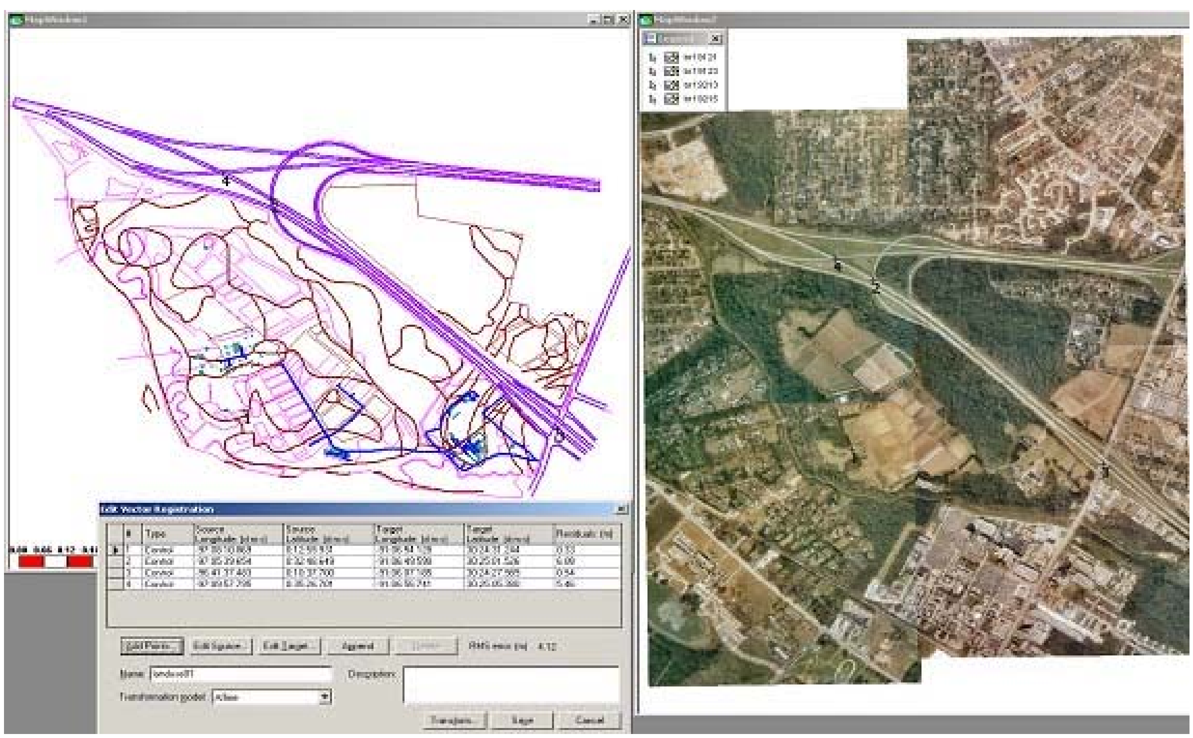


Fig. 6.5: Vector Data Registration.

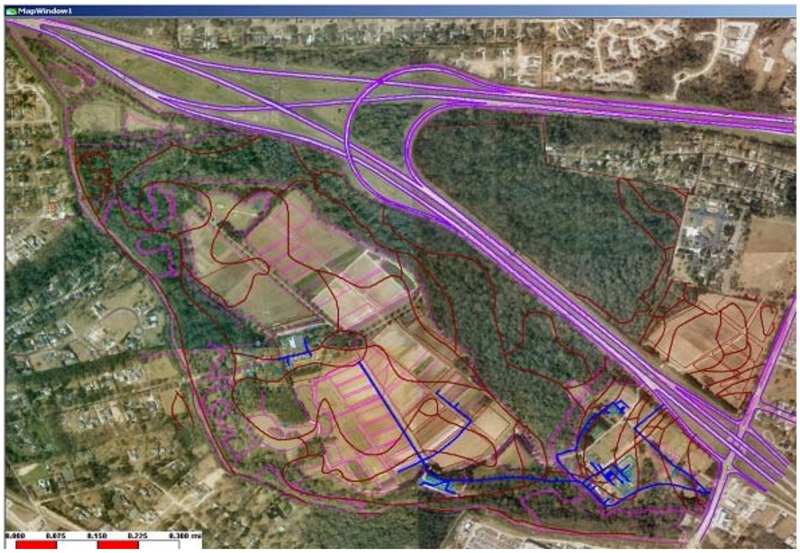


Fig. 6.6: Vector Data fit aerial photographs after Registration.

Fig. 6.7: Image Registration

A landscape architect was hired to make a land-use sketch of the urban/public horticulture center. The next step is to import the sketch and make it fit the map. First, I scan the sketch paper in JPG format, and then, using *Insert* > *Insert Interactive Image* command in GeoMedia, I insert the scanned sketch to warehouse "Basemap." Earlier, *Vector Registration* was used to fit the CAD file to the map; this time, *Image Registration* will be used to fit the

sketch file for the map. Three control-point pairs are used to do this registration. Fig. 6.7 shows the prior sketch and the map after registration. As mentioned before, a handheld GPS receiver was used to get the position of current roads and paths. The global positioning system (GPS) is a worldwide navigation and positioning system in which a network of 24 satellites serves as spatial reference points, enabling receivers on the ground to compute their geographic position.

Now, I will import the position of roads and paths (stored in ArcView shape files) into the GIS map. Using *ArcView* as the connection type, a new connection is made to the folder where the shape files store. After finishing the connection, the command *Add Feature Classes* is used to display the roads and paths in the map window, and then the command *Output to Feature Class* is used under menu *Warehouse* to store this data in the "Transportation" warehouse and name the feature class "Road" (Fig. 6.8). Fig. 6.9 displays the roads over the aerial image and shows how roads fit the image much more closely as they were both defined with the same coordinate system (In this site, it is UTM North American 1983 Zone15.).

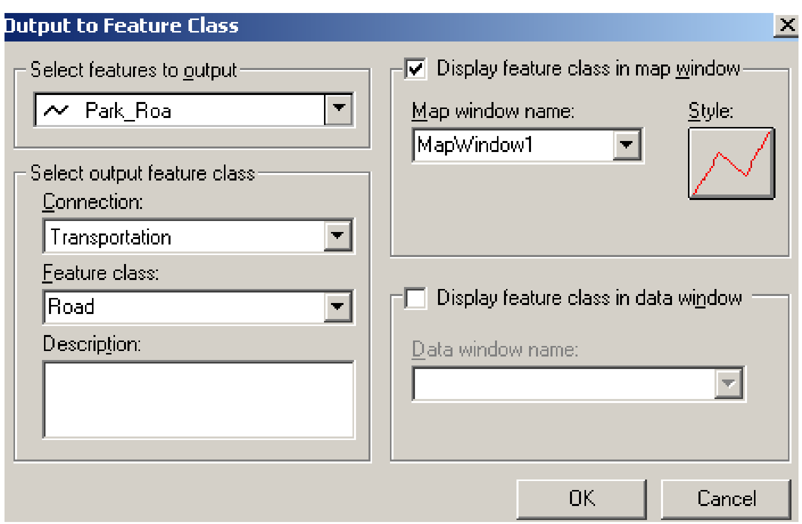


Fig. 6.8: Output feature class ArcView Shape File to warehouse.

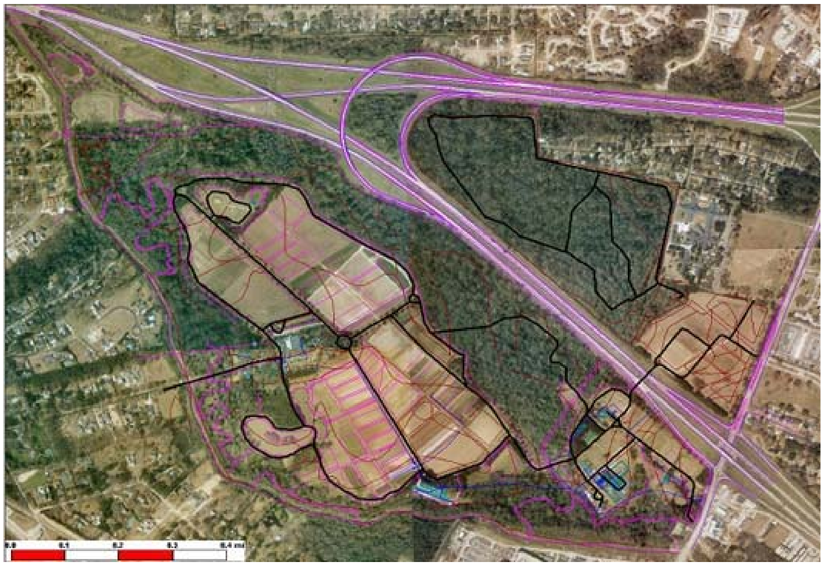


Fig. 6.9: Roads and Paths within the Burden Center Site

6.7.3 Digitizing and Modifying

In this prototypical spatial database, several warehouses are created to store different base data, such as aerial photographs, roads, and land use. However, the data from the CAD file does not cover all the information needed, e.g., water body and some new changes, and some elements do not fit aerial photographs accurately because of the imprecision of CAD files when created previously. Furthermore, most graphic elements from CAD files are just lines, although polygons are needed to represent some objects, for example, the land use area. In this section, we will discuss digitizing and modifying used to solve those problems.

Digitizing is a method of converting information from one format to another using a trace methodology. Traditionally, digitizing has meant the creation of a spatial dataset from a hardcopy source, such as a paper map or a plan. On-screen digitizing is the creation of a spatial dataset by tracing over features displayed on a computer monitor with a mouse. I will use only on-screen digitizing in this project.

GeoMedia Professional provides efficient and intelligent tools for digitizing and modifying. I will use the aerial photographs and sketch images registered in the previous section to perform digitizing, including the water body and land use area in the urban/public horticulture center. To do this, I trace over these components on the aerial photographs and sketch images to digitize them and, thus, to turn them into vector data.

GeoMedia Professional provides *Insert Feature* and *Insert Area By Face* to perform digitizing and *Placement and Editing* to modify geometry; meanwhile, it includes six types of vector snaps and six types of raster snaps that aid users in placing or editing geometry.

Before digitizing the land use area in the urban/public horticulture center, it is a new feature class needs to be created to store the data, and the water body will be stored in the feature class "LandUseLevel1." Using the *Warehouse* > *Feature Class Definition* command, a new feature class named "UrbanPublic" is created in warehouse "LandUse" for land use features in urban/public area. Then, using the *Insert* > *Insert Feature* command, I use the aerial photograph as a guide to create a body of water in feature class "LandUseLevel1", and use sketch image as a guide to digitize land use in "UrbanPublic".

Using the tool *Insert Area By Face*, I draw polygons to represent the land use areas based on the graphic elements (lines) just converted from the CAD file, and store the features (polygons) in the feature class "LandUseLevel1" of warehouse "LandUse".

Using those tools and methods, I digitize or edit interstate, buildings, roads and paths, boundary, and soil type, etc.

While geometry (feature) is created in a feature class, users can enter attributes of the new geometry to the table linked the associated feature class.

Fig. 6.10 shows the tools' menu of GeoMedia, and Figs. 6.11 and 6.12 show the map after digitizing and modifying.

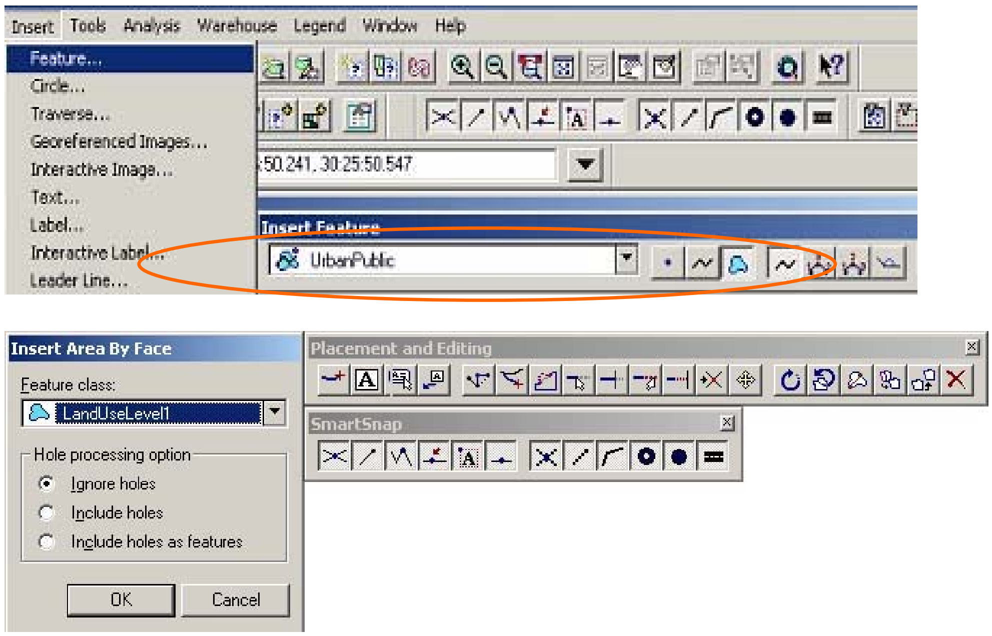


Fig. 6.10: GeoMedia Tool Menu: Insert Feature; Insert Area By Face; Placement and Editing; Snap Toolbar.

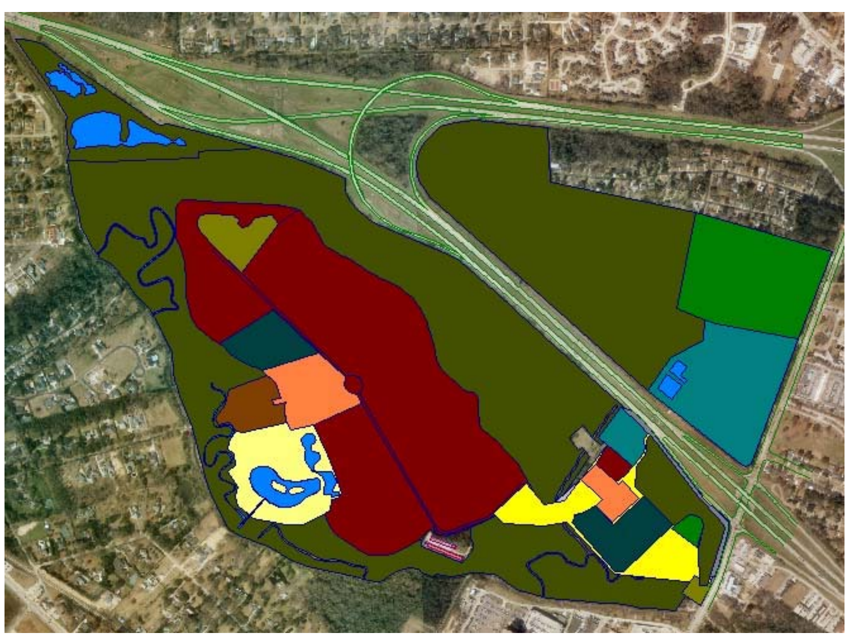


Fig. 6.11: Map After Digitizing and Modification (Landuse Level1)

Fig. 6.12: Map After Digitizing and Modification (Urban/Public Horticulture Center)

Data collection, conversion, and modification are all quite time consuming. I have only completed some basic data; a great amount of data will be collected and organized in the future development of the GIS database development.

6.7.4 Non-graphic Data Management

What has been discussed in previous sections is graphic data. As we know, non-graphic data is another basic type of data in a GIS database. Non-graphic data describes the characteristics of the graphic images. Non-graphic data includes attributes, geographically referenced data (coordinate system), and spatial relationships.

In GeoMedia Professional, when importing (inserting) aerial photographs (georeferenced image), I used the coordinate system attached with the photograph (Aerial photographs should include the coordinate system file.). When converting the CAD file, the same coordinate system file was used.

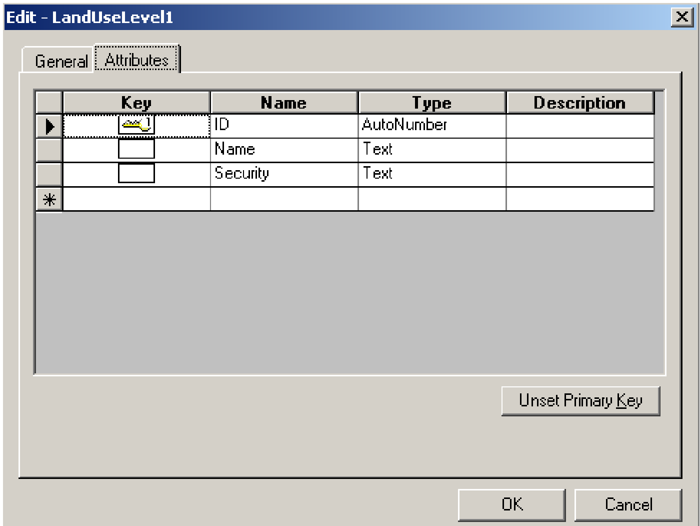


Fig. 6.13: Dialog Box of Editing Attributes

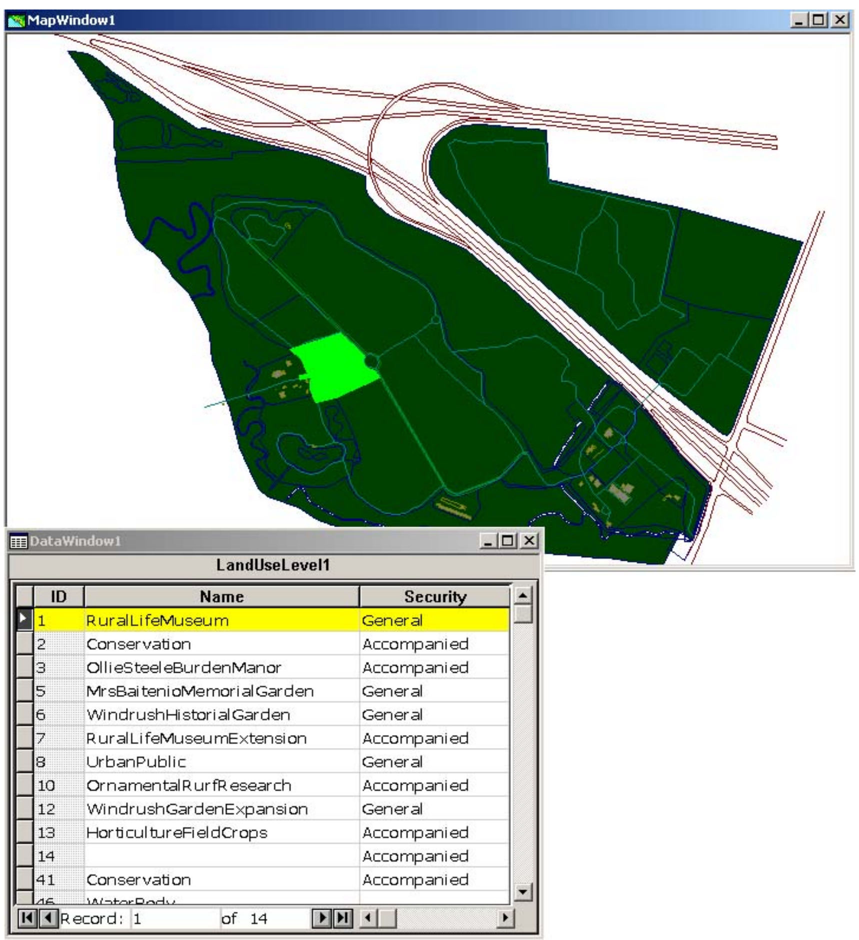


Fig. 6.14: Enter Attributes

GIS software packages often include the capability to store and retrieve non-graphic data (attribute) associated with map features. Non-graphic attributes are stored and linked with their associated map features to support map display and analysis.

In GeoMedia Professional, while a feature class is defined, a linked table is created to record the attributes of the feature class. Users need to define and add the attributes to the relevant feature. For the feature class "LandUseLevel1", I will add attributes of name and security to each feature. Starting *Warehouse>Feature Class Definition* command, I select and edit "LandUseLevel1", and then add two rows named "Name" and "Security" (Fig. 6.13).

The next step is to enter attributes for each feature in "LandUseLevel1." Starting the *Window > New Data Window* command and selecting the feature class "LandUseLevel1," a data window of the table is displayed; by selecting one row (representing a feature) to highlight it, the relevant geometry in MapWindow will highlight simultaneously, and then I enter the feature attributes in data window (Fig. 6.14). I repeat the operations entering attributes for all the other feature classes (e.g., "Soil," "UrbanPublic," "road," etc.).

Some feature attributes are created in Windows Access, and GeoMedia offers the tool *Join* to import the Access table into the GIS database and connect to its associated feature. A join is a type of query that extracts selected data from two tables that have at least one common field (normally creating a field called identifier) and combines it into a new table. I use *Analysis > Join* command to perform multi-field joins on feature classes. This allows users to create a relationship between two feature classes, so that attributes of each can be shared between them in a single resulting query. Users specify which feature classes to join, which attributes within those feature classes to join on, and what type of join operation to perform.

I have an Access table recording some attributes of buildings. After one common field named “BldgID” is created as identifier in two tables, I will import the table to the feature class “BLDG.” Making a new connection to the Access file, and starting the *Analysis > Join* command, the join dialog box displays (Fig. 6.15). The output join result is a query. After exporting the query to a new feature class replacing the old one, “BLDG,” I get an updated feature class with new attributes (Fig. 6.16).

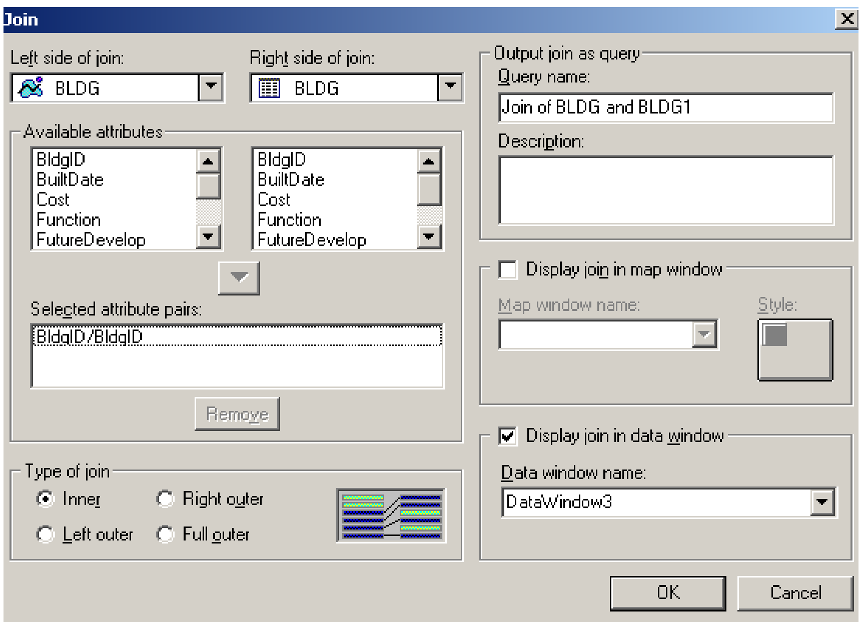
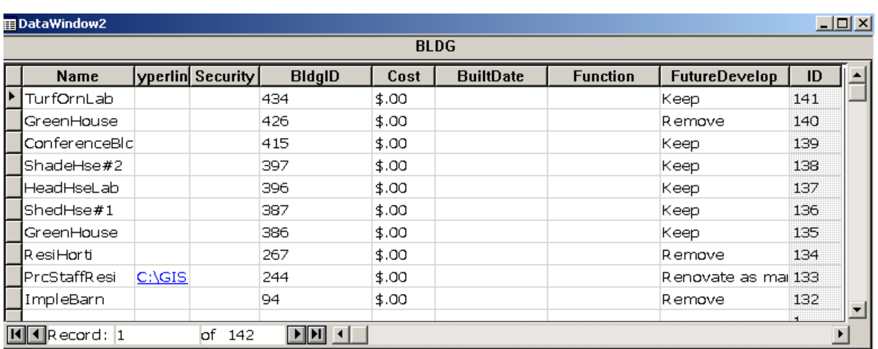


Fig. 6.15: “Join” Dialog Box



DataWindow2

BLDG

Name	yperlin	Security	BldgID	Cost	BuiltDate	Function	FutureDevelop	ID
TurfOrnLab			434	$.00			Keep	141
GreenHouse			426	$.00			Remove	140
ConferenceBlc			415	$.00			Keep	139
ShadeHse#2			397	$.00			Keep	138
HeadHseLab			396	$.00			Keep	137
ShedHse#1			387	$.00			Keep	136
GreenHouse			386	$.00			Keep	135
ResiHorti			267	$.00			Remove	134
PrcStaffResi	C:\GIS		244	$.00			Renovate as mai	133
ImpleBarn			94	$.00			Remove	132

Record: 1 of 142

Fig. 6.16: Updated Table After Join

6.7.5 Mapping and Illustrating

GIS technologies play a great role with a set of special utilities for performing routine mapping and geographic analysis. This toolbox of programs is invoked by simple commands that operate on graphic and non-graphic database elements. The utilities can be used alone in simple applications or combined with others to build more complex applications.

I will use utilities of GeoMedia Professional to display the land use classifications of the entire site and map the security site. Furthermore, I will show some pictures and a panorama of landmarks within the Burden Center.

In the previous section, two feature classes were created, including the land use classifications of the entire site (level 1) and the urban horticulture center (level 2). I will make a land use map using GeoMedia tool –*Thematic Display*. *Thematic Display* symbolizes geographic features according to non-graphic attribute data through the use of color and other user-defined display properties. For example, according to the name (attribute of the land use features) of the land use, the areas can be displayed in certain colors or symbols. In GeoMedia Professional, starting the *Legend > Add Thematic Entry* command, I select the feature class we want to display ("LandUseLevel1"), and select the attribute (name). GeoMedia assigns the different features, presenting color randomly, or users can define the color or symbol personally. Finally, I make a layout and add the map, the legend, and the scale bar. Fig. 6.17 is the final land use map.

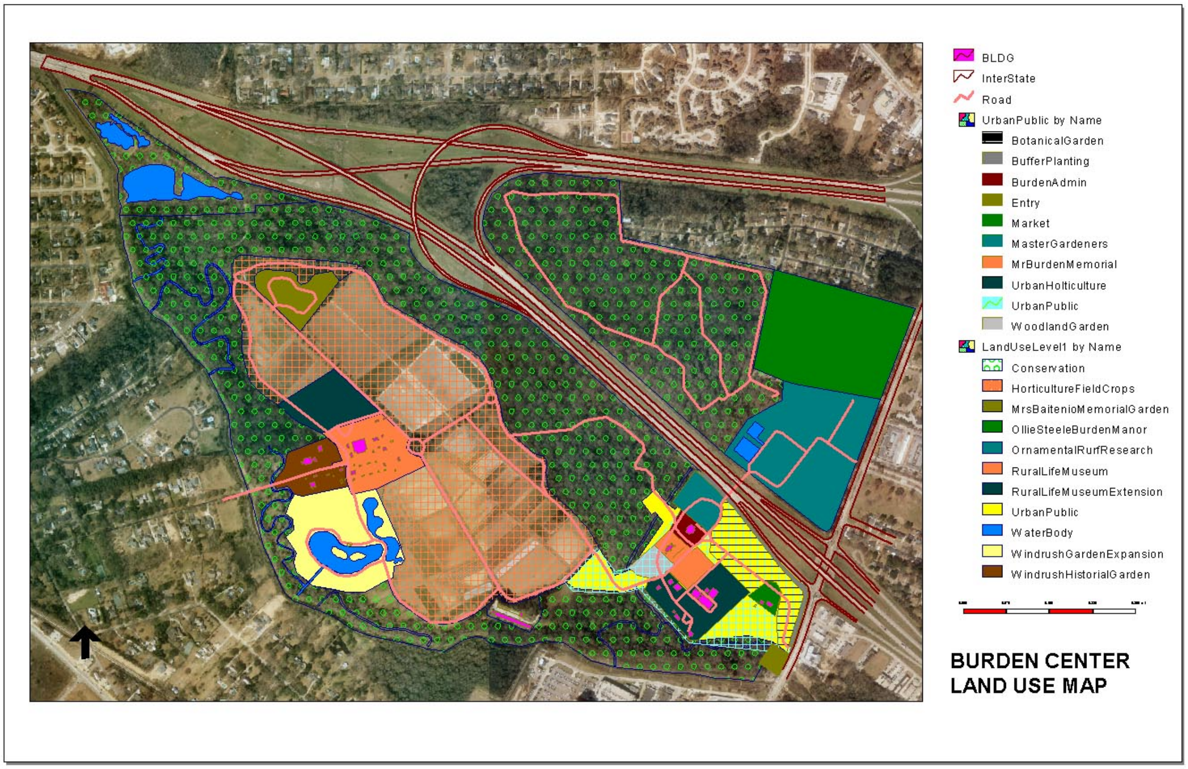


Fig. 6.17: Land Use Classification Map

The security map is used to illustrate the restricted access management for the entire Burden Center site. The entire site is classified into three security levels: restricted access (coded by red), general access (coded by green), and access accompanied by staff (coded by yellow). The restricted areas should be posted or marked to guide visitors in the site.

I have already assigned the security attribute to features of land use feature classes. Now, I make three attribute queries to request the restricted areas from the land use feature class and building feature class (some buildings are restricted access). In GIS, the *Attribute Query* command allows users to search the database for a specific value or a range of values for one attribute or a combination of attributes that apply to one feature class. By starting the *Analysis > Attribute Query* command, selecting the feature class and setting the filter as "Security = Accompanied," I get the query of "Accompanied." I repeat the steps to make the

other two queries, "General" and "Restricted," and then present them in a layout. Fig. 6.18 shows the security map.

Now, I use hyperlink to illustrate some pictures and a panorama for the landmarks within the site. Hypertext associates an external file or World Wide Web location with a feature. In GeoMedia, users can insert, edit, and open (play) hypertext. To associate hypertext with a feature, users first define a hypertext column in the feature, and then define the hypertext for the cell in the data window using the *Insert > Hypertext* command. If the cell already contains hypertext, the *Edit Hypertext* dialog box appears, which allows you to modify the hypertext. Fig. 6.19 shows a picture hyperlinked to a building.

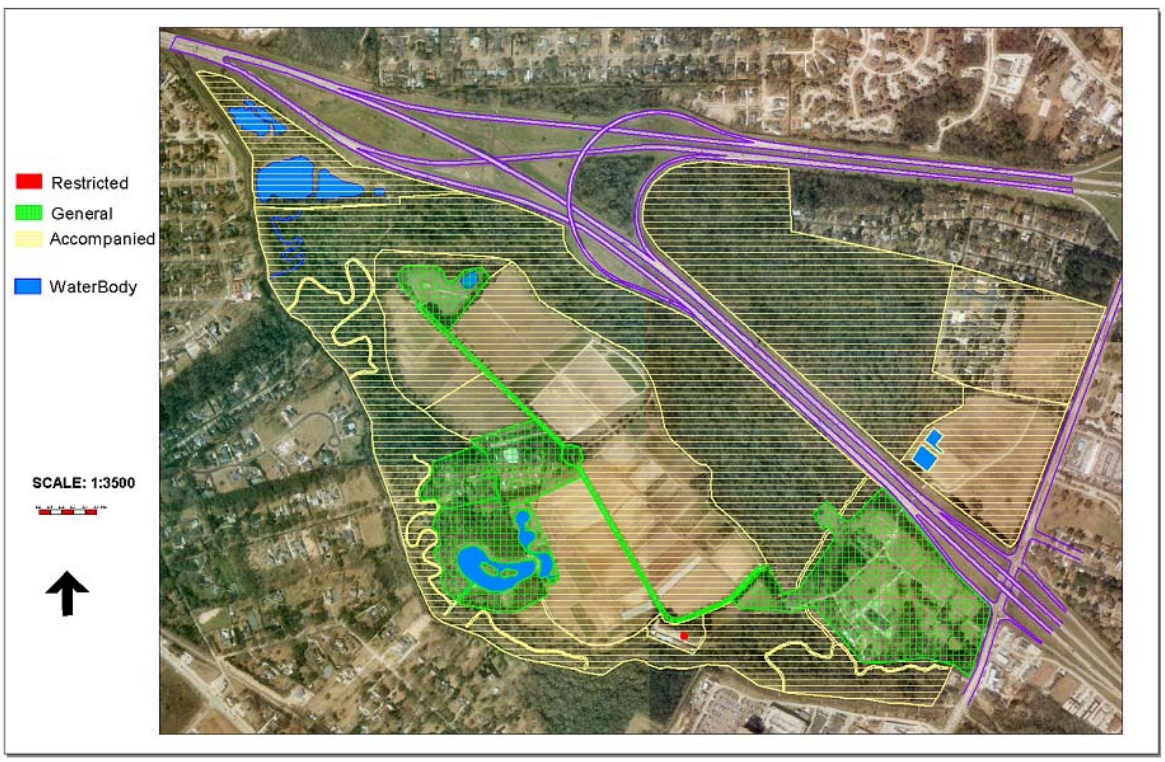


Fig. 6.18: Security Management Map

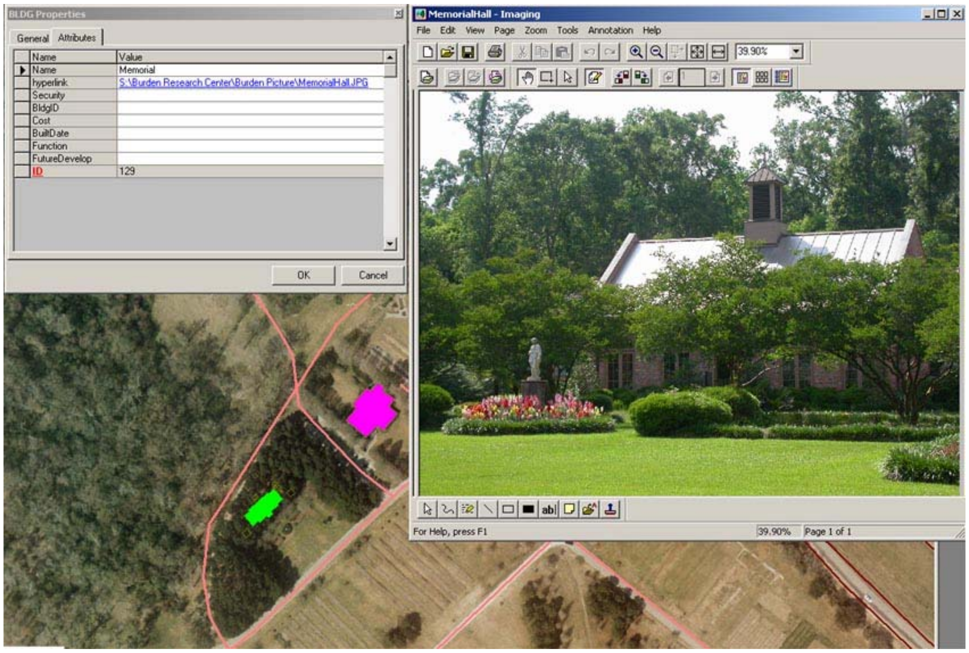


Fig. 6.19: Hypertext Link

6.7.6 Staff Training

People in GIS implementation always play a big role. When a GIS is managed effectively and staffed properly, its chance is high to succeed.

The most appropriate approach to GIS varies from project to project. In the Burden Center project, the GIS is operated within a single organization at the beginning of the project, although it may be developed to multiple organizations. The overall management is assigned to a single organization operating on behalf of all participants, so the executive is needed to coordinate the activities of the participants.

In the Burden Center, the organizational structure of GIS is centralized, with one body providing GIS services to the participants, and the participants share the data and resources. A GIS unit is created and placed for GIS responsibility in the CADGIS Lab, LSU. The Computer Aided Design and Geographic Information Systems (CADGIS) Research Laboratory at Louisiana State University is dedicated to teaching and research in the areas of

computer applications, and it also provides specialized support to other academic and research units of the University, to state and federal agencies, and to private organizations.

GIS training takes place at multiple levels. The types of training for GIS staffs generally include GIS system management, system software, general GIS concepts, and the applications of GIS technologies. In the Burden Center project, the GIS staffs should receive training in the operating system (e.g., Windows2000 Professional), basic database design concept, Microsoft Access, general GIS concepts, GeoMedia Professional 5.1, and raster and vector data process software (e.g., AutoCAD, Photoshop). The system vendor and the CADGIS Lab at LSU can provide these training courses. Various levels of courses, GIS workshops, conferences, and other events are provided in the CADGIS Lab.

6.7.7 System Development and Maintenance

This GIS project just built a prototypical database that assists the organization in identifying the format and structure requirements of the selected GIS software — GeoMedia Professional. The development of the database is the most time-consuming and costly aspect of the GIS implementation, and the data import and conversion are long–term and continuous operation. In the Burden Center GIS project, more data is needed to collect and import to improve the database. Moreover, because time will have passed since the source materials were committed to conversion, it will be necessary to bring all records up to date.

The designs and implementations of GIS always remain flexible to shifting organizational mandates and structure, advancements in technology, introduction of new techniques, and personal changes and additions. Periodic reviews, such as the major system maintenance, play an invaluable role in keeping the project on track. The reviews are focused

on particular aspects of the GIS implementation and development, such as data import, hardware, software, and application development.

Software components of a GIS are ever changing through new release of a particular product and the introduction of new products by the industry, and the cost of equipment continues to decrease relative to increased capabilities. GeoMedia has issued some extension products to enhance add-on software applications that are horizontal in nature, extending the capabilities of the GeoMedia core products for the performance of specialized tasks. Periodic review of new software releases and extensions and new hardware is another important part of system development.

6.8 Summary

This prototypal GIS database is used to put GeoMedia Professional, DBMS, and GIS to work on the development and management of the Burden Center. The approach is to prepare inventories of natural and cultural features of the entire site (the beginning is focused on the urban horticulture center), provide map presentations facilitating the site planning and design, apply predictive models to evaluate alternative proposals, and set up an ongoing landscape design and management for long-term decision making by the management partners.

The maps are presented to the Burden Center, the LSU Agriculture Center, and the Burden Foundation, as well as at public forums. The multiuse maps include a physical plan and a security management plan. Based on professional evaluation and reflecting public concerns, a refined plan will be prepared. The digital maps will allow Burden Center and other management agencies to make adjustments to the final plan as projects are implemented.

The prototype is the beginning of a GIS database system. In the future, it needs more detailed inventories for each land use of the entire site. The users can add any needed data to

expand the system. For example, designers can add the location map of hospitals near the Burden Center into the database to study the safety precautions for the visitors. Before studying an issue, users needed to collect and input the relevant data into the database. It is still an arduous and long-term task to develop a refined and final GIS database system.

CHAPTER 7 CONCLUSIONS

This paper presents the result of a study of the possibilities for developing a GIS database in facilitating the process of park planning and management. In this thesis, GeoMedia Professional 5.1 and Microsoft Access are selected as GIS-based tools to assemble a GIS database for PPM; thirteen thematic layers are used to represent most features of a park site, and nine GIS data models are designed for PPM (5.2.2); how to use these thematic layers and data models to make a template of GIS database for PPM is also described (5.3).

The capabilities of some GIS software packages (i.e., ArcGIS, GeoMedia, 3D GIS) are studied in the research: spatial representation, modeling and spatial analysis, sketch planning, 3-D representation, and web-mapping and online participation. All these abilities can be used in the traditional process of PPM (4.1). As an incredible tool, GIS has changed the approach to PPM. A GIS database offers benefits to all the participants in the process of PPM: integration, efficiency, synthesis, speed, and flexibility. On the other hand, GIS is just a tool. It has some limitations, such as needing trained staff.

7.1 Advantages

Advances in information technology have made GIS powerful and cost-effective tools for land analysis, planning, and management. Arlinghaus, 1994, stated the advantages of using GIS tools:

- Ease and speed of map revision and map scale changes
- Inexpensive production of short-run special purpose maps
- Potentially greater mapping accuracy
- Changes in the database are immediately reflected in digital map

- Spatial analysis

In this thesis, the first four advantages were proved, and the last one will gradually be tested following the development of the database. As revolutionary tools, GIS can change the way professionals participate and operate in the process of PPM. The advantages of a GIS database in PPM are both theoretical and practical.

7.1.1 Integrative and Inclusive

The development process of integrating a GIS database is not only the integration of different data types but also the integration of needs, responsibilities, and activities of the participants in the PPM. A GIS database provides a digital data collection of different formats and provides effective relationships amongst the data. When one feature or attribute is changed, the other associated data are also changed relatively.

Using this common platform of a fully integrated database, all the participants can work together on the same scale and resolution. They share the information in the database with the same symbols, the same scale, and the same attributes. Any changes made by any of the authenticated users can be easily represented and are instantly available to other users. The designers' products can be incorporated directly into the work of other professionals.

7.1.2 Efficient

The PPM process is time-consuming and complex due to vast quantities and different types of data that are collected and analyzed. Effectively managing this data and deriving meaningful results are essential to a successful PPM system. GIS is a very efficient tool to handle a large amount of data in a relatively short time. Within the GIS database system, all the operations (e.g., queries, buffers, overlays) can be combined to make a single model or sets of models, and then users can use the models to derive different results with different

variables. With these inexpensive trials, more time can be saved to do other work rather than on the execution of each model.

Traditional operations in the process of PPM take place with a lot of file paper and rolls of drawings. GIS allows all information or files to be conveniently stored and accessed in a database. GIS also allows spatial data and its attributes to be displayed with an efficient visualization tool, the on-screen map. Data previously displayed as a printed list, a database file, or a spreadsheet will come alive in a GIS as the data is displayed using a map interface.

7.1.3 Map Synthesizing

Graphic representation plays the leading role in the process of PPM. It transfers planning ideas and strategies among professionals and provides illustrations for the public and agencies. The graphic capabilities of GIS provide dynamic and synthesizing map representations. Users can produce maps using the richness of symbols with variable line weights, fill patterns, fonts, and even hand-drawn symbols. Users also can import different formats (even hand-free sketches) of drawings from different professionals into the GIS database to produce needed maps.

7.1.4 Speedy, Flexible

The rapid evolution of contemporary society means that demographics, economics, and policies change more quickly. Thus, the park planning and management has to be more flexible to respond to ever-changing circumstance. It was about every ten to twenty years for master plans and comprehensive plans to be revised. But now, it is at about five-year intervals or even more frequently. If some information has been changed, it is easier to make modifications based on the GIS database. The data within the GIS database is collected from different resources, and changes of this data can be imported into the database and used to

update and revise the planning maps. Based on the dynamic GIS database system, planning maps are no longer static images, but a flexible and dynamic system.

7.2 Critical Factors

7.2.1 Data Quality

In order to make sure the maps and results are accurate, the quality of collected data is the most important issue. Data must be of the highest possible quality, accurate, relevant, and complete. The database must be concise, avoiding data duplication and redundancy. Data must be timely and current, and presented in a way that is clear and understandable. Before usage, data must be tested and known. A GIS database system that contains trusted and strategic information is a valuable enterprise resource for professionals and agencies to make right decisions. Bad data must produce inaccurate knowledge that turns out wrong strategies and decisions, and that is the beginning of disaster.

Different kind of data is required to develop and reformat in the database. This is a process requiring a substantial investment of personnel, time, and financial resources. Actually, only after data input and digitization are finished, the users may receive the advantages and benefits of the GIS database system.

7.2.2 Need Trained Staff to Maintain the System

Although some GIS software packages, such as ArcGIS and GeoMedia Professional, are not difficult to learn (even two or three days of trainings can be enough to get started), it still needs trained personnel who are designated to perform several specific jobs or functions. These jobs include project and system management, database administration, and system analysis and operation. The complexity of the GIS database system, number of users, and sophistication of the applications dictate the number and level of skills of personnel needed

for a specific GIS. If it is required for the development and maintenance of application programs, system support, and problem resolution, the personnel with knowledge of appropriate programming skills are needed.

7.3 Lessons Learned

We discussed the metadata in a previous chapter and showed that metadata is "data about data." In the GIS database design, metadata plays a key role, and that is reflected in several aspects of data. A significant lesson learned is that in the beginning of the GIS database design, it is necessary to think thoroughly about some aspects of the metadata, which include the spatial reference, data organization information, and entity and attribute information.

Spatial reference, a system of intersecting coordinate lines--meridians and parallels--on a flat surface on which features from the curved surface of the earth are mapped and used to measure spatial location, is about how the data is referenced to the real world (coordinate systems). When all the data files are collected, it is very important to make sure the data is at the same coordinate system, or a coordinate system file should be created to represent the map projection of the data files. This can keep all the spatial data and maps located at the same and correct position on the surface of the earth. In the prototypical GIS database of the Burden Center, the projection coordinate system is UTM Northern Zone15, and the geodetic datum is North American 1983.

Data organization information is about data models, relationships among the data models, and how the data is organized. The object-oriented (OO) technology is used to design the GIS database for PPM. The data is designed to reflect the objects that are abstract representations of the real world. In the process of PPM, it is necessary to map the existing condition and future development of the site. One way is to organize all the objects or entities

into two groups or feature classes -- “existing” and “proposed.” Although this method can display the maps of “existing” and “proposed” easily, it causes the problem of data redundancy, because many objects may be kept for future development. For example, an existing object that will be used in the future, such as an old building kept or preserved for future use, would be duplicated in two feature classes. In order to avoid data redundancy, each data model is designed as a feature class, and a name is used as descriptive of the class characteristic that is being modeled. Such a procedure is especially useful when two classes are involved in more than one relationship. For example, “building” is used as the name of the class to model all the buildings in the site, while “existing” and “proposed” are designed as attributes to describe the building object. All the objects needed in the site are modeled using this way (See Fig. 5.3 and Fig. 6.1). The existing map and future development map are derived from querying the attributes of “existing” and “proposed” separately.

I think the most important lesson I learned is how productive the design process becomes in the prototype design and pilot implementation. Using personal GIS database design to prototype aspects of the Burden Center GIS database design is highly productive. This method helps to quickly test and prototype any design idea to determine if it will meet the real world requirements.

7.4 Future Development

GIS will play an important role in research, demonstration, and design. The speedy development of computer technologies provides more effective and convenient tools in PPM.

7.4.1 Portable, Wireless GIS

The trend in computer hardware has indicated that more powerful computing capabilities are packed into smaller and smaller spaces. In the last decade, it has been seen that the

physical size of the computers became smaller, going from normal desktop units toward laptop and "notebook" units with equal power. Tablet PC provides more convenient and portable operations to GIS users. The laptop workstations are also available with competitive prices.

The smaller size of computer hardware, together with better digital communications, gives the opportunity for a portable GIS. It will be seen that GIS workstations will soon appear in a number of applications such as transport control, emergency services, etc.

Wireless technology offers unrestricted data communication. With the tablet PC and wireless network, professionals can even finish operations on the site, such as data import and transport, spatial analysis, etc.

7.4.2 Intelligence GIS

It is seen that artificial intelligence will become an important component of GIS. This includes techniques such as fuzzy logic, expert systems, neural networks, and learning systems. Natural language processing will also provide GIS with capabilities of better interaction with the user. More intelligent tools will be developed for better decision-making using GIS technology.

Advances in GIS, combined with the proliferation of commercially available digital data, have substantially broadened the analytical capabilities of professionals engaged in the process of PPM. The role of spatial information technologies in PPM will surely expand substantially in the future.

REFERENCES

- http://www.gis.com/software/index.html
- http://www.gis.com/data/
- http://www.spatialintelligence.com.au/whatisgis/whatisgis.htm
- http://www.nvrpa.org/pohick/index.html
- http://www.esri.com/library/whitepapers/pdfs/arcgis_3d_anal.pdf
- http://www.multigen.com/products/3d_gis/index.shtml
- http://www.multigen-paradigm.com/support/dc_files/SB3D_Whitepaper.pdf
- http://www.multigen.com/support/dc_files/SiteBuilder3D_brochure.pdf
- Donley, Charles, AICP, New Community Planning Tools in Real Life Applications, http://gis.esri.com/library/userconf/proc02/pap0854/p0854.htm
- http://gislounge.com/glossary/bldefdigitizing.shtml
- http://www.fes.uwaterloo.ca/crs/plan674d/futuregis.pdf
- Milstead, J. and S. Feldman, 1999. Metadata: Cataloging by any other name... Online, Inc. (magazine article, published January 1999): http://www.onlineinc.com/onlinemag/metadata/Dublin Core Metadata Initiative (frequently asked questions)
- O'Toole, Brian E., Mary Beth Fletcher and Russel Banks. The Integration of ArcView/3D Analyst and 3D Simulation Technologies for Interactive Visualization of Urban Environments, http://gis.esri.com/library/userconf/proc00/professional/papers/PAP969/p969.htm.
- Antenucci, John C., Kay Brown, Peter L. Croswell, Michael J. Kevany, and Hugh Archer. 1991. Geographic Information Systems – A Guide to the Technology. Van Nostrand Reinhold.
- Arlinghaus, S. L., ed. 1994. Practical Handbook of Digital Mapping: Terms and Concepts. CRC Press, Boca Raton, Florida.
- Barnett, Jonathan. 1982. An Introduction to Urban Design, Harper and Row Publishers Inc., New York.

- Batty et al, Michael. 2000. Visualizing the City: Communicating Urban Design to Planners and Decision-Makers. http://www.casa.ucl.ac.uk/publications/full_list.htm (paper 26)

- Batty, Michael, Martin Dodge, Bin Jiang, and Andy Smith. 2000. New Technologies for Urban Designers: The VENUE Project. http://www.casa.ucl.ac.uk/publications/full_list.htm (paper 21)

- Batty, Michael, Martin Dodge, Bin Jiang, and Andy Smith. 1998. GIS and Urban Design. http://www.casa.ucl.ac.uk/publications/full_list.htm (paper 3).

- Bevelander, Marjan. 2001. The Application of GIS in Major Urban Planning Projects in the Netherlands, MSc Unigis.

- Booth, Bob and Andy Mitchell. 1999-2001. Getting Started with ArcGIS, ESRI.

- Christiansen, Monty L. 1997. Park Planning Handbook. Join Wiley & Sons, Inc.

- Cutler, Laurence Stephan and Sherrie Stephens Cutler. 1982. Recycling Cities for People—The Urban Design Process. Boston, Mass. CBI Pub. Co.

- Densham, P. 1991. Spatial Decision Support Systems. in D. J. Maguire, M. F. Goodchild and D. W. Rhind (Editors) Geographical Information Systems. Longmans, Harlow, UK. p. 403-412.

- Densham, P. 1996. Visual Interactive Locational Analysis. in P. Longley and M. Batty (Editors) Spatial Analysis: GIS in a Modelling Environment. GeoInformation International, Cambridge, UK. p. 185-205.

- Garvin, Alexander and Gayle Berens. 1997. Urban Parks and Open Space. Washington, D. C. ULI-the Urban Land Institute.

- Harris, B. (1989) Beyond Geographic Information Systems: Computers and the Planning Professional. Journal of the American Planning Association. p. 55, p. 85-90.

- Hanna, Karen C. 1999. GIS for Landscape Architects. ESRI Press.

- Hanna, Karen C. and R. Brian Culpepper. 1999. GIS in Site Design. Join Wiley & Sons, Inc.

- J., Grimshaw D. 1994. Bring GIS into Business. Longman.

- James A. LaGro, Jr. Site Analysis--Linking Program and Concept in Land Planning and Design. John Wiley & Sons, Inc.

- Klosterman, R. E. 1997. Planning Support Systems: A New Perspective on Computer-Aided Planning. Journal of Planning Education and Research, in press.
- McCurdy, Dwight R. 1985. Park Management. Southern Illinois University Press.
- Phillips, Leonard E. 1996. Parks: Design and Management. McGraw-Hill.
- Spreiregen, Poul D. 1965. Urban Design: the Architecture of Towns and Cities. New York, McGraw-Hill.
- Singh, Raj R. 1996. Exploiting GIS for Sketch Planning, http://gis.esri.com/library/userconf/proc96/TO300/PAP260/P260.HTM
- Star, J. and Estes J. E. 1990. Geographic Information System: An Introduction. Upper Saddle River, NJ: Prentice Hall.
- Weir, L. H. 1928. Parks: a Manual of Municipal and Country Parks. A. S. Barnes and Company.

VITA

Zhitao Su was born on November 30, 1966, in Jiangxi, China. He is the second of three children born to Qunsheng Su and Xuezhen Zheng. He received a Bachelor of Science degree in Architecture from Tongji University in Shanghai, China in July of 1988. After his graduation, he worked in some architectural design firms for ten years. From 1999 to 2001, he was employed in Bechtel, China as a senior architect. He is a first-degree registered architect in China.

In 2001, he entered Louisiana State University and is currently a candidate for the degree of Master of Architecture to be awarded in August 2003.