Balancing Environmental Quality and Economic Vitality in the Adirondack Park

Adirondack Park Agency
Center for Technology in Government

CTG Project Report 95-3

Center for Technology in Government
University at Albany / SUNY

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EXECUTIVE SUMMARY

New York's Adirondack Park encompasses 12 counties and 105 towns in upstate New York. Whiteface Mountain, Lake Placid, and vast stretches of wilderness share the park with towns and businesses, sportsmen and women, vacationers, and year-round residents.

The Adirondack Park Agency (APA) plays a pivotal, often controversial, role in the life of north country communities. Its mission is to maintain the delicate balance between environmental quality and economic vitality in the region. As regulator of land use over the 3.5 million acres of privately owned land in the Park, the APA maintains tens of thousands of records about real property, natural resources, and physical and civil infrastructure. These records are kept in filing cabinets, map trays, microfiche jackets, film canisters, boxes, closets, and a few computerized databases that, together with 50 headquarters staff, fill every inch of the building from basement to attic. Staff depend on these records every day to give advice or make decisions about proposals to buy land, construct buildings, or carry on other development projects. The information is important to lawyers, realtors, landowners and developers, researchers, and federal, state, and local governments. Organizing, finding, and using effectively so many different kinds of information has become a critical problem for both the agency and its customers.

Collecting the information needed to give an answer or make a decision often consumes much more time than the analysis of the request. Gathering existing information, rendering geographically oriented data into a consistent scale, and moving files among different staff specialists take much more time. As a result, it takes several days to respond to a phone inquiry, weeks to make a jurisdictional determination, and months to issue a permit.

During 1994-95, the Center for Technology in Government worked with APA and several corporate and university partners to develop and evaluate a prototype system to combine document records and geographic data into a unified "electronic reference desk" that allows agency staff to point at a land parcel displayed on an electronic map and summon legal documents, other maps, project plans and related information about the property. They may find the parcel by owner name, tax parcel ID or simple map location. The prototype gathers into one place and one format a wide variety of useful information. Using this prototype, which concentrated on data for land in Essex County, APA staff were able to identify those activities where technology would improve responsiveness and reduce operating costs. The prototype and its evaluation illustrated for the agency the financial and staff resources that would be needed to develop and implement a complete system. The project also identified significant potential for internal quality improvements and new customer services.

APA and its customers can benefit greatly from a system similar to the one prototyped at CTG. The system can help APA provide the same services more cheaply, and it can reduce average customer waiting time dramatically. The response time for two-thirds of APA's customer contacts, telephone inquiries, can be reduced by 99%. Other customer transactions can see response time improvements ranging from as little as 3% for highly technical major projects to 67% for local planning requests. The system can also help APA promote reengineering of internal work processes and development of a variety of positive external relationships and enhanced services. However, the cost of acquiring and maintaining such a system is relatively high, particularly in light of the evolving nature of the technology involved. Due to relatively high current technology prices and the likelihood that less expensive technology and data sets will soon become available, we recommend an evolutionary approach to system implementation focused first on those aspects of the system that will yield short term productivity gains and improved responsiveness to customers.

The key issue for APA, then, is not *whether* it should convert to a fully digital approach to geographic and document data, but *when* it should convert. The estimated annual benefits will remain high well into the future, and it seems clear that they will outweigh the annual costs by a considerable margin. It also seems clear that one-time system acquisition and data conversion costs will continue to drop for the next several years at least. An evolutionary strategy involving the gradual acquisition of selected data layers and a building block approach to hardware and software acquisition seems most likely to maximize benefits and minimize risks.

In addition to the specific results related to the prototype system, the project produced the following benefits for the Adirondack Park Agency:

System Benefits

The project helped agency staff think about a full system in terms of both products and customers and helped them distinguish those functions which could be improved by automation from those that are not amenable to technology-based improvements. The project and the experience with the prototype system enabled APA staff to think about a full system in terms of the work that they do and to identify key features and data structures that would be required in a full system to effectively support their work processes. They also gave the agency an opportunity to view its workload and performance the way its customers do and showed the important differences between customer perceptions and staff perceptions of major activities.

Prototype development entailed a close examination and immediate improvement of work processes and existing information management practices. For example, APA developed database indexes to support its existing jurisdictional inquiry process. By putting these indexes on several existing free-standing computers, the agency has already decreased the time it takes to access the information needed to support customer transactions.

Intergovernmental relations, especially with the county governments in the Park, have improved, and effective partnerships have been demonstrated. During the project, it was necessary for APA to work with local governments to obtain and digitize some of the data to support the prototype system. As one result, Essex County (the area emphasized in the prototype) now has digitized tax map data to support its own work processes, and APA has a comprehensive electronic database for the most populous region of the Park.

Experience with the prototype enabled agency staff to identify specific additional improvements in quality and program design that would be made possible by an integrated information system. After experimenting with the prototype and participating in facilitated discussions, APA staff identified many possible improvements in their operations. These ranged from better use of staff time, to more effective internal communications, to better use of data for long-range analysis and planning. They also saw new ways to support responsible economic development, to engage in cooperative data creation efforts, and to improve interagency and intergovernmental relations.

The project results also hold many lessons that are of value to any government organization facing similar problems regarding prototyping, land records, data development, and the need to integrate and manage information in a variety of formats.

Lessons Learned

The sooner a prototype is developed, the more it can stimulate creative problem solving. In this regard, a quickly-developed prototype is better than one with more features that takes longer to construct. Introducing agency staff to a stripped down technology solution, loaded with their own data, is a powerful catalyst for creativity. Subsequent project activities, including the final prototype design and the modeling and benefit analyses, are much more grounded in reality because staff have seen the technology in action and have developed some confidence in its potential by having experienced first-hand how it might work.

A prototype is a valuable tool to focus attention on non-technical issues. In defining the workflow to be automated in a prototype, agency staff must discuss what they actually do in performing their jobs. This produces a better understanding of how those jobs can be changed (with and without the technology) to improve service. A prototype system can then serve as a powerful focus for discussion of important agency business problems and helps direct attention to key policy and management questions: What is the problem we're trying to solve? How do we currently attack the problem? What do we need to be able to solve the problem? How will we measure improvement? Who will benefit? While these questions don't require a prototype to answer, having a prototype in hand shows how information, processes, and technology work together.

The automated permit retrieval system prototype demonstrates a unique model for integrated records management and land information systems. A number of states and counties have sought to improve land records management and the related services they provide. The APA system is a first attempt to manage integrated records across different physical media and institutional sources. Other governments struggling with disparate types and forms of data will benefit from knowing more about the core technologies and information management techniques explored in this project.

A coherent data development and management strategy is essential to the success of any system which relies on a variety of data formats and sources. No system is better than the quality, integrity, and consistency of the data it contains. The project demonstrated the importance of having a clear picture of an organization's data resources and a well-articulated data management program. Some key program elements include sufficient metadata to describe datasets, consistent coding schemes for related data, data modeling to identify and make use of the relationships among data elements and data types, and recognition that data resources belong to the entire organization and should not become isolated in separate work units or program areas.

Use of existing spatial or tabular data is a simple, quick, and cost-effective method of populating a new geographic information system (GIS) with data, but users must be aware of the special problems presented by temporal inconsistencies and scale variability across different data sources. Use of existing data is particularly desirable when prototyping, since it enables a prototype system to become functional in far less time than when data must be acquired from outside sources. However, both time of data creation and scale of physical representation are sources of unavoidable inaccuracy when different data layers are used in concert. This problem is manageable if well-documented and well-understood by users.

Service bureaus that perform document conversion provide highly specialized services; the services offered, quality of results, and prices charged are likely to vary widely. Choice of vendor may be strongly influenced by the output file formats they are able to provide and their ability to be read by image display software. In addition, tight quality control is needed at every step of the document conversion process. Sending sample data to several vendors is highly recommended; in this way image quality, job pricing, file storage requirements, and timeliness of delivery may be evaluated. Several vendors, each with a specific area of expertise, may be needed to complete a complex document conversion process.

1. PROJECT OVERVIEW

About the Adirondack Park

New Yorkers are blessed with one of the most important, unique, and outstanding park areas found anywhere in the country -- the Adirondack Park. Created in 1892 and now almost six million acres in size, the Adirondack Park is larger than the State of Vermont. It is also the largest state park in the contiguous United States and the largest natural area and designated wilderness east of the Mississippi. Larger than Yellowstone, Everglades, Glacier, and Grand Canyon National Parks combined, it is also the primary component of the Champlain-Adirondack Biosphere Reserve. This Reserve is the largest in North America and the fourth largest of some 300 such Reserves in the world, areas internationally recognized for their unique and special value to conservation, education, and scientific research.

The Adirondack Park embraces dozens of ancient mountains, hundreds of glacial lakes, thousands of acres of fragile wetlands, some of the most precious and diverse scenic, natural, plant, fish and wildlife resources in the eastern United States. Forty-two percent of the Park (2.5 million acres) is owned by the people of the State, part of the Forest Preserve which the State Constitution requires be "forever kept as wild forest lands." The remaining 3.5 million acres are privately owned. The Park has about 130,000 year-round residents, an additional 75,000 seasonal residents, and approximately nine million visitors annually. It is also within a day's drive of some 60 million people. Not surprisingly, tourism is its major industry.

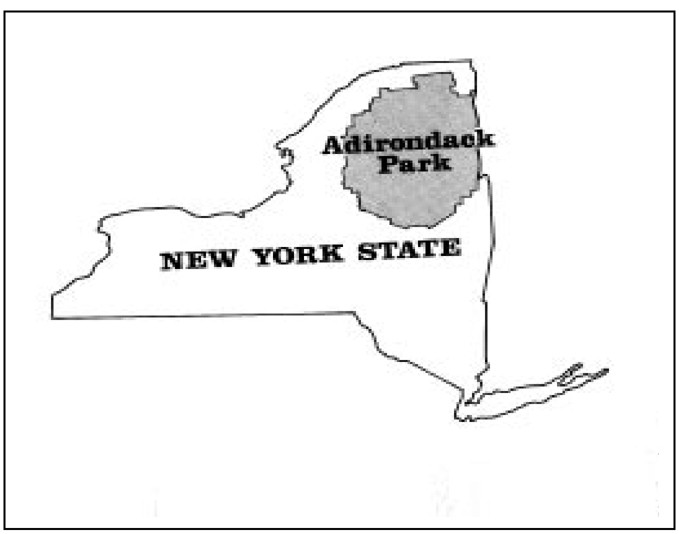


Figure 1
New York State with Adirondack Park highlighted

Current APA Operations

The New York State Adirondack Park Agency (APA) is an independent agency within the Executive Department. By its enabling statute, the Adirondack Park Agency Act (Executive Law, Article 27), it is mandated to formulate land use development regulations and long-range policy for Park. It also administers the State Wild, Scenic and Recreational Rivers System Act (Environmental Conservation Law, Article 15, Title 27) for private lands along over 1,200 miles of Park rivers, and the Freshwater Wetlands Act (Environmental Conservation Law, Article 24) for over 850,000 acres of wetlands on both public and private lands. The Agency undertakes these responsibilities with a staff of 65 employees having functional specialties in site planning, resource analysis, law, regional and local planning, environmental education, administration, cartography, engineering, and economics. Staff answer to a Board of 11 members that meets monthly to make decisions on various development proposals and to take action on reports of the agency's legal, enforcement, planning, and other standing committees.

The Agency also administers interpretive centers in the towns of Paul Smiths, in Franklin County, and Newcomb, in Essex County. The goal of these centers is to explain the natural and human characteristics of the Adirondack Park and to educate both residents and visitors about the importance of conserving and protecting the Park's resources.

The task that absorbs the greatest amount of staff and Board attention is the administration of the Private Land Use and Development Plan, which seeks to protect the State's interest in the Park while allowing use of the privately-owned land within it for private purposes. The 2.5 million acres of public lands in the Adirondack Park are managed according to the State Land Master Plan developed by the Agency. These public lands are categorized according to their resource characteristics, pattern of use, and ability to withstand additional recreational activity. The 3.5 million acres of private lands in the Park are governed by the Adirondack Park Land Use and Development Plan, adopted by the NYS Legislature in 1973. This plan classifies the Park's private lands into six categories according to their ability to withstand development without significant adverse environmental impacts. The number of buildings allowed varies, depending on the private land use classification. Further, depending on the classification of the private land parcel on which it is proposed, permits for many types of development are required.

In its capacity as regulator of development and subdivision, the APA serves a varied clientele. Owners of land within the Park seek advice on whether a permit is necessary for proposed development projects or as a condition of mortgage financing and similar real property transactions. APA issues permits after determining that the proposed development satisfies statutory and regulatory requirements. In issuing a permit, the agency is required to consider 37 statutorily enumerated development considerations. Permits are recorded in county clerks' offices, and "run with the land" very similar to a deed, binding subsequent purchasers and other grantees of the land involved. Each permit contains extensive and detailed findings about what project is being proposed; the environmental setting including the land use area in which the development is to take place; the proximity of the project to navigable waters, wetlands, historic preservation areas and endangered species habitats; and what impact the proposed development will have on the Park's environment. Permits indicate the conditions under which adverse impact on Park resources can be minimized. In addition, input from owners of property adjoining a proposed development site is weighed. The agency also issues formal legally binding "letters of non-jurisdiction" when it determines that no permit is required for a proposed project.

Since 1973, the agency has reviewed over 10,000 development projects and subdivisions, averaging some 400 permits issued each year. These records alone total over 120,000 pages. In addition, the agency maintains a variety of other records related to real property including reported violations of development restrictions or environmental laws. Over 1,000 multi-page letters constituting binding legal advice about whether a permit is necessary are also issued annually. These and other land management documents, including legal opinions, jurisdictional advice, vested rights decisions, maps, photographic and other non-standard documents, dating from 1973 to the present, are used in determining the need for land use permits in the Adirondack Park. Together they represent an overwhelming mountain of paper, taking up literally hundreds of cubic feet of storage space and presenting enormous information, organization, maintenance, and access challenges to the agency.

This information is stored in file cabinets, map trays, microfiche jackets. film canisters, boxes, closets, stairwells, and any other available space in the agency's 16,000 square foot log office. Ready access to these records has been limited to the Ray Brook headquarters and is frustrated by a lack of personnel to manage extensive paper files along with the various special media formats. At the same time, however, the agency has developed an extensive capability using Geographic Information System technologies. It has created or enhanced automated maps to describe the extent and characteristics of land use areas depicted on the Official Adirondack Park Land Use and Development Plan Map and to prompt key environmental issues for permit review staff.

The agency was recently studied by a Task Force concerned with reducing delays in service to citizens. Currently, citizens and businesses must wait weeks or even months for decisions, advice, or permits from the agency before they can proceed with development projects, or make other personal home improvements or business decisions. The agency's inability to provide timely responses to public inquiries is rooted primarily in the inordinate amount of time required for staff to search and locate paper files and other information required to provide legal advice to landowner clients of the agency. The Task Force concluded that automation of the functions discussed above is an essential element of procedural reform in light of the nature of the problems with access to the documents and the personnel constraints at the agency. Inquiries for particular factual questions -- "Does a permit exist for property x?"; "What is the zoning classification of my land?" -- that under best conditions now take several weeks would be available for immediate response. More complex legal inquiries that would still require research and analysis would be made more consistent, with less time-consuming quality control procedures, and should be facilitated significantly. An integrated approach to information and records management is essential because of the disparate types and forms of data which the agency must rely on daily to make well-founded decisions affecting the Park's natural resources and the lives and livelihoods of residents and property owners. For the public, this would bring agency response times into the normal business decision "windows" for mortgage commitments and real estate transactions that have become unmanageable for many Park landowners. This would mean significant savings for clients of the agency.

Center for Technology in Government Project

The project conducted at the Center was one of four selected from a field of 21 proposals submitted in 1993. Initial discussions began in December 1993 and design work began in early 1994. The project team included APA program and technical staff, faculty experts from the University at Albany's Department of Public Administration and Policy, and CTG professional staff and graduate students. The project team also included several corporate partners. Computer Sciences Corporation (CSC) served as principal systems architect for development of the prototype. Hewlett-Packard Corporation (HP) provided development and evaluation platforms for this activity, and NYNEX Corporation donated telecommunications resources. Environmental Systems Research Institute (ESRI), contributed ArcView2, a front-end for its Arc/Info geographic information system software. Excalibur Technologies Corporation provided use of its EFS document management product.

Project Objectives

The project was designed to prototype, demonstrate, and evaluate a rapid document and map retrieval system for all agency records related to real property. The system should allow agency staff to respond immediately to public inquiries that currently require extensive and time-consuming data search and retrieval and should eventually allow on-line remote access to essential agency information. Within this larger goal, the project team pursued four major objectives:

1. Create a prototype system that integrates geographic information, databases, and documents.

2. Convert existing agency data for use in the prototype.

3. Estimate the costs and performance characteristics of a full system and devise a data conversion strategy for populating a full system.

4. Identify additional customer service improvements and other extended benefits that a new system could provide.

Project Workplan and Participant Roles

Figure 2 shows the major blocks of work that comprised the project workplan. CSC played the lead role in workflow analysis and prototype design. CTG, APA, and CSC all shared in the prototype development process. With respect to data preparation, APA staff took responsibility for the conversion of existing GIS data and maps, while CTG staff concentrated on the conversion of document and microform data. CTG research staff, and faculty fellows conducted the evaluation efforts.

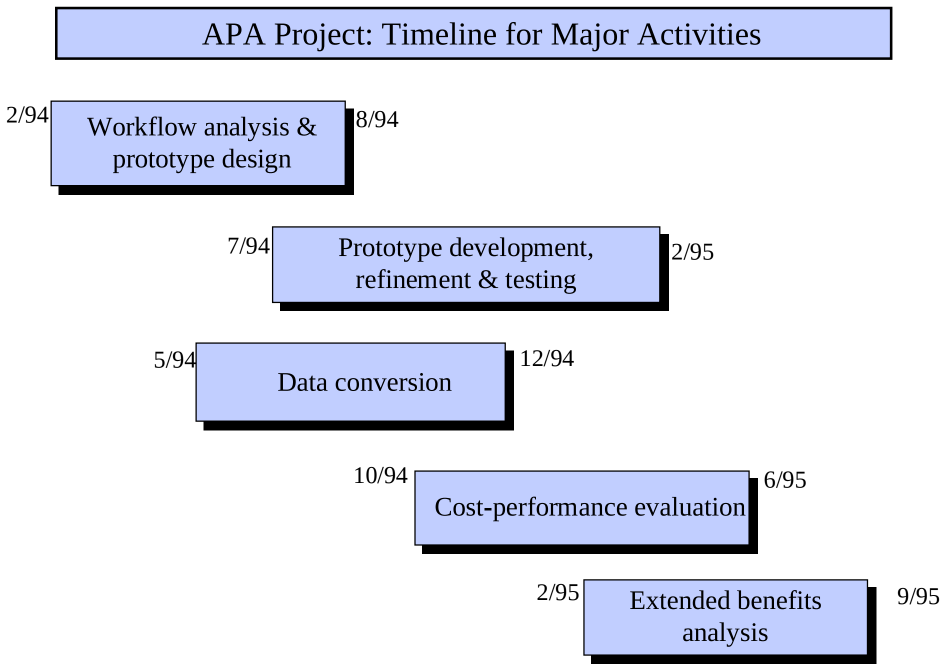


Figure 2
Overview of the Project Workplan

1. Creation of an Integrated Geographic Information and Document System. This activity involved the analysis of existing agency work processes and the definition and creation of an on-line system that provided APA staff with access to geographic data, geographic analysis tools, and paper documents such as deeds and project files. The information in the system was keyed to property locations, owner information, and major transaction types. Given that no commercial off-the-shelf system offered this combination of functionality, the prototype entailed building a custom integration of a Geographic Information System (GIS) and a document management system.

2. Populating the Prototype System with Existing Agency Data. The agency's existing electronic databases of geographic and record-oriented data needed to be modified to support the new on-line functions. In addition, paper- and microfilm-based documents were converted into electronic form and entered into the prototype database. It was not possible to create a database containing all necessary information for the entire Adirondack Park within the scope and resources of the project. Since APA wanted the prototype system to be data rich, comprehensive data was incorporated for one area of the park, rather than providing a more extensive coverage of partial data for a larger geographic area. Essex County was chosen as the prototype target, with two local regions (North Elba and Lake Placid) having the most complete data available.

3. Estimating Cost and Performance Characteristics of a New System and Devising a Data Conversion Strategy for the Future. In order to evaluate how well the prototype and ultimately, a fully implemented system might meet the agency's objectives, CTG used a multi-method approach to evaluation. The evaluation efforts included facilitated group modeling conferences, two surveys, and staff interviews. During February and March 1995, 26 APA staff were trained in the use of the prototype. Prior to the demonstration of the prototype, each staff member was asked to complete a brief survey. Following the demonstration and training, a second survey was implemented and follow-up interviews were conducted by CTG staff. Additionally, APA staff participated in a series of three group modeling conferences between October 1994 and March 1995. The first and second of these conferences were designed to examine the cost and performance characteristics of a fully implemented system and the potential impacts of a full system on customer turn-around time. The third modeling conference was conducted to examine in detail the costs associated with creating or converting the various data types necessary to support a full system.

4. Identifying Additional Customer Service Improvements and other Extended Benefits. Several of the research methods used by the CTG evaluation staff sought to capture the potential extended benefits of a fully implemented system. The primary purpose of the cost-performance modeling conferences was to examine the costs and benefits of the limited and expanded system options. However, some of the data emerging from those conferences indicated that further analysis of the agency's work processes was needed in order to recognize the maximum benefits of automation or, alternatively, to achieve productivity benefits without the introduction of technology. In order to further examine these issues, CTG conducted the staff surveys and interviews and a series of analyses that attempted to get at the question of how work organization can leverage relatively small staff savings into relatively large service improvements.

2. PROJECT RESULTS

Objective 1: The Prototype System

APA and Computer Sciences Corporation (CSC) originally envisioned a prototype that contained a complete set of functionality for processing jurisdictional inquiries (JIFs). These inquiries are filed by landowners or their agents for a formal determination by APA that a permit is or is not required for a proposed activity. The original design included customized user interfaces for different staff members depending on their job functions, with workflow capabilities that would route JIF applications through the appropriate processing steps. Scanning and printing modules were included so that all members of the agency who currently handle the paper files could understand how the technology would impact their jobs. This system was to be built by integrating four technologies: a geographic information system, a document management system, a workflow system, and a database system to serve as data repository and communication link between system components.

As the design work progressed, it became clear that resource constraints would preclude constructing a prototype to the original specifications, and several changes were made in the design. Workflow capabilities such as on-line forms and routing of electronic folders among staff members was eliminated from the prototype. Adding new documents by scanning them in was not possible in the prototype, and all documents were batch-loaded. A single user interface combining functionality common to all users was provided rather than a series of customized interfaces for different kinds of staff. Because of the smaller scale of the prototype, data management tools provided by the GIS and document management systems were used in lieu of a specialized database system. The technical details of the prototype system are contained in Appendix C.

Compared to the vision APA had for a full system, the prototype had several important limitations. The most important was the inability to create and store new work products. For example, a user could locate a parcel, and view the documents associated with it, but could not store these data together into a new folder. The prototype did not take advantage of many of the possible links between documents across folders, and relied on the GIS software to display overlaps and relationships. In addition, the absence of interprocess communications between the GIS and the document software meant that a user could not re-use old sessions to look at new documents. This led to a buildup of open sessions which slowed the prototype's performance.

Despite these limitations, however, the integration of technologies that could display maps and documents in a single integrated system was critical in educating the APA staff in how the technology could revolutionize their operations. Briefly, the prototype works as follows:

When an APA staff member is investigating a property or case inquiry, the system provides access to several types of APA information. Through the workstation, the user can locate a property on a map, and view it in combination with other geographic data. Staff members may also look for existing related actions, read scanned document images from the existing files, and print a record of this information for their own or their customer's use.

Parcels can be identified by pointing to a location on an electronic map, by selecting the parcel's Tax Map ID (if known), by searching an index for a name associated with the property, or by using a search feature which identifies parcels that are within a specified distance from a known location.

Several coverages can be overlaid on the base map (e.g., land classification, wetlands). In addition, scanned images of documents associated with the parcel (such as deeds and past project determinations) can be displayed in concert with the map. The system can print any displayed window as well as standardized reports.

Figure 3 below illustrates how the prototype combines and displays geographic information with database and document information for a particular land parcel.

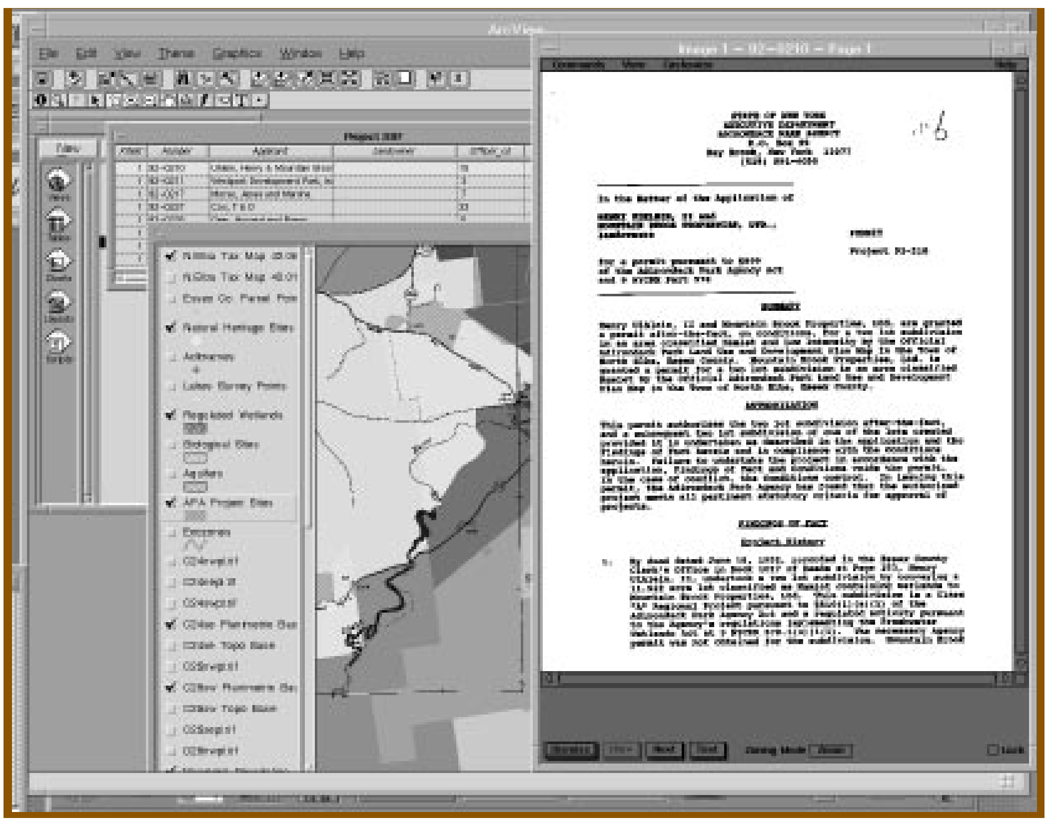


FIGURE 3
Prototype User Interface

In hindsight, this simplified system was exactly the right thing to provide to the agency. It allowed staff to see the basic capabilities of the technology relatively quickly and at a relatively low cost, and to imagine how the technology could be used to do their jobs better. More importantly, because all agency staff were exposed to the same functionality, they could envision how technology could enable work redesign by combining tasks and re-organizing workflow. If we had constructed specialized user interfaces for individual staff, this would have served to automate the current division of responsibilities. Instead, this sample of the basic capabilities allowed the agency to think more broadly about how the technology would change its operations.

Objective 2: Conversion and Integration of Existing Data into the Prototype System

Approximately 80% of the total cost associated with a Geographical Information System is related in some way to data collection (Thapa and Bossler, 1992). Because it is both costly and time-consuming to locate and acquire data, convert it to digital form, and integrate it into a GIS, the prototype included as much of APA's existing digital data as possible. Conversion of other data to digital form was also necessary and approached in several ways.

Spatial Data Integration Issues

Coverages present in the agency's existing GIS were integrated into the prototype without conversion, and several database files were imported directly from their native structures. Many types of image data (TIFF, Erdas LAN, and others) were also used in their original formats. In this manner, the prototype became functional far more quickly than if new data had to be acquired from outside sources. Table 1 below lists some of the data initially included in the prototype; Appendix C.2, Table 1 presents a comprehensive list of data and sources.

Data Type	Scope	Scale
Parcel Centroids	Essex County	1:24000
Real Property Parcel Data	Essex County	1:24000
APA Project Sites	Park-wide	1:24000
Land Classification	Park-wide	1:24000
Land Classification (Large Scale)	Park-wide	1 pixel = 1 acre
Biological Sites	Park-wide	1:24000
Road Network	Park-wide	1:250000

Table 1
Sample Data Layers - Existing Data

A number of important issues were encountered and addressed during this process.

Accuracy
One common problem with the use of spatial data, determining its level of accuracy, was minimized since many of the coverages used in the prototype were acquired from state agencies such as the Department of Environmental Conservation and the Department of Transportation. These coverages are widely used throughout New York, and a high level of accuracy is assured since these agencies may be held liable for any error or inaccuracy in their data. Coverages created by APA were assumed to have an adequate level of accuracy for agency needs.

Temporal Inconsistency
Temporal inaccuracy or inconsistency may become a problem when working with spatial data. An especially difficult situation became apparent when tax parcel data from the NYS Office of Real Property Services, Project and JIF tables from APA, and tax maps from localities were compared. Each of these datasets was updated at a different point in time; thus ownership information was not consistent from one to another. Exact parcel location and extent were likely to be inconsistent as well. The most recently updated of these three datasets would show new lots or sublots, and consequently new owners, that the others would not.

Scale Variations
Variable scale across coverages is an unavoidable problem when working with spatial data. In this project, scale accuracy problems were evident when combining displays of some of the ecological coverages with parcel tax maps. Most coverages were created at a large scale (1:24000), and were displayed at an unacceptably large scale only when used as overlays on tax maps, where scales ranged from 1:1200 to 1:9600.

CTG attempted to ensure spatial data accuracy by registration of all spatial data to a consistent base map. In the prototype, data was frequently referenced at the tax parcel level. Existing tax maps might have been a good choice for the base map, but acquisition and conversion of data at such a large scale was far beyond the scope of the prototype. Instead, the base maps used were 1:24000 planimetric maps created by the NYS Department of Transportation, which were converted to digital format by the NYS Department of Environmental Conservation. Although no "official" base map for New York State exists, this base map may be considered a *de facto* standard, since it is widely used throughout the state by both public and private sectors, and is of sufficiently large scale to serve as a base map for a wide variety of applications.

Tabular Data Integration Issues

In addition to the spatial data added to the prototype, several of APA's existing database tables were added, to be used as indexes to both spatial data and document images. Four tables were included: one each for APA Project Sites, Jurisdictional Inquiries, Enforcement Sites, and Pre-Existing Subdivisions. Prior to their addition to the prototype, these database tables resided on four separate computers, and were maintained by different departments. Because of inconsistencies, numerous problems were encountered in the use of these tables as indexes, ultimately limiting the functionality of the prototype.

Unique Parcel Identifiers

Initial prototype design specified three ways to locate a tax parcel: by tax ID, landowner name, or geographic location. Once a parcel was selected, a map showing the location of the selected property could be displayed, and Project Site or Jurisdictional Inquiry (JIF) documents pertaining to the parcel could be viewed. In order to perform these tasks successfully, the unique tax ID associated with a parcel was to be used as a link between the table containing parcel data and the project site and JIF tables. We assumed that a parcel could be uniquely identified by tax ID in all tables where it was present.

The only table containing detailed information about individual tax parcels was provided by the NYS Office of Real Property Services as a component of one of the existing coverages. Each record could be identified by tax parcel ID, and the table could be queried by all three required methods. For reasons detailed below, this table could not be directly linked to any of the APA's own database tables.

Each of APA's database files was organized by file ID number, meaning that this was the *only* value in a table that could be relied upon to uniquely identify a project site or JIF. Identification by tax ID was not possible, since a value for tax ID was missing in over half the records in each table. Records which contained a tax ID did so in a variety of formats, and any or all of these formats might be encountered in a single table. Lists of tax IDs for each project site did exist, but were stored in a separate database file which was not available for the prototype

Element Definitions and Relationships

The relationship between project sites and Tax ID's was also problematic. Project sites might be composed of one or many tax parcels, so selection of a single project ID did not guarantee that a single parcel would also be chosen. Moreover, querying project site and JIF tables by landowner name was also impractical, since the distinction between 'landowner' and 'permit applicant' was unclear, and values for both landowner name and applicant were often missing. Query by geographic location was possible only for project sites, and this was done by linking the project site table to spatial data for each site through the project ID field. In any case, none of these queries produced the unique tax ID needed to link either table to tax parcel data. We addressed this problem by creating an indirect spatial link between tax parcel and project site, overlaying parcel points on project sites, and visually determining which project site(s) applied to the chosen parcel.

Converting and Adding New Data

We now turn to the particular problems faced in the conversion and development of new map and document data for the project. An important part of GIS implementation is the conversion of data to digital form, and integration of digital data into a single repository. These steps are equally important for document imaging systems. In each case, data from a wide range of sources, often in many scales, sizes, and formats, must be converted to a format compatible with the chosen software and hardware. Table 2 lists some of the new data that was converted and added to the prototype. Appendix C.2, Table 2 presents a comprehensive list of data and sources.

Data Type	Scope	Scale/Density
Wetlands	Town of Keene	1:24000
Tax Maps	Town of N. Elba	1:24000
APA Project Sites	Park-wide	1:1200 - 1:9600
JIF Documents	Essex County	300 dpi

Table 2
Sample Data Layers - New Data

New Maps

Several tax maps for the town of North Elba were added to the prototype datasets. These were scanned at the Essex County Real Property office by APA staff, since the original maps could not be removed. The maps were originally large scale Mylar maps, at scales ranging from 1:1200 (1 inch = 100 feet) to 1:9600 (1 inch = 800 feet). These were scanned at 400 dpi using a Vidar TruScan large document scanner connected to a 486 class PC, and integrated into the prototype as Group IV TIFF files.

Topographic maps were also scanned by APA and added to the prototype. Topographic maps are similar to the planimetric maps used as base maps for this project, but include contour lines to show elevation or topography for a quad. These were done in-house from map sheets already in APA's possession. Scanning was done with the same hardware described above, and was also stored as Group IV TIFF data.

Paper Documents

Two different approaches were taken to converting paper documents for inclusion in the prototype. The first technique was a comprehensive scan of all pages from a set of project files selected by the agency. Later in the project, another set of project documents was scanned, using only selected file contents.

The first attempt at data conversion was a simulation of an in-house manual conversion effort, using PC-based technology. In May 1994, a clerk spent two weeks scanning a set of project folders from Essex County parcels. The first 25 projects from 1973 were used; these folders ranged from a few to several hundred pages. These documents included deeds, hand-drawn maps, staff notes, and any other materials stored in the folders. No attempt was made to eliminate redundant or unnecessary documents. The scanning was performed on a 486 class PC, using a desktop scanner (HP ScanJet IIcx) and Windows software. EFS document management software for retrieval. Various agency staff reviewed the results of the scanned documents under EFS, and felt that the selected resolution was adequate for their purposes. While reading documents on-line was helpful, it seemed that users would likely choose to print the scanned images.

During the test period, several hundred documents were scanned. On average, about 150 pages per day were scanned, compressed, and stored in this desktop experiment, for a production rate of about 4 minutes per image (assuming a six hour work day). Computer processing took about 1 minute per page at 300 dpi, while the mechanics of paper handling (removing staples, paper placement, re-assembling folders) took much of the remaining time.

For a small set of documents, an attempt was made to implement optical character recognition. Processing time increased markedly, with only fair results. These results may have been caused by the choice of technology, or from the variable quality of the source documents. Since optical recognition was not a primary goal of the prototype, this path was not pursued further.

Later in the project, a second attempt was made at in-house scanning. This time, agency staff reviewed the contents of 50 project files for Lake Placid and North Elba, which evolved as the focus of the prototype dataset. Projects were selected from each available year (1973-1994), in order to provide a chronological view of the project process. From each project file, items were selected which were representative of the most commonly encountered types of documents.

Following this review, 250 pages were scanned, again at 300 dpi. When compressed in Group IV TIFF format, most documents required 50 - 60 KB per page. These pages were stored with a fixed naming convention, which included the project folder number. This structure was used in turn to load the documents into Excalibur's EFS document management software for retrieval. Various agency staff reviewed the results of the scanned documents under EFS, and felt that the selected resolution was adequate for their purposes. While reading documents on-line was helpful, it seemed that users would likely choose to print the scanned images.

Microfiche Documents

Much of the staff time spent on data conversion concerned the transformation of previously archived data to electronic form. As part of an earlier document archiving effort, the Agency had reduced part of its historical database to analog media. JIF files from 1979 through 1985 were recorded on 16mm microfiche. In addition, some JIF files and project data (ranging from standard page sizes to D- and E-size architectural drawings) had been transferred to 35mm film. Since the manipulation of this data required specialized equipment, both types of data were outsourced to service bureaus for processing.

16mm data conversion. The agency estimated that about 17,500 pages were available on fiche. Several vendors were contacted for bids, and were given sample fiche for experimentation. For the final processing, the agency located uncut fiche rolls which were used as the final data source. The vendors were asked to provide an index to documents and folders to our specifications. Most of the original data was scanned from 8 1/2" x 11" typewritten documents, and converted legibly.

The indexing of images was more difficult. Spot checks of the initial set of scanned images against the indexes prepared by the vendor showed several errors and inconsistencies. The vendor made several attempts before we felt secure in the indexing effort. There were also several problems with the formatting of the tapes used to move data from the vendor's computers to the project workstations.

These images were also stored as Group IV TIFFs, with 50-70 KB per page, similar to the manually scanned project files. Once loaded, the images were found to be of good quality and legible on the workstation screens. Four months elapsed between the selection of a vendor and the completion of document processing.

35mm data conversion. A second data conversion goal for the APA was the conversion of its 35mm microfilm records to digital form. This effort encountered many problems and could not be completed during the project. For example, there were great variations in the types of documents recorded on the 35mm film, ranging from standard paper formats to E-size architectural drawings. The recording density (and the associated reproducibility) varied as well to accommodate these different formats. In addition, there was no reliable index to the documents to determine what data was stored where.

Most of the vendors who responded to the 16mm bid request could not process 35mm microfilm. Those which responded had difficulty reaching the quality standard desired by the agency. Vendor pricing varied greatly as well. Larger format documents required more customized processing by the vendor, with a necessary increase in price. The uncertainty in content resulted in great variations in pricing estimates.

By the end of the project, two vendors had been located which were able to process the 35mm data to the standards needed by the agency. This information was given to the APA for subsequent review and procurement. Eight months elapsed from the time the first vendors were contacted until this point had been reached.

Storage Requirements

The project team learned that storage requirements for document or map images are likely to be substantial. Despite the fact that the Group IV TIFF format includes file compression, the large number of documents a typical system would include makes it necessary to estimate the number of images to be stored, and the size of each file in order to acquire the appropriate type and quantity of storage hardware. Some average figures from the prototype are listed in Table 3.

Data Type	Approximate Document Size
Document images	50-60KB per page
Tax maps	125KB per map sheet
Planimetric maps	300KB per quad sheet
Topographic maps	3MB per quad sheet

Table 3
Data Types and Document Sizes

Objective 3: The Cost-Performance Evaluation - Working Faster and Cheaper

In order to assess the potential costs and benefits of a new system based on the prototype experience, CTG staff conducted several activities designed to gather workload and performance data, to define the data and functions to be incorporated into a new system, and to estimate the costs and performance characteristics of a fully implemented new system.

Analysis of Existing Agency Work

The types of work conducted at APA can be viewed from two different perspectives. First, one can consider APA’s workload from the point of view of its customers. In other words, what are the main tasks and transactions that comprise customers’ waiting time? Alternatively, one can consider how the workload looks from the perspective of APA staff. In this case, what are the main tasks and transaction types that require most of the staff's time and attention? The identification of major types of work depends on the perspective taken.

Table 4 below compares these two perspectives. Column 1 shows 16 major transaction types in order of staff days per year spent on each type (the staff perspective). The three transaction types that consume the most staff time are work on major project permits (4,000 staff days per year), enforcement activities (1,700 staff days per year), and responding to jurisdictional inquires (1,575 staff days per year). For each transaction type, the total staff days per year was computed by multiplying the frequency of each type of transaction by the average number of full time staff work days required to complete a single transaction of that type. These estimates do not take into account the amount of time that a task may sit in a queue awaiting attention.

Column 2 shows the number of transactions per year for each type (the customer's perspective). In this view of the agency's work, the major functions appear to be in high volume information dissemination activities, especially phone inquiries. The top three transaction types by frequency are phone inquiries, (4,500 per year), JIFs, (900 per year), and requests for maps (500 per year).

Note the paradoxical relationship between these perspectives. Phone inquiries, the activity which represents the highest frequency of customer contact (4500 per year) is a relatively minor activity when considered in terms of staff time consumed, requiring only about 321 staff days per year. Conversely, relatively low frequency transactions, such as major project permits (160 per year), consume large proportions of total staff time (4000 staff days per year).

Transaction Type	(1) Total Staff Days Per Year Per Transaction	(2) Number of Transactions Per Year	(3) Average Staff Days Per Year Per Transaction	(4) Average Turnaround Time Per Transaction (Days)
Major Projects	4000	160	25.0	60
Enforcements	1700	400	4.3	
JIFs	1575	900	1.8	20
Minor Projects	1200	240	5.0	21
Cartographic	1200	300	4.0	
Admin. Research	536	500	1.1	30
Phone Inquiries	321	4500	0.1	3
Environmental Impact	225	50	4.5	
State Lands	230			
10 Simple UMP's	35	10	3.5	
4 Complex UMP's	140	4	35.0	
20 Inquiries	40	20	2.0	
1 Map Updates	15	1	15.0	
Public/Political Inquiries	120	30	4.0	5
Wetland Delineation	107	300	0.4	
Map Seeking	54	500	0.1	14
Pre-application Reviews	50	100	0.5	
Economic Development	30	15	2.0	
Local Planning	17			15
240 referrals @ .25 hrs	9	240	0.0	
25-40 contacts @ 2 hrs	8	30	0.3	
DEC Referrals	11	300	0.0	

Table 4
Major Categories of Customer Transactions by Total Staff Days Per Year with Turnaround Time and Frequency Data

This difference in perspective on APA’s work has important implications for the agency and its objective of improving relationships with customers. If the agency organizes itself and its work processes to complete its major tasks as expeditiously as possible, it may not be able to respond optimally to its most frequent citizen contacts. That is, the seemingly good idea of maximizing the internal work processes of the agency can lead to unacceptable turn-around time.

Options for Defining the Scope of a New System

An integrated GIS and document management system could be configured to support one, several, or even most of APA's transaction types. The costs and benefits of a system designed to support one cluster of transactions would be different from a system designed to support a different set. Similarly, the future system could include, a few, most, or a comprehensive array of digital data sets. Estimating the costs, benefits, and other impacts of a fully implemented system therefore requires that the scope of that system be clearly defined in terms of its functionality and data resources. Two potential versions of a final system (one less expensive and less functional and other more expensive with more functions) were defined and analyzed during the cost-performance evaluation.

Three levels of functionality were defined during the cost-performance modeling conferences. The first level was simply the agency's current level of operations and automation. The second and third levels represented a minimally configured future system and an expanded future system. Eleven kinds of functionality were considered, ranging from basic hardware needs, to methods of access to map data, to workflow automation, to archiving, and so on. To illustrate, the system function called "archiving" could be handled at different levels of sophistication. Currently, archiving is accomplished both by manual filing of paper documents and by the use of microfiche. Under the minimal system, archiving would be accomplished entirely with microfiche. The expanded system envisions a fully electronic archiving function including document images in electronic format.

Three discrete data groups were then associated with each system package. The groups were constructed based on the result of staff interviews designed to identify which data sets were used most often by which staff units. Data Group 1 contains the data sets necessary to support jurisdictional inquiries (e.g., tax maps, land classifications, roads, wetlands, hydrography). Data Group 2 contains those non-statutorily required data sets that APA staff use frequently (e.g., topography, watersheds, aquifers, soils). Data Group 3 contains non-statutorily required data sets that staff use least often (e.g., historical files, demographics, protected species, power lines). Group 1 data sets would support the largest proportion of staff activity, Groups 2 and 3 would support additional activities.

Table 5 illustrates the options for a future system which were then evaluated. The horizontal axis represents increasing levels of system functionality ranging from the current system through modest enhancements to a much expanded "full system" conceptualized by APA staff. The vertical axis illustrates options that have increasingly more digitized data layers with Data Group 1 being the data necessary to make jurisdictional findings and Data Groups 2 and 3 including some less frequently used but technically important data sets. Cost and performance characteristics were then estimated for the shaded cells which represent the current or "baseline" system, and a "minimal future system" and an "expanded future system."

	Level of System Functionality

Data Population Strategy	Current Mostly Manual System	Automate w/ Minimal Functionality	Automate w/ Expanded Functionality
Digitize Groups 1,2,3			Expanded Future System
Digitize Groups 1&2			
Digitize Group 1 only		Minimal Future System	
Current Mixture of Paper and Digitized Data	Baseline		

Table 5
Conceptual Overview of System Functionality and Data Options

Performance Improvement Estimates - Working Faster
This portion of the analysis focused on the eight transaction types that represent the areas where APA staff felt productivity and turn-around time improvements were most needed and where an automated system was expected to have the most impact. These eight transaction types represent approximately 6,800 of APA's total of 8,600 annual customer-focused transactions or about 80% of APA's work measured by frequency of transactions. When looked at in terms of workload for APA staff, these eight transaction types represent approximately 9,000 of APA 11,400 annual staff days -- again about 80% of APA's volume of work.

For most transaction types, the APA staff reached strong consensus about the potential turn-around time effects of the minimal and expanded systems. In the cases of dissension, the points of agreement and disagreement were diagnosed and analyzed in further detail, often with estimation and analysis of numerical models of sub-processes within the overall transaction type. In some cases, the agency staff team seemed eager to embrace the technology and were optimistic about its impacts. For example, the estimates indicate that the minimal system could eliminate virtually all of the customer waiting time associated with phone inquiries. For other functions, the team agreed that the determinants of customer delay were not among those that the system could affect, and therefore, impact on customer turn-around time would be minimal. For example, most of the waiting time associated with major projects involves waiting for additional information from external sources or for complex staff analysis. These sub-processes are expected to be affected minimally or not at all by an automated system.

The results of these estimates and process models is summarized in Table 6.

	Base	Base	Limited System*		Expanded System*	
	Transactions Per Year	Turnaround Time (Days)	Time Saved		Cumulative Time Saved	
			% Reduction	Days	% Reductio n	Days
Transaction Type						
Major Projects	160	60	0.01	0.5	0.03	1.5
JIFs	900	20	0.25	5	0.40	8
Minor Projects	240	21	0.02	0.5	0.05	1
Phone Inquiries	4500	3	1.00	2.99	1.00	2.99
Public/Political Inquiries	30	5	0.10	0.5	0.20	1
Map Seeking	500	14	0.46	6.5	0.46	6.5
Local Planning Referrals	240	15	0.33	5	0.67	10
Resolved Enforcements(1)	200	90	0.06	5	0.17	15
Total Transactions	6770					
Avg. Decrease (weighted by number of transactions)			74%		78%	

*Limited System includes Data Group 1. Expanded System includes Data Groups 1-3.
(1) One half of total enforcements are resolved in 90 days. Half remain unresolved.

Table 6
Reductions in Customer Turnaround Time
By Level of System Functionality and Transaction Type

The rows in Table 6 contain data for the eight selected transactions types. For each transaction type, the first and second columns present the number of transactions per year and the base turn-around time -- the estimated average number of days that a customer waits under the current system. The table also presents for each transaction type the estimated number of days that would be eliminated if the minimal system were implemented along with the associated percent reduction. The same data is also presented for the expanded system. For example, the current base waiting time for a JIF determination is about 20 days. The limited system would reduce that time by five days or 25%, while the expanded system would reduce the waiting time by another three days or a total reduction of 40%. On average, customers could expect a response within 15 days with the limited system and within 12 days with the expanded system.

This data represents the potential improvements in the delivery of service to APA's customers, one of the key objectives in the project. The largest percentages of turn-around time saved are associated with phone inquiries (close to 100%), local planning referrals (67%), map seeking (46%), and JIFs (40%). Transactions showing relatively low potential reduction in turn-around time include major project permits (3%), minor project permits (5%), and the resolution of enforcements (17%).

Two features of Table 6 deserve further comment-- (1) relative reductions in turn-around time and (2) the effect of transaction volume on external perceptions of APA's performance. With respect to turn-around reduction, notice that the impact of both the limited and expanded systems on minor project permits and public or political inquiries are identical -- time savings of half a day for the limited system and a full day for the expanded system. However, these identical impacts in real terms translate into a 20% turn-around time reduction for public and political inquiries and only a 5% reduction in turn-around time for minor project permits. This is because the base time to complete public and political inquiries (5 days) is substantially less than that for minor projects (21 days). Therefore, while real waiting time has been reduced by an identical amount, the perceived improvement in customer service is dramatically different. We discuss later how these relative effect interacts with decisions about work design and work priorities.

The second important feature implicit in Table 6 centers on simple volume effects. Phone inquiries are a key transaction type in this respect. An automated system can have dramatic effect on the waiting time associated with phone inquiries (eliminating almost 100% of the total waiting time), and phone inquiries represent an exceedingly large proportion of total customer transactions (fully two thirds of the total annual volume of transactions analyzed). In short, if the relative waiting times associated with high volume transactions can be drastically shortened, as would be the case with phone inquiries, citizen perceptions of agency responsiveness would be vastly improved.

To illustrate this point, look at the weighted average percent decreases in turn-around time shown in Table 6. The limited system would eliminate 74% of the citizen waiting time for APA action. The corresponding reduction in mean waiting time for the expanded system is 78%. Note, however, that these rather dramatic effects can be attributed mostly to the ability to respond to phone inquiries much more quickly. Since phone inquiries are such a large fraction of APA's customer transactions, this seemingly simple improvement has a high degree of leverage.

The Cost Performance Evaluation - Working Cheaper

This section examines the costs associated with either the minimal or the expanded system including system acquisition and annual maintenance costs and further development. Annual benefits are also estimated in terms of cost savings or cost avoidance that will accrue to APA as a result of system implementation. This section focuses on the potential reduction of costs associated with a system and does not consider possible quality effects of the new system, nor new products or services that might be available as a result of system implementation. These additional, less easily quantifiable, effects are discussed later. No attempt has been made to quantify the value of the faster customer turn-around times discussed in the previous section.

An Overall Cost-Benefit Model

Table 7 presents in summary form, the dollar costs and benefits associated with both the limited and expanded systems. Costs include one-time system costs, one-time data acquisition costs, and annual expenditures for new staff needed to manage the computer system and maintain the data. Two types of annual savings are estimated--annual staff savings reflecting less staff effort to accomplish information management and data maintenance functions and other annual savings such as reduced paper, map acquisition costs, or travel costs.

	Dollar Costs (Thousands)					Dollar Benefits (Thousands)		
	One Time Costs			Annual Costs		Annual Savings		
	System (1)	Data	Total	System Admin.	Data Mgmt.	Staff	Other	Total
Limited System w/Data Group 1	$317	$206	$523	$30	$30	$142	$2	$144
Expanded System with Data Groups 1-3	$627	$220	$847	$60	$60	$237	$21	$258
(1) Includes estimates for hardware, software, system development, & staff training								

Table 7

Summary Of One-Time and Annual System Costs and Annual Savings

The first row of Table 7 presents the values of all these variables associated with the limited system. The second row presents the same values for the expanded system. The figures in the second row are cumulative including all costs associated with the limited system. For example, the one time cost associated with acquiring data for the limited system is approximately $206,000 reflecting only those costs associated with Data Group 1. The one time cost for all three data groups is estimated at $220,000 implying that the marginal costs associated with acquiring Data Groups 2 and 3 is $14,000. The one time system costs were estimated during the October cost-performance modeling conference. Most of the system benefits are comprised of savings in staff time.

Changes in Staff Time Required for Various Tasks

During the March Cost-Performance Modeling conference, APA staff estimated the total savings in staff time for twelve transactions types that could be attributed to the implementation of the limited and the extended systems. These time saving estimates made up the bulk of the annual dollar savings associated with the system as displayed in Table 7 above.

For example, JIFs under the present system require an estimated 1575 days of APA staff time. If the limited system were implemented, 394 staff days could be saved. If the expanded system were installed, a total of 520 staff days could be saved or 33% of the total staff effort associated with JIFs. Each transaction type was analyzed in the same way.

In total, the limited system would save APA an estimated 789 staff days per year. This amounts to approximately 3.3 FTE employees or 7% of the total effort associated with completing all sixteen transaction types analyzed by CTG. If the expanded system were implemented, APA could save an estimated total of 1322 days or about 5.5 FTE staff. This amounts to about 12% of the total effort associated with the sixteen transaction types analyzed by CTG. Converted to dollars, these staff savings are estimated at $142,000 annually for the minimal system and $237,000 annually for the expanded system.

The areas where automation will probably have the least impact include major projects, enforcements, cartographic work, and wetlands delineation. Relatively high impact areas include responding to citizen requests for maps, responding to local planning requests, responding to phone inquiries, and responding to jurisdictional inquiries. In many cases, the fraction of staff time saved is considerably less than the fraction of turn-around time being saved by APA's customers. For example, customers would experience almost a total elimination of waiting times for phone inquiries, but staff time savings would be only 40%. In this case, staff would still be spending much of the time responding to requests, but the system would allow staff to respond to most queries while the customer was on the phone, thereby eliminating customer waiting.

Data Conversion and Maintenance Costs

The March data modeling conference began with a detailed elicitation of the characteristics of all 28 data sets represented in Data Groups 1-3 along with a description of what would be involved to acquire or convert each one for use in a new integrated system. From this discussion, it became clear that some of the data conversion effort would have to take place over an extended period of time with a half-time or full time staff person allocated to this purpose. However, before the system could become even minimally functional, an intensive one-time data conversion effort would have to be undertaken. All three Data Groups contain data sets that would require such a one-time conversion. It is also important to note that APA already maintains a stand-alone GIS system and therefore, several of the data layers are already held by the Agency and need only minor changes for use in a new integrated system. Total one-time data conversion costs were estimated at $218,000 ($205,000 for Data Group 1, $11,300 for Data Group 2, and $1200 for Data Group 3).

A second class of data comprises those data sets that either require on-going maintenance or that should be acquired in the future through the routine operations of APA. All of the data sets in this second class should be maintained or acquired as part of the job of a new data manager that APA had identified as necessary to operate the system. Hence, three functions define the job description of the data manager--(1) maintain pre-populated data sets, (2) add records as they are developed by APA's on-going use of the system, and (3) add records as they are developed by other agencies. These costs are represented in Table 7 by the annual costs of data management (i.e., the salary costs associated with at least one new data manager).

Limitations in Reported Cost and Benefit Figures

All of the cost and benefit figures reported in this section were taken directly from estimates provided by APA and CTG staff in the cost and performance modeling conferences held between October 1994 and March 1995.

The benefit figures estimated directly for staff time savings are probably the most reliable of the figures presented. These figures were estimated twice through independent processes. In October, staff time savings were estimated by looking at a functional view of APA's work. The work analysis was essentially repeated in March when APA's workload was analyzed in terms of sixteen types of customer transactions. The time estimates from these two separate methods were fairly close. The March estimates came out slightly higher because many of the transactions captured small pieces of staff time that could be saved but were missed when broad functions were looked at in October. Additionally, much staff analysis in October and March focused on refining these estimates.

The one time cost figures have been checked several times. In addition, they are quite close to independent estimates of system costs prepared by APA staff in a prior budget request. If the one time system costs have a "soft spot," it is probably that they underestimate the training and staff development costs that will be associated with installing a new system.

The data maintenance costs reported in this section of the report are probably the least reliable of the reported cost estimates for several reasons. First, the analysis assumes that most of the data sets in Data Groups 2 and 3 will be added to the system incrementally by the data manager. No attempt has been made in any of this analysis to determine if a half time data manager would in fact, be able to support the limited system, or if a full time data manager would be able to adequately support the expanded system.

The analysis also assumes that a number of important data sets will become available from other sources and could each be added to the system in two staff days. These cost estimates assume that the agencies responsible for providing that data will provide it in a format readily convertible to that required by the new APA system. If this assumption is incorrect, these costs will be higher.

Objective 4: Benefits of a New System - Working Better

This section discusses some of the ways that a new system might further enhance APA's operation and help APA provide new or better products and services to its customers.

Potential for Reengineering Work Processes

The cost-performance evaluation suggested that some of the major improvements in customer turn-around time might be accomplished by a reexamination of work flow and priority issues even in the absence of labor-saving automation.

In order to begin to explore the possible impact of work reengineering, CTG worked with APA staff to craft a simple work flow model that used the frequency and time numbers derived from the March conference to illustrate how a redesign of work flow and priorities might possibly impact on customer waiting times. This work began by drawing a flow diagram that traced the typical flow of three types of work through the agency (JIFs, minor projects, and enforcements). This flow diagram was a simple process map for these three transaction types.

Each type of transaction calls upon seven functional areas within APA -- consult, expert advice, mapping, field work, research, writing, and administration. Sometimes a transaction needs to draw upon a functional area several times. For example, all 240 minor projects require a minimum of one hour of consult time. Of these, 200 require an additional two hour consult, 160 a third two hour consult, and 120 a fourth two hour consult. This indicates that a single minor project transaction queues up several times within the consultation function, creating a lengthened waiting time for customers.

Furthermore, individual work unit priorities determine how long each type of transaction will take. If all internal work units assign consistent priorities to major transaction types, high priority transactions would deliver measurably better customer turn-around time. For example, if all units gave top priority to minor projects, then the customer waiting time for these projects could approach the actual staff time of 5 days per project. Similarly, if all units gave priority to JIF transactions, JIFs would have low waiting times and customer waiting times would fall to approach actual staff time (1.5 - 2 days). Changing work priorities within a given unit will not change the amount of work that the unit faces nor the amount of work that the unit can complete in a single year. But paradoxically, customer waiting time can be decreased dramatically for some key transaction types even though the total work load within each functional area remains constant. (This, of course, is limited by the proportion of total waiting time that the agency can control. Waiting times that depend on the action of external actors will not be affected by internal changes in priority.)

If each unit assigns priority at random or at its own discretion, then no transaction type will have optimally low customer waiting times. In this example, allowing each function to assign its own priorities leads to all transaction types having longer than optimal waiting times and no transaction type receiving expedited treatment.

Reengineering Without Technological Support

Most of the insights related to the potential for reengineering work processes to speed up customer response time would be valid even if APA does not acquire any additional technology. Approximately two thirds of APA's customer contacts come in the form of phone inquiries with jurisdictional inquiries representing the second largest in transaction volume. If APA set a working priority that all phone queries be answered by the end of the business day, the average customer waiting time could be cut from three days to one. This single change would improve the response for 4500 customer transactions by two-thirds or two out of three days wait. That is, this one change in agency-wide work priorities could improve dramatically about two-thirds of all of APA's customer-oriented transactions.

Undoubtedly, such a policy would delay other work in the Agency. Assume that all of the priority attention were to come at the expense of major project work. The already long delay on major project work would probably be lengthened by several days more as staff redirect their time to answer phone inquires more quickly. This might be an acceptable trade-off for APA. Several hundred major projects would have their associated waiting extended from 60 days to, say, 65 while up to 4500 phone inquiries would be handled more expeditiously. This kind of rethinking and reorganization of work can take place in the absence of any new technology. However, it will require an agency-wide articulation of what types of work are to receive priority treatment. Work priorities could no longer be set on a unit-by-unit basis. Of course, labor saving technologies could serve to combine process reengineering with staff time savings so that customer turn-around time savings could be accomplished without the difficult trade-off in other areas of agency performance.

Probable Extended Benefits and Potential Internal Quality Improvements
After the prototype demonstration and a two-week experimentation period, 22 APA staff were interviewed about potential quality improvements and extended benefits that the new system might enable or provide. No attempt was made to reach consensus about the potential benefits or to match potential benefits to specific functions performed within the agency. The benefits indicated by APA staff during the interviews were compiled, duplicate items were eliminated, and the resulting list was categorized into six types of benefits:

- improved cooperation with other government entities in the Park
- improved ability to conduct analyses to support economic development
- improved decision-making and analysis
- improved data quality and data management
- improved internal communication
- improved internal time management

Improved cooperation with other government entities in the Park. Much of the work performed by APA staff is closely linked to that of other state and local government entities. A new system would allow information created by APA to be more readily shared with other government entities with similar concerns and responsibilities. For example, many issues relevant to APA are also relevant to the New York State Departments of Environmental Conservation and Parks and Recreation, and these agencies need similar information in order to conduct their work. Additionally, local governments within the Park face many of the same issues and concerns as APA with respect to balancing land use and economic development with environmental protection. APA staff indicated that the process of creating and sharing new data could improve local relationships, many of which are currently strained. APA staff indicated that an automated system and the cooperative development of electronic data would enable them to foster and improve relationships and allow them to work more effectively with local governments toward common goals. It also would enable APA to provide expertise to local governments which do not the have the resources to conduct the types of analyses that APA staff conduct daily. Staff also thought APA would be able to assist local governments in the effective use of information for planning and decision-making.

Several APA staff members thought that ideally, access to the agency’s information could be made available to related state and local government agencies through the use of electronic networks. This network of information could be expanded to provide “one-stop shopping” for permits. For example, many individuals and businesses must deal with APA regulations as well as those of local governments and State agencies in order to undertake land development. The sharing of regulatory information would allow each agency to provide information about others' regulations to assist developers in a more comprehensive and coordinated way.

Improved ability to support economic development. The agency's level of interest in economic development activities has varied over time with changes in agency leadership. Today, APA is trying to overcome its reputation for being anti-development and the agency's current leadership has made economic development a high priority. Many of the towns within the Park have lost industries and are finding it difficult to attract new business to their areas. In order for the towns to become viable, it is necessary for the agency to allow the development of new business and to support those currently in existence.

APA staff indicated that an integrated system would provide an excellent tool to support a variety of the economic development activities. For example, the system could pull together all of the relevant data for site location for a variety of different types of business and industry. APA staff would be able to use the system to select sites which meet all of the customer's needs as well as the various restrictions that must be observed. Feasibility studies and other necessary analyses could be conducted in a much shorter period of time than under the current manual system. The system would also allow for more comprehensive analyses of the regional effects of business growth within the Park.

Economic development activities are also related to the benefits of data sharing within government. The data necessary to support the system would be of great use in economic development activities of the towns and villages within the Park. For example, digitized tax map data; the location of lakes, rivers, streams, wetlands and transportation networks; and a variety of other data types would allow for much more rapid analyses for determining ideal locations for business development. Toward this end, the agency has begun to share both digitized data and expertise with the local governments within the Park. Additionally, the agency has been partnering with such entities as Essex and Saratoga Counties, Niagara Mohawk, and Saratoga Economic Development Corporation to share in the development of tax map data. In these resource-sharing endeavors, both the costs and the benefits of the data creation accrue to all of the partners while the knowledge and expertise of the partners is also leveraged.

Improved decision-making and analysis. One of the largest areas of concern at the agency has been consistency in decision-making. Citizens have expressed concern about "surprises" in the agency's determinations. Land owners want consistent answers to questions about land development. The need to address these issues was also noted in the 1994 Task Force Report.

During the interviews, many APA staff said that the existence of an automated system would greatly improve consistency of responses. In particular, APA staff would be able to review all documents related to past decisions, including the maps that were used, legal determinations, and property history and characteristics to facilitate consistent decision-making. Under the current system, it is nearly impossible to access all of the documents related to past similar decisions of the agency. This is currently done by relying on the memory of APA staff who may have worked on related cases or by redoing past analyses in order to consider all the factors that led to a particular decision. This is, of course, highly resource intensive, and staff are often unable to incorporate past decisions into their current work. Staff also said the existence of electronic information would help ensure that all relevant information is used. Important factors would not be missed and errors would be reduced, improving the quality of decision-making.

Further, additional types of analyses would be made feasible by the existence of complete agency information in electronic formats. For example, the agency would be in a better position to conduct time-series analyses, to examine "what-if" scenarios, and to examine cumulative effects of regulations and decisions. Additionally, APA would be able to view the effects of decisions in one area of the Park on other areas. These types of analyses, while vital to the long-term success of the agency and the concerns of land owners in the Park, are very costly to conduct manually and are not often done under the current system.

Improved data use and management. Many APA staff told the interviewers that a networked system would lead to improvements in data quality, management, and access. A networked environment would allow for the sharing of documents and project files. Several staff members noted that at times, maps needed to conduct an analysis related to one project were in use by another staff member conducting another analysis. A networked environment would prevent delays in work related to these occurrences since both staff members could use the same maps at the same time.

A networked environment would also allow for ready access to databases. Under the current system, databases are maintained and housed on stand-alone computers. In order for staff to access these databases they must physically sign on to a specific machine. Again, the networked environment would save time and prevent queues and delays in obtaining relevant information for staff analyses. Additionally, updated versions of files and databases would be available to all staff in real time.

Issues related to archiving and records management could be addressed more easily with an automated system. As noted earlier, the ability to access historic records is a key issue related to improving service to APA's customers. Under the current process, completed project files are archived using 35mm film. However, the agency does not own or have ready access to a reader and is therefore creating archives in a format which cannot be accessed easily.

Staff members also felt that the system would allow for easier and more comprehensive report generation. Many of the agency's reports are currently created through a manual process. Due to resource constraints, it is often not possible to gather certain types of information about the agency's activities. For example, it may not be possible to compile data on the number of inquiries by type of projects (e.g., commercial development), without an enormous amount of manual work. This inability precludes the agency from systematically identifying trends or potential issues of concern.

Improved internal communication. Many of the APA staff indicated that an automated system, in particular one that would allow for work flow management, would facilitate communication within the agency. One specific improvement would be the use of an electronic phone log. Under the current process, land owners or their advocates often shop around the agency for answers to their questions. In addition, sometimes more than one staff member is inadvertently conducting analysis on the same piece of property. The sheer physical proximity of APA staff provides some check on this form of duplication, but it is not foolproof. Many of the staff who deal directly with the public indicated that an electronic phone log, accessible to all staff, would prevent these duplications of effort. Additionally, a log would enable APA staff to direct communications to those individuals already familiar with a case, and therefore improve the quality and consistency of their customer interactions.

Many of the potential improvements in communications relate to the network capabilities of information and document sharing as well as the electronic phone log. A networked system would allow for the sharing of databases, decreasing the amount of oral communication necessary to support the agency's work activities. The networked environment should also facilitate communication about who is responsible for which cases, allowing new supporting documentation and information to flow directly to the individuals conducting the work.

Improved internal time management. A large proportion of the staff work conducted at the agency goes through a two-stage process. The first part of the process is a jurisdictional inquiry initiated when a landowner, attorney, or realtor contacts the agency to determine whether the agency has jurisdiction over the proposed activities. An analysis must then be conducted by APA staff to provide this answer. If the agency does have jurisdiction, the second stage of the process, a project review, must be conducted to ensure that the proposed activities meet the relevant rules and regulations. Many activities undertaken in stage two are the same as those conducted during stage one. Many of the individuals interviewed said that these activities are often conducted twice, once during each stage. The proposed system would allow for the electronic sharing of results of the first stage so that they need not be repeated. Both stages of the analysis would be conducted using the same data, therefore increasing consistency across the work units and providing feedback to the staff conducting stage one work about additional data or considerations that could be included in future work.

Many of the decisions and actions of APA cannot be completed without site visits of the property or properties in question. Several staff members who conduct these site visits said that the existence of an automated system and ready access to relevant data would help them better prepare for field work. Under the current process, APA staff, operating under time constraints, are often unable to obtain information pertaining to a property prior to their visits. On occasion, costly site visits are inadvertently repeated. This results in duplicative work which could be avoided through a system mechanism to track site visits and related on-site findings.

Staff also indicated that the system would facilitate the generation of reports related to staff time spent on tasks, therefore enabling the agency to more effectively and efficiently allocate resources and plan for future work activities.

3. VALUE OF THE PROJECT

Summary

APA can benefit greatly from a system similar to the one prototyped at CTG. The system can help APA provide the same services more cheaply, saving the equivalent of 3.3-5.5 FTEs. In addition, the system can help APA provide faster service to its customers. The average customer waiting time could be reduced by as much as 78%. The system can also help APA promote reengineering of internal work processes and development of a variety of positive relationships and enhanced services. However, the cost of acquiring and maintaining such a system is relatively high. CTG's analysis shows that it will take the system about six years to pay for itself out of staff and incidental savings (this estimate does not place a dollar value on faster and higher quality services). This estimated pay-back period is relatively long, particularly in light of the evolving nature of the technology involved. Due to relatively high current technology prices and the likelihood that less expensive technology and data sets will soon become available, we recommend an evolutionary approach to system implementation focused first on those aspects of the system that will yield short term productivity gains and improved responsiveness to customers.

Several technology trends also argue for an evolutionary system implementation approach. First, the system package prototyped and analyzed by CTG is a UNIX-based system that "pasted together" within UNIX shells a GIS system and a document indexing and imaging system. This strategy implies that the platforms necessary to drive this system are separate from the lower-cost Windows-based workstations and networks that APA plans to acquire to support its office automation plan. It seems likely that in the near future Windows-based software will advance rapidly to the point where the machines that would support office automation and local area networking within APA could also support GIS, document imaging, and document indexing functions in an integrated environment. When this occurs, the marginal cost of acquiring the GIS and document management systems will drop dramatically, because these functions could be well supported without acquiring much new hardware.

The second important cost factor centers on acquiring and managing the data layers. To illustrate, consider the wetlands data that is currently maintained by APA. The estimated costs for converting the existing wetlands data for half of the park is approximately $32,000. These costs are associated with scanning, cleaning, and vectorizing existing hard copy maps that were commissioned by APA. In the future, however, APA knows that it will be able to acquire wetlands data in already digitized and vectorized form from the consultants who are completing the mapping. Once the world of wetlands mapping moves to a digital standard, the one time costs associated with converting data will vanish.

This example is especially clear because APA is the primary "owner" of wetlands data within the Park. Once APA converts to a digital standard, everyone else who needs to have wetland maps in digital form can get them at almost zero marginal cost. In the same way, once other agencies convert to digital standards, APA will also have very low marginal costs associated with acquiring data layers. This situation will become more and more prevalent in the next few years as spatial data resources of all kinds move to digital formats.

In the interim, cost sharing strategies could quickly cut the conversion costs for any given data set by half or more. APA has entered into two such resource sharing arrangements with Essex and Saratoga Counties to create digital tax maps and continues to develop additional partnerships in the development of tax map data. These partnerships should serve to substantially reduce the total costs of this particular data layer.

Given these trends, it seems likely that both the costs associated with hardware and software and the costs associated with data conversion and maintenance will drop considerably in the near future. However, as these costs drop, the benefits will remain high. Over the next few years, the system analyzed in this report will become a better and better buy for APA to consider.

The key issue for APA, then, is not *whether* it should convert to a fully digital approach to geographic and document data, but *when* it should convert. The annual benefits as estimated in this report will remain high well into the future, and it seems clear that they will outweigh the annual costs by a considerable margin. It also seems clear that one-time system acquisition and data conversion costs will continue to drop for the next several years at least. An evolutionary strategy involving the gradual acquisition of selected data layers and a building block approach to hardware and software acquisition seems most likely to maximize benefits and minimize risks.

Value to the Adirondack Park Agency

In addition to the potential benefits of full system implementation, benefits from the project itself also accrued to the agency.

The project helped agency staff examine those features of a full system that would yield the most benefit in future operations. The project and the experience with the prototype system enabled APA staff to think about a full system in terms of the work that they do and to identify key features and data structures that would be required in a full system to effectively support their work processes. The cost-performance modeling conferences helped staff distinguish those work functions which could be improved by automation from those that were not amenable to technology-based improvements. They also gave the agency an opportunity to view its workload and performance the way its customers do and showed the important differences between customer perceptions and staff perceptions of major activities.

Prototype development entailed a close examination and immediate improvement of work processes and existing information management practices. The process of prototype development necessitated that the agency closely examine its existing information infrastructure and the processes associated with information access to support work processes. As a result of these project activities, APA made some immediate changes in the way it manages and uses existing data, both electronic and hardcopy. For example, APA developed database indexes to support its existing jurisdictional inquiry process. By putting these indexes on several existing free-standing computers, the agency has already decreased the time it takes to access the information needed to support customer transactions. Moreover, the staff survey showed that more than one-third of respondents believed that their experience with the prototype enabled them to identify relationships between datasets which would facilitate their work.

Experience with the prototype enabled agency staff to identify specific improvements in quality and program design that would be made possible by an integrated information system. After experimenting with the prototype and participating in facilitated discussions, APA staff identified many possible improvements in their operations. These ranged from better use of staff time, to more effective internal communications, to better use of data for long-range analysis and planning. They also saw new ways to support responsible economic development, to engage in cooperative data creation efforts, and to improve interagency and intergovernmental relations.

The digitized data prepared for Essex County has gone a long way toward a comprehensive electronic database for the most populous region of the Park. In order to demonstrate the prototype features and functionality, it was necessary to populate the system with data focusing on one geographic region. Data for Essex county was chosen as it would support the largest proportion of the agency's transactions. This data is currently being used by the agency and has served to increase the agency's responsiveness to those inquiries specific to that county. Other data created to support the prototype itself is also of value to the agency's existing processes.

Intergovernmental relations, especially with the county governments in the Park, have improved and effective partnerships have been demonstrated. During the course of the project, it was necessary for the agency to reach out and foster relationships with local governments to obtain the data to support the prototype system. As one result, Essex County now has digitized tax map data to support its own work processes. Because of the partnership arrangement with the Park Agency, the County was able to convert this data from paper to digital formats at a much lower cost than if it had done so alone. Tax map information, compiled by county governments, is probably the most dynamic geographic dataset in the prototype, as changes occur in property ownership. At this time, only a few of the counties in the park have converted tax map data to digital form. Most have not yet begun this process. The project created an opportunity for APA and these local governments to work cooperatively to develop and maintain these data over time. In addition, the prototype system has been useful as a focus of discussion among many organizations about common goals and strategies for the Park.

Value to State and Local Government

The project also generated insights into the use of prototyping, geographic information systems, spatial data and document imaging which are useful to any government organization.

A quickly-developed prototype is better than one with more features that takes longer to construct. A critical step in the development of the APA prototype was showing an initial version to the agency within months of the original design meetings. Although this prototype did not integrate GIS and document management as they envisioned, introducing the agency staff to the basic technology, loaded with their own data, was a powerful catalyst to their imaginations. In the survey, nearly 60% of the respondents said that the prototype experience facilitated their vision of necessary system features. Subsequent project activities, including the final prototype design and the modeling and benefit analyses, were much more grounded in reality because staff had seen the technology in action and had developed some confidence in its potential by having experienced first-hand how it might work.

A prototype is a valuable tool to focus attention on non-technical issues. While this is something we observe in all the projects the Center has executed thus far, this was especially true in this project. In the process of working with Computer Sciences Corporation and CTG staff in defining the workflow to be automated, agency staff members had an opportunity to discuss what they actually do in performing their jobs. As a result of this activity, the agency has a better understanding of its work flow and how it can be changed (with and without the technology) to improve service. Many of the results of these re-engineering sessions were precipitated by discussions about what the prototype system should do, which led to greater understanding of what the Agency could achieve through simple process redesign. Later in the project, seeing a live demonstration of the prototype, with agency data loaded into the system, served as powerful catalyst for discussion of the important issues about the agency's business problems and focused attention on key policy and management questions: What is the problem we're trying to solve? How do we currently attack the problem? What do we need to be able to solve the problem? How will we measure improvement? Who will benefit?

While these questions don't require a prototype to answer, having a prototype in hand shows how information, processes, and technology work together. As a result, agency staff are better able to create and evaluate solutions that involve technology.

The APA automated permit retrieval system is a unique model for integrated records management and land information systems. A number of states and counties have sought to improve land records management and the services they provide. The APA system is a first attempt to manage integrated records across different physical media and institutional sources including documents, maps, and photos. A key factor in full implementation will be an ongoing network of relationships among the various agencies which are suppliers and users of the APA data. Attention to authenticity, updating, error correction, shared standards, and other issues will all be required. In these respects, the project can serve as a model for many organizations. Other governments struggling with disparate types and forms of data will benefit from knowing more about the core technologies and information management techniques explored in this project.

A coherent data development and management strategy is essential to the success of any system which relies on a variety of data formats and sources. No system is better than the quality, integrity, and consistency of the data it contains. The project demonstrated the importance of having a clear picture of an organization's data resources and a well-articulated data management program. Some key program elements include sufficient metadata to describe datasets, consistent coding schemes for related data, data modeling to identify and make use of the relationships among data elements and data types, and recognition that data resources belong to the entire organization and should not become isolated in separate work units or program areas.

Metadata is a valuable addition to spatial data that makes sharing data with others easier. Metadata is simply information about other information . It provides a concise summary of the information a user needs to know about a spatial dataset in order to determine its suitability for a given purpose. Such information might include the dataset's creation date, its creator, the primary data source, the original scale, and intended use of the dataset. At present, the addition of metadata to spatial data is considered optional, but its inclusion is becoming much more common, and should be strongly encouraged. Knowledge of a coverage's metadata enables users of spatial data to make informed decisions about whether a dataset is the right one for their particular purposes. In addition, as agency needs and personnel change, the original structure and assumptions about the data may be lost if it is not well-documented.

Data modeling is a valuable tool for examining the existing relationships between data elements, and showing where others might be created. Conversion and integration of digital data into a GIS may be a relatively simple task, but the utility of this data once integrated is by no means guaranteed. Before attempting to integrate tabular data, particularly if it is to be used as an index, the data must be evaluated carefully to ensure that it is capable of supporting the required functionality. Although a data model cannot show all aspects of the relationships between data elements, it can show the explicit relationships required between different types of data, and suggest the means of establishing these relationships if they are not already present. This is especially important because the implicit relationships that are readily understood by people who work with data by looking at it must be made explicit when the same data is used in a GIS, since the system cannot "see" the relationships.

Use of existing spatial or tabular data is a simple, quick, and cost-effective method of populating a new GIS with data. This is particularly desirable when prototyping, since it enables a prototype system to become functional in far less time than when data must be acquired from outside sources. Spatial datasets (coverages) and tabular data are, in most cases, easy to convert to the desired format and integrate into a GIS. This is true despite the fact that most GISs store their spatial data in a proprietary format since most GISs have extensive conversion facilities for other major GIS formats. Database software is normally capable of converting to and from a wide range of tabular data formats. This approach facilitates project initiation by eliminating a major data collection effort, minimizing startup costs and delays. As more funds become available to improve the data sources, refined data layers can be readily added, gradually improving accuracy and completeness.

Scanning of tax maps is an inexpensive first step to getting cadastral (tax parcel) data into a GIS. For maximum utility, such maps should be vectorized, or converted from raster to vector format. Scanned, or raster images, incorporated into a GIS may be used as display images only; they cannot be used for spatial analysis techniques such as overlay analysis, area calculations, or boundary checking. Raster data is stored in a grid cell pattern, where map features are approximated by filling in the grid cells that most closely resemble a feature. Vector data is stored as a series of X, Y coordinates, and the location of every point along a feature may be determined. Because every point can be known, continuous lines or polygons may be constructed whose length, area, perimeter, and exact location may be calculated.

The temporal aspects of spatial data are a source of special difficulty, especially with tax parcel data. Updates concerning changes in tax parcel information, such as subdivision of lots or changes in ownership, must be made consistently to all pertinent datasets to avoid the creation of an inconsistent and misleading database that cannot be relied upon for either spatial or temporal accuracy. However, when using data provided by others, control over the timing of updates is rarely possible. Thus, a degree of inconsistency within the system must be tolerated. The presence of this inconsistency and its effect on the conclusions drawn from the data must be made clear to all users in order to minimize potential confusion.

Scale variability is unavoidable when combining a wide variety of coverages of differing types. All spatial data is created at a specific scale, and is most accurate at that scale. Although it is acceptable to use a coverage at a smaller scale (features reduced in size) than the one at which it was created because spatial accuracy does not suffer, it is *not* acceptable to use a coverage at a scale far larger (features enlarged in size) than its original scale. A general rule of thumb is that the largest scale at which a coverage may be displayed while maintaining spatial accuracy is twice the original scale: for example, a planimetric map whose original scale is 1:24000 should not be relied upon for a high degree of accuracy when displayed at a scale larger than 1:12000. It is important to note that decisions made based on overlays of coverages displayed in violation of this rule must be tempered by an awareness of the potential for inaccuracy. Larger scale maps are desirable because they can provide a high degree of detail and accuracy, but the drawbacks of increased cost of data acquisition and conversion, greater data complexity, and increased time required for update and maintenance of databases must also be considered.

Service bureaus that perform document conversion provide highly specialized services; the services offered, quality of results, and prices charged are likely to vary widely. For these reasons, it may be necessary to choose vendors based upon their ability to produce high-quality output from a single type of data. Sending sample data to several vendors is highly recommended; in this way image quality, job pricing, file storage requirements, and timeliness of delivery may be evaluated. Several vendors, each with a specific area of expertise, may be needed to complete a complex conversion process.

File formats and quality control are essential considerations when converting documents to digital images. From discussions with scanning vendors, we learned that there is a great variability in document compression and resolution standards. It was fortunate that the particular technologies used in the prototype (ArcView2 and EFS) were able to use a common variant of the Group IV TIFF format. Without a common standard, additional conversion would have been necessary prior to loading digitized data. Group IV TIFF is a commonly used file format, but there are many subformats which may be vendor- or hardware-specific, and these subformats are not necessarily compatible with one another or with the software used to display document images. Choice of vendor may be strongly influenced by the output file formats they are able to provide and their ability to be read by image display software. In addition, tight quality control is needed at every step of the document conversion process. This will ensure the best possible image quality, as well as correct indexing of all document pages. Indexing problems may be very difficult to detect and correct; providing the vendor with an accurate index of microfiche or microfilm contents is a necessary preventive step.

Value to the University Community

The project provided an opportunity to combine two discrete technologies (GIS and document imaging) into an integrated system. By combining knowledge and skills from the disciplines of computer science, information science, and geography and planning, the university and corporate members of the project team devised an effective linkage between GIS and imaging concepts and technologies. The result was a system which allowed agency staff to use the prototype as an "electronic reference desk" with access to many different kinds of information needed to answer questions and make decisions. For the system designers, this was a unique opportunity to work across disciplines and gain broader perspectives on the technical tools and information management issues embedded in the system.

The project's research efforts validated and refined the use of cost-performance models in program and system evaluation. Cost-performance models have been used in several CTG projects to understand the interplay among different levels of organizational and system investment and different costs, savings, and other benefits. The models developed for this project, were by far the most extensive and served to validate the methodology as well as to produce valuable evaluation data. CTG staff and faculty fellows have become more proficient in their use and agency staff find them rigorous, but highly insightful and instructive.

Students had the opportunity to apply their training and theoretical knowledge to help solve practical problems in a complex and dynamic environment. University students seldom have the opportunity to put their classroom learning into practice in outside organizations. This project involved graduate students from public administration and policy, information science, computer science, and geography and planning in an applied research effort which focused each of their disciplines on a common problem. The students worked with new technologies, complex and imperfect data, organizational dynamics, and important public policy issues that no course work or traditional research project could have duplicated. As a result they are all better prepared to contribute to future research and future employers.

Value to Corporate Partners

Corporate partners benefited from the opportunity to experiment with a new form of system integration: document imaging and GIS. The marriage of document imaging and GIS is a fairly new idea and is not currently available through any commercial product. The corporate partners were able to investigate several approaches to this linkage and to learn how to make it cost-effective as well as innovative. This knowledge may lead to new products, services, and partnerships in the future.

The services and products provided by corporate partners were demonstrated to many state and local government agencies in the context of practical problems they all share. The APA project has been presented to both statewide and national audiences. Scores of government organizations at the federal, state, and local levels have attended demonstrations and professional seminars designed to present key issues in land management, spatial data management, and integrated information systems. The system and its partners were also showcased at a national convention for intergovernmental initiatives, Interchange 94. Each of these events exposed the work and products provided by our corporate partners to a burgeoning public sector market.

APPENDIX A
TIMELINE

Dates	Event
November, 1993	Project acceptance by CTG
November, 1993	Initial meeting with APA
December, 1993 - June, 1994	Corporate partners selected
March, 1994	Facilitated planning meeting
March, 1994	Requirements analysis
March - June, 1994	Prototype definition
June - September, 1994	Prototype development
September, 1994	Prototype demonstrated at Interchange 94
September, 1994 - January, 1995	Additional prototype development and testing
October,1994	Cost Performance Modelling Conference
February, 1995	Prototype installed at APA
February - March, 1995	Prototype evaluated by APA staff
March, 1995	Customer Service Modelling Conference
March, 1995	Data Modelling Conference
March, 1995	Evaluation Interviews
March, 1995	Public Demonstration
June, 1995	Technical Report Completed
October, 1995	Evaluation Report Completed
December, 1995	Final Report

APPENDIX B
PROJECT PARTICIPANTS

NYS Adirondack Park Agency
- John Banta, Director of Planning
- John Barge, Information Systems Manager
- Greg Hill, Assistant Director of Regulatory Programs
- Edward Hood, Assistant Director of Planning
- Colleen Parker, Project Review Specialist
- Barbara Rottier, Associate Counsel

Center for Technology in Government
- David Andersen, Public Administration and Policy
- Peter Avery, Project Coordinator
- Donna Berlin, Facilities Manager
- Peter Bloniarz, Research Director
- Anne Miller, Graduate Assistant
- Paul Husek, Graduate Assistant
- Steven Hyde, Graduate Assistant
- Kristine Kelly, Research Associate
- Soonhee Kim, Graduate Assistant
- Eliot Rich, Research Associate
- John Rohrbaugh, Public Administration and Policy

Bay Networks
- Mark Culotti

Computer Sciences Corporation
- Thomes Morgan
- Kenneth Meehan
- Henry Driver

Hewlett Packard
- Richard Riis
- Donna Knights

ESRI
- Peggy Harper
- Julio Olimpio

Excalibur
- Joan Dickinson
- Roland Murphy

NYNEX
- Neil Corkery

Oracle Corporation
- Paul Winslow

Xyplex
- Dick Desmarais

APPENDIX C
PROTOTYPE DESCRIPTION

C1 - Hardware and Software Architecture

The hardware consisted of three Hewlett-Packard Model 712/80 workstations, each with the following features: 64 MB RAM, a 1GB internal hard drive, a 1GB external hard drive, and a 20" color monitor, running HP-UX 9.03, and one HP e35 9000 server, configured as follows: 128 MB RAM, 4 GB total storage, a 4 mm DAT tape drive, and one CD-ROM drive, running HP-UX 9.04.

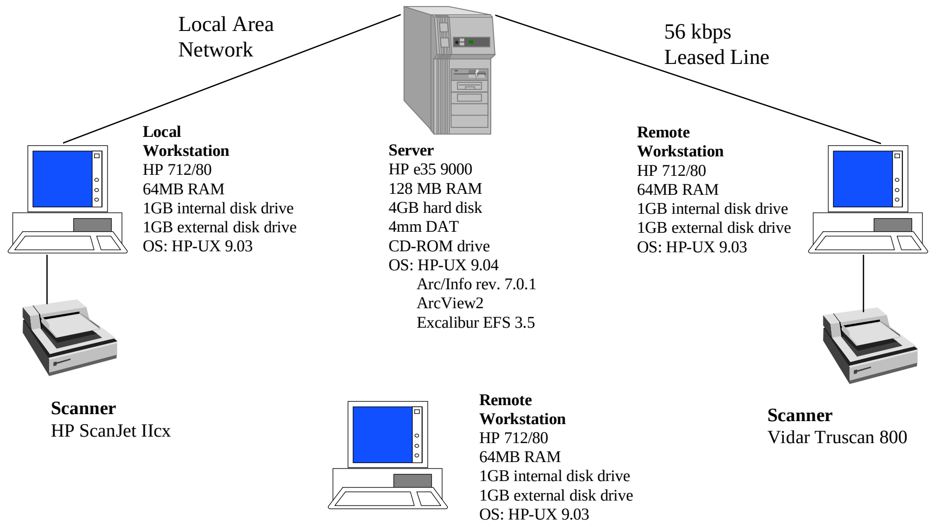
Hardware was configured in two different ways. During the development portion of the project, the server resided at CTG and was connected to the local workstation through a local area network, using 10 Base T. The local workstation was also connected to a Hewlett-Packard ScanJet IIcx scanner. The remote workstation resided at the APA offices in Ray Brook, connected to the server via a 56 kbps leased line provided by NYNEX. Another scanner, a Vidar Truscan 800, was connected to APA's remote workstation.

During the evaluation portion of the project, the configuration was reversed: the server was now resident at the APA offices in Ray Brook, and the local workstation (now APA's) was connected to it using thin-net cabling. The CTG workstation, now the remote site, was connected to the server via the 56 kbps leased line. The third workstation, located at Computer Sciences Corporation in Rockville, Maryland, was a standalone throughout the entire development and evaluation process.

Both local and remote workstations accessed software located on the server through *telnet* sessions. Software resident on the server included: ARC/INFO rev. 7.0.1, ArcView2, and Excalibur EFS 3.5. Three site licenses were available for each software package. ArcView2 and Excalibur were integrated through the use of UNIX shell scripts. Communication between the two applications was done in asynchronous mode, again through the use of shell scripts and a command-line interface. ARC/INFO was used as a supplementary source of data (coverages) for ArcView2, and was not integrated with the other software packages.

An illustration of the hardware and software as it was configured during the development portion of the project is shown on the following page.

Hardware and Software Configuration
for APA Prototype



Shown in development configuration

C2. Data Summary

The original data included in the APA prototype consisted of a variety of datasets already possessed by APA in digital form. These data included numerous ARC/INFO coverages containing attribute information about the Adirondack Park, scanned images of planimetric maps covering the entire Park, a digital satellite image of the Park, and database files containing project site, enforcement, and jurisdictional inquiry information for the Agency. These datasets are summarized in Table 1.

Documents pertaining to Jurisdictional Inquiries and APA Project Sites were added to the prototype during the course of the project. JIFs from Essex County for the years 1973 to 1985 were originally stored on 16 mm film (microfiche), and were converted to Group IV TIFF files by Gannon Technology of Reston, VA. A total of 35,692 pages were converted, at a cost of $0.245 each. The converted files were provided on 4 mm DAT tapes; Perl scripts were used to load these into EFS and assign the correct filenames.

The APA Project Site documents were originally paper documents; 50 important project folders for Essex County, selected by APA, were scanned manually and entered into the prototype by APA. Approximately 250 pages of documents were scanned. In addition to these documents, an ARC/INFO coverage, a scanned topographic map, and two scanned tax maps were added to the prototype. A summary of the data added to the prototype is shown in Table 2.

Various indexes were used to link database files, spatial data, and document images together. For example: JIF documents were accessed based on the JIF number contained in a record selected from the Jurisdictional Inquiry index. The value contained in the JIF_number field of the record was used as an argument when EFS was started, which then brought up the appropriate document images. Project documents were accessed in the same manner, using the Proj_number field. Enforcement documents were not included in the prototype; the enforcement index, in this case, was simply a viewable table, as was the pre-existing subdivision table. Each of the above index files was originally a compilation of APA's transactions of a specific type, stored in dBase format.

Several additional indexes were also added to the prototype. These were database files associated with Arc/Info coverages, and were added as needed for use with ArcView2 scripts; except for one table, none of these were seen or accessed directly by the users. The exception was the Attributes of Essex County Parcel Points table. This could be searched to find a specific land parcel or parcels.

Data Type	Format	Data Source	Scope	Sc
Geographic Data:				
Planimetric base maps	Arc/Info polygon coverages	NYS Dept. of Environmental Conservation	Parkwide	1 :
Thematic Mapper image	unclassified raster satellite image	EOSAT (Earth Observation Satellite Company)	Parkwide	1 :
USGS names	Arc/Info point coverage	United States Geological Survey	Parkwide	1 :
Real Property Parcel data	Arc/Info point coverage	NYS Bureau of Equalization & Assessment	Essex County	1 :
Land Classification - Small Scale	classified raster satellite image	Adirondack Park Agency / EOSAT	Parkwide	1
Land Classification - Large Scale	Arc/Info polygon coverage	Adirondack Park Agency	Parkwide	1 p
APA Project Sites	Arc/Info point/line/poly coverage	Adirondack Park Agency	Parkwide	1 :
Significant Biological Sites	Arc/Info polygon/line coverage	Adirondack Park Agency	Parkwide	1 :
Natural Heritage Sites	Arc/Info point coverage	NYS Dept. of Environmental Conservation	Parkwide	1 :
ALSC Pond data	Arc/Info point coverage	Adirondack Lakes Survey Corporation	Parkwide	1 :
Aquifer data	Arc/Info polygon/line coverage	Adirondack Park Agency	Parkwide	1 :
Ecozones	Arc/Info polygon/line coverage	NYS Dept. of Environmental Conservation	Parkwide	1 :
Municipal Boundaries	Arc/Info polygon/line coverage	NYS Department of Transportation	Parkwide	1 :
Hydrology	Arc/Info polygon coverage	NYS Dept. of Environmental Conservation	Parkwide	1 :
Essex County Parcel Centroids	Arc/Info point coverage	NYS Bureau of Equalization & Assessment	Essex County	1 :
Road Network	Arc/Info line coverage	NYS Department of Transportation	Parkwide	1 :
Shaded Relief Map	Arc/Info GRID data	USGS Digital Elevation Model Data	Parkwide	1 :
Database Files / Indexes:				
APA Project Site Index	dBase file	Adirondack Park Agency	Essex County	
APA Enforcement Site Index	dBase file	Adirondack Park Agency	Essex County	
APA Jurisdictional Inquiry Index	dBase file	Adirondack Park Agency	Essex County	

Table 1
Original data layers

1. Coverage names are in the form x99xxcl, and are matched to TIFF files with the corresponding filename xx99xxpl.tif.

Data Type	Format	Data Source	Scope	Sc
Geographic Data:				
Regulatory Wetlands	Arc/Info polygon coverage	Adirondack Park Agency	Town of Keene	1 :
Topographic Base Map	raster scanned image	APA / NYS Dept. of Transportation	Single quad	1 :
Tax Maps (2)	raster scanned images (400 dpi)	Adirondack Park Agency	Town of N. Elba	1:1 1:9
Document Images:				
Jurisdictional Inquiry (JIF) Documents	raster scanned images (300 dpi)	Adirondack Park Agency	Essex County	
Selected Project Documents	raster scanned images (300 dpi)	Adirondack Park Agency	Essex County	
Additional Indexes:				
APA Pre-existing Subdivision Index	dBase file	Adirondack Park Agency	Essex County	
Attributes of Adknames	Arc/Info attribute table	Adirondack Park Agency	Parkwide	
Attributes of APA Project Sites	Arc/Info attribute table	Adirondack Park Agency	Parkwide	
Attributes of Essex County Parcel Points	Arc/Info attribute table	Adirondack Park Agency	Essex County	
Attributes of Land Classification	Arc/Info attribute table	Adirondack Park Agency	Parkwide	
Attributes of Municipal Areas	Arc/Info attribute table	Adirondack Park Agency	Parkwide	
Attributes of Quads	Arc/Info attribute table	Adirondack Park Agency	Parkwide	

Table 2
Data Added During Project:

2, 3. Filenames are in the form yy-9999_99x, where yy is the year, 9999 is the transaction number as assigned by APA, 99 is the sequence number fo character indicating document type (Project, JIF, or Enforcement). Some Project filenames have an additional character following the transaction num underscore; this was included to match APA's naming convention.

C3. Operational Description

APA Office Support System Prototype

This section describes the capabilities to be provided by the prototype system in support of the Public Service Office and Case Worker functions of the APA. The scope of the prototype has been reduced from its earlier concept; the current design focuses on the rapid retrieval of documents and geographic information which was otherwise unavailable or untimely.

1. Screen Overview

When ArcView is started, the user will open an ArcView "project" from the menu bar . An ArcView project is a collection of views (maps), scripts (programs to display data), charts, and tables. (Figure 1). Each of these elements may be accessed by clicking on the column on the left side of the project window. A list of the items available within the type is listed, and may be activated by clicking on the desired item. When the project is loaded, the Map window is open. It displays an overview of the Park. The Map window has a table of contents on the left border, with the themes available in the database. These themes include tax maps, wetland maps, project sites, and the other geographic data contained in the database. The remainder of the window displays the selected map set.

One or more tables will also be open, presenting the Projects, JIF and Enforcement databases. These databases are presented in a spreadsheet-like form, with each entry as a row in the table. Above the windows is a set of pull-down menus which provide access to various ArcView functions. Under the menus are two rows of buttons which assist with the most common actions.

2. Public Service Officer / Case Manager Functionality

When a PSO or Case Manager is investigating a property or case inquiry, the Office Support System provides access to several types of APA information. Through the workstation, the user can locate a property on a map, and view it in combination with other geographic data. The user may also look for existing related actions, read scanned images from the existing files, and print a record of this information for their use.

2.1 Parcel Identification

The first step in using the Office Support System is identifying the parcel or parcels in question. The system has a record of the Real Property Inventory for Essex County in place, with corresponding geographic references. Locating a parcel of interest may be done in several ways.

2.1.1 Parcel Identification by Map. To query information about parcels in the park, the PSO uses the map to establish its location. When a map is displayed, the user may zoom in or out from the current location, or pan across the map to find the parcel in question.
2.1.2 Parcel Identification by Tax ID. To locate a property using tax identification information, the PSO selects the Tax Map # Select option from the APA Views menu .

This will lead them through a series of steps to identify the town, and map characteristics of the property. The property will be highlighted in yellow on the map window. The scale of the window may be adjusted manually.

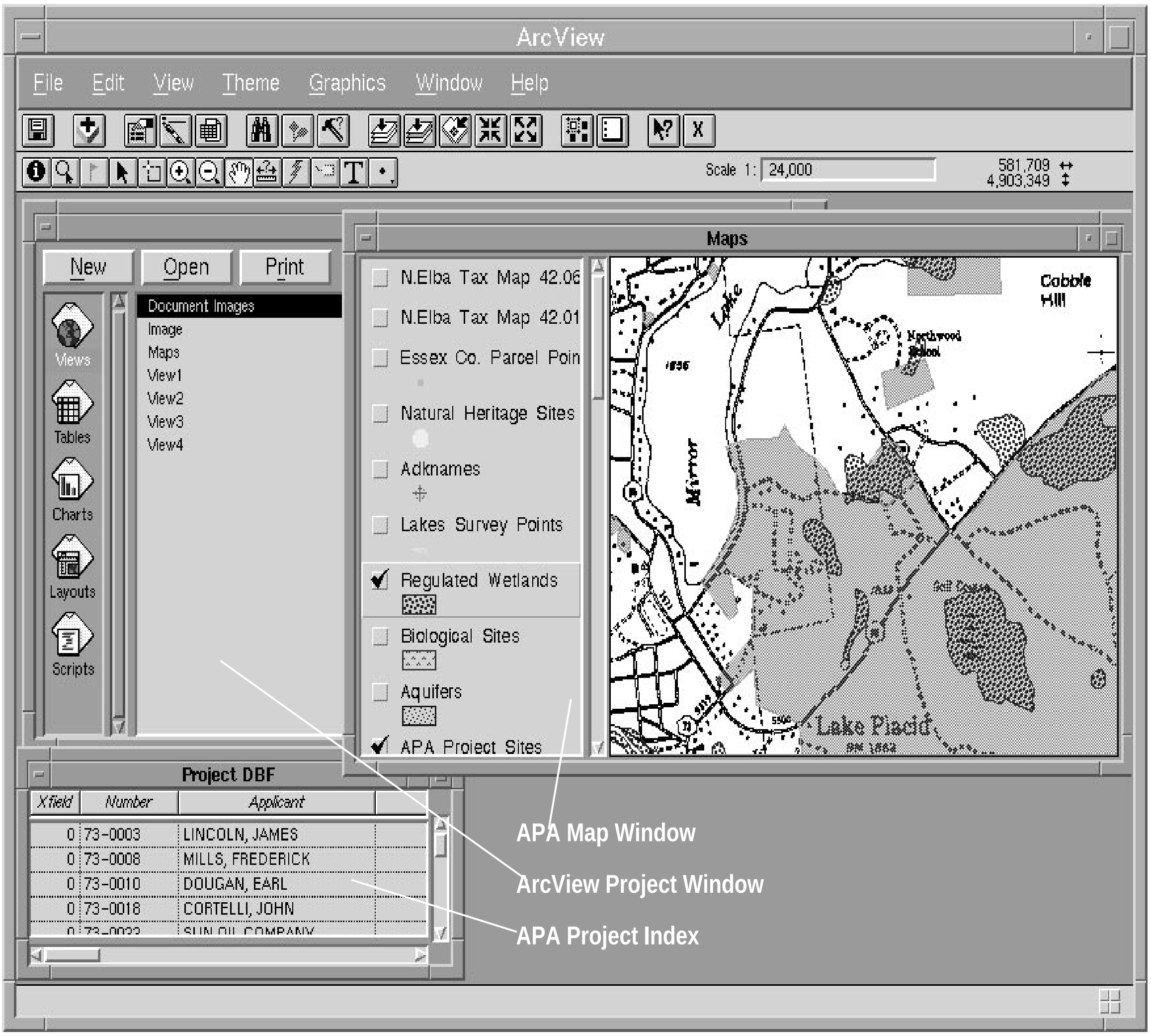


Figure 1
Sample ArcView Project Display

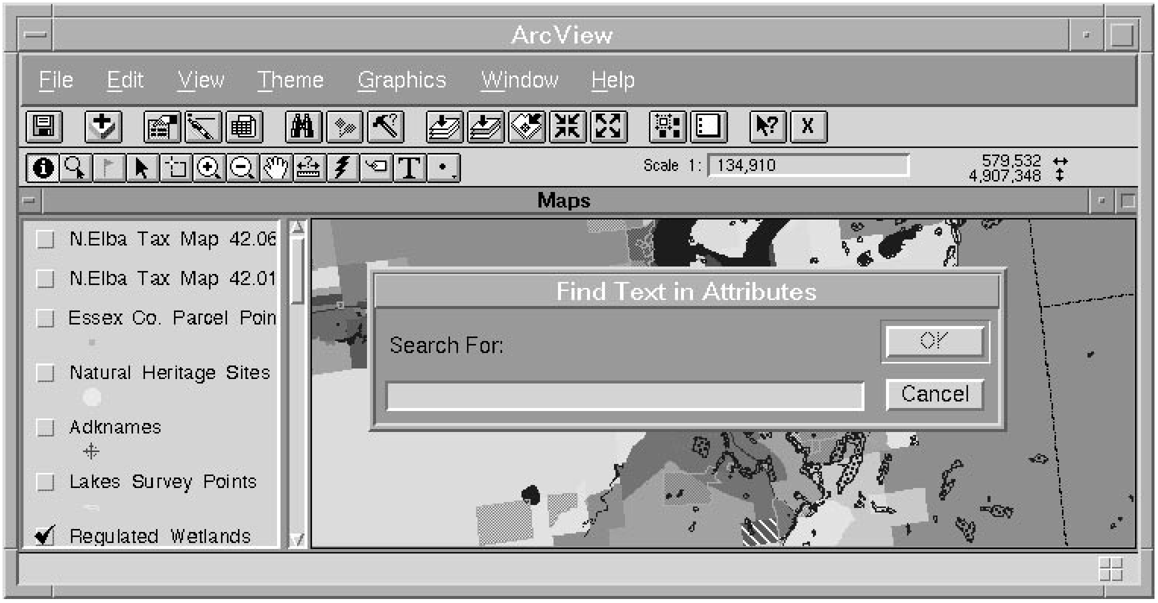


Figure 3
Search of Property Attributes using Find command

2.1.3 Parcel Identification by Name. A search for a name associated with a parcel may be performed using either the Query Builder or the Find Function. The Find function (Figure 3) of ArcView asks the user for a word or number associated with the property in question. It then finds the first entry in the database which has that word or number anywhere in its record and shows the associated property in the map window. This method allows only one attribute to be specified, and returns only one record.
The Query Builder function of ArcView allows the user to construct a more complicated search. Here, the user may specify each of the values of interest, and the system will return all records which meet the specification.

2.1.4 Parcel Identification by Proximity. To select parcels by distance, the PSO has two options. The first method is to use a 'rubber-band-box'; this allows the user to select parcels from the map window at a variable distance from a given site. Alternatively, the PSO may find all parcels within 100 yards of a selected parcel by pressing the Flag button from the button bar.

2.2 Reviewing Project, JIF and Enforcement Databases. The Project, JIF and Enforcement indices as of 9/94 have been loaded into the ArcView project. Through ArcView, the PSO can scroll through the data, or use either the Query Builder or Find commands to locate properties of interest.

2.3 Review of Document Images. Digitized images of documents are available in three ways: based on a map selection, a specific Project Index entry, or a specific JIF entry. Enforcements are not available as part of the prototype.

2.3.1 Project Documents based on Map. From a parcel in the map window, the PSO may choose to view all projects folders associated with the parcel. To do this, they would click on the "X" button. This will start up an Excalibur session each project known for the parcel, up to five parcels.

2.3.2 Project Documents based on Project Index. To view the contents of a project file, the PSO highlights the relevant project in the Project DBF window, and clicks on the "P" button from the second row of buttons. This will start up an Excalibur session, with the first document in the folder displayed.

2.3.3 JIF Documents based on JIF Index. To view the contents of a project file, the PSO highlights the relevant project in the Project DBF window, and clicks on the "J" button. This will start up an Excalibur session, with the first document in the folder displayed.

Whenever a folder is opened, the first image of the first document will be displayed. To view documents for the same property in another index, the user will need to select the property and re-query.

The PSO will be able to review or print the documents in this folder. When finished with this folder, the PSO will close the folder manually.

2.4 Map Buttons. The APA database has three predefined views of maps available. These permit rapid access to standard views of data. These maps include:

Group 1: (All at 1:24000) scale	Land Class Planimetric Tax Maps Wetlands Parcel
Group 2: (At 1:2400)	Tax Map Centroid
Group 3: (At 1:2400)	Tax Map Centroids Wetlands Land Use Planimetric

When the appropriate button is pressed, the scale and coverages displayed in the map window will be adjusted to the above settings.

2.5 Printing Map and Property Data. The PSO will be able to print a standard report on a selected property, consisting of the maps from Group 1 and Group 2, above, as well as a list of the property's data from the Attribute table. To do this, the PSO will press the print button from the menu bar.

ArcView also provides the ability to print the currently displayed map window. The PSO may print the currently displayed map window by clicking on the Map window and selecting the "Print" Option from the File Menu. The default options will print the maps; the alternate selection prints the map legend.

APPENDIX D
RELATED PRODUCTS

Glennon, Robert C. and Smith,Daniel T. (1993, August). Proposal for "Automated Permit Retrieval System" & Staff Analysis, CTG.APA-001.

Hedstrom,Margaret. (1993, November). "Analysis and Recommendations Concerning the Records Management Program of the Adirondack Park Agency" prepared by the New York State Archives and Records Administration, Bureau of Records Analysis and Disposition, State Education Department, CTG.APA-002.

Smith, Daniel T. (1994, February). Report of the Task Force on Expediting Adirondack Park Agency Operations and Simplifying its Procedures, Findings and Recommendations, CTG.APA-003.

Dawes, Sharon. (1994, May). Letter to Paul Peck and attachment - submission for Interchange 94, CTG.APA-004.

Institutional Review Board. (1995, January). Memo to Sharon Dawes, RE: Human Subjects Review of No. 95-001 "Adirondack Park Agency Office Support System", CTG.APA-005.

Giguere, Mark. (1994, June). Literature Review & Selected Annotated Bibliography, CTG.APA-006.

Andersen, David, Rohrbaugh, John, and Kelly, Kristine. (1994, November). Interim Report on the APA Cost Performance Model, CTG.APA-007.

Kelly, Kristine and Hyde, Steven. (1995, March). Preliminary Analysis of Interview Data, CTG.APA-008.

Andersen, David, Hyde, Steven and Kelly, Kristine. (1995, March). Interim Report on the APA Data Population Model, CTG.APA-009.

Hyde, Steven and Morris, Michael. (1995, June). Project Document Index, CTG.APA-010.

Andersen, David, Avery, Peter, Kelly, Kristine, Hyde, Steven and Rohrbaugh, John. (1995, May). Update on Cost Performance and Customer Turn-Around Time Modeling Completed in April, May and June, CTG-APA-011.

Kelly, Kristine and Hyde, Steven. (1995, May). Potential Quality Improvements and Extended Benefits of an Office Support System for the APA, CTG.APA-012.

Kelly, Kristine and Hyde, Steven. (1995, March). Results from Pre and Post Survey of APA Staff, CTG.APA-013.

Bloniarz, Peter A., Miller, Anne, and Rich, Eliot. (1995, June). Using Technology to Change Work: Technical Results from the APA Prototype, CTG.APA-014.

Andersen, David, Avery, Peter, Kelly, Kristine, Hyde, Steven, Rohrbaugh, John and Kim, Soonhee. (1995, October). Evaluating the APA Prototype: Prospects for Providing Cheaper, Faster, and Better Services to APA's Customers, CTG.APA-015.

APPENDIX E
SELECTED BIBLIOGRAPHY

Budic, Zorica D. (1994, Spring). Effectiveness of Geographic Information Systems. *Journal of the American Planning Association*, **60**(2), 244-259.

This research article discusses an effort to judge the impact of implemented GIS systems via a survey of four local governments in southwestern states. The results provide several interesting categories of measures that might be used by CTG in evaluating the impact of GIS technology.

Felleman, John. (1994, Fall). The emerging role of a state land information system in environmental sustainability, *URISA*, **6**(2), 11-24.t

This research-based, policy piece by a SUNY professor in the College of Environmental Science and Forestry makes the theoretical justification for the use of integrated land information systems [LIS] in the management of New York's environment.

Fletcher, Patricia T. et al. (1992, August). *Managing Information Technology: Transforming County Government in the 1990s*. Syracuse, NY: Syracuse University School of Information Studies Center for Science and Technology.

This detailed report, a component piece of a national study of county-level IRM, while not specific to GIS at its broadest level, provides several useful tools that can be used to evaluate the efficacy of (GIS) systems both before and after implementation. Case study designs, as well as telephone and instrument survey methodologies are described. Also discussed are methodologies for evaluating costs and benefits of IRM systems. A portion of Chapter 9 examines a case study of a GIS system for the city of Las Vegas, Nevada.

Gavrel, Katherine. (1990, April). *Conceptual Problems Posed by Electronic Records: A RAMP Study*. Paris: General Information Programme and UNISIST of UNESCO, PGI-90/WS/12.

This paper provides detailed insight into archival concerns associated with electronic records. Chapter 3 provides insight into basic archival principles and Chapter 4 deals specifically with problems associated with geographic information systems. While Chapter 4 does not make specific recommendations regarding GIS, it does reference other (inter)national GIS projects that have grappled with archival issues in their implementation.

Land Records Modernization and Geographic Information Systems Planning. (1991, February). WI: Various State Agencies.

This report outlines the steps involved in implementing an LIS/GIS system; from delineating system functionality via conducting a detailed data inventory and user survey, formulating an RFP, ensuring system requirements necessary for complying with accepted GIS standards, and a system implementation timetable. This report is based on the WINGS system referred to in several other references in this bibliography.

Montgomery, Bob. (1994, April). Protecting data assets tops GIS migration concerns. *GIS World*, pp. 38-40.

This trade journal article, although written from the perspective of a GIS practitioner, echoes many of the technical data concerns and considerations voiced in the archival references cited in this bibliography.

New York State Archives and Records Administration [SARA], State Government Records Management Information Series. (1990). *Introduction to Optical Disk*. Albany, NY: SARA.

This booklet presents a fundamental discussion of optical disk storage technology. While the discussion of the technology is geared towards the uninitiated, there is a useful discussion of the basics of the technology as it relates to archival considerations.

New York State Archives and Records Administration [SARA], State Government Records Management Information Series. (1994, May). *Guidelines for the Legal Acceptance of Public Records in an Emerging Electronic Environment.* Albany, NY: SARA.

This booklet presents a clear and useful discussion of the system requirements necessary to support the appropriate legal and evidentiary status of state government agency records created by electronic technologies (GIS and optical imaging included).

New York State Archives and Records Administration [SARA], State Government Records Programs Advisory Services. (1994, May). *Directory of State Government Optical Imaging Applications*. Albany, NY: SARA.

This directory details all agencies in New York State government that are currently pursuing programs that use optical imaging technology, and includes many GIS systems that are currently under development. The status, hardware and software characteristics, and agency contact person for each project are provided.

New York State Department of Environmental Conservation [NYSDEC]. (1990, May). *Geographic Data Source Directory.* Albany, NY: NYSDEC.

This directory details over 75 geographic data sources that have potential for inclusion in GIS applications. For each source, information provided includes contact person, subject category, data coverage and data format.

New York State Forum for Information Resource Management [NYSFIRM]. (1992, March). *Forum Policy Committee GIS Project Report*. Albany, NY: NYSFIRM.

This policy report, dealing specifically with GIS issues, is part of a larger, statewide IRM effort (see following citation). It specifically examines issues associated with the proposed development of a multi-agency, GIS system in the Lancaster area of Erie County. Policy discussions of information resource development, stewardship, use, and information infrastructure and technology management are included.

New York State Forum for Information Resource Management [NYSFIRM]. (1992, August). *Developing an Information Resource Management (IRM) Program for New York State*. Albany, NY: NYSFIRM.

A policy discussion report that discusses a framework for the evaluation of statewide, information resource management issues.

Public Records: VISION 2000. (1993, December). Albany, NY: Governor's Task Force on Filing and Recording.

This four volume report contains the recommendations of the Governor's Task Force on Filing and Recording for the future direction of the management of land records in the state of New York. Included along with the final report are an Executive Summary, an inventory of local government land documents, and a literature review/annotated bibliography. The annotated bibliography is particularly good, and significantly augments the scope of what is presented here.

All three volumes described here are contained on disk in ASCII format (found in a jacket inside the Executive Summary).

Stasz, Cathleen et al. (1990).*Information Technology in the U.S. Forest Service*. Santa Monica, CA: The Rand Corporation.

This very useful report details work done by Rand Corporation consultants as they assisted the U.S. Forestry service in planning for the development a GIS system that integrates land management planning, system dynamics modelling and basic office software. The report details the entire process, from initial system specification meetings with the agency through an analysis of hardware and software requirements to the final recommendations made by the consultants. Appendix A contains a useful framework for a cost-benefit evaluation of a GIS system.

State of Texas, Department of Information Resources Management. (1991, November). *State Strategic Plan for Information Resources Management*. Austin, TX: Department of Information Resources Management.

While generally addressing topics at a much broader level than GIS, the third outlined strategy of the report deals with plans to develop an inter-agency, integrated GIS system for the state.

Thapa, Khagendra and Bossler, John (1992, June). Accuracy of spatial data Used in geographic information systems, *Photogrammetric Engineering and Remote Sensing*, **58**(6), 835-841.

This very useful report details work done by Rand Corporation consultants as they assisted the U.S. Forestry Service in planning for the development of a GIS system that integrates land management planning, system dynamics modelling and basic office software. The report details the entire process, from initial systemspecification meetings iwth the agency through an analysis of hardware and software requirements to the final recommendations made by the consultants. Appendix A contains a useful framework for a cost-benefit evaluation of a GIS system.

U.S. Department of Commerce [USDOC], Technology Administration - National Institute of Standards and Technology. (1992, August). *Spatial Data Transfer Standard (SDTS)*. Washington, D.C.: USDOC.

This technical publication details the SDTS that has been developed to facilitate the physical file encoding of geographic and cartographic data.

Utility Graphics Consultants for Winnebago County, WI. (1990, June). *Winnebago County Geographic Information System (WINGS) Multiparticipant GIS Study Conceptual Design Workbook.* Englewood, CO: Utility Graphics Consultants.

This planning document contains useful planning information associated with the design of a county wide GIS system that integrates zoning, deed, tax, utility and community planning information. The document is not in prose, however, rather it is a reproduction of a series of overhead transparencies used by the consultants at a planning meeting, so its primary usefulness is only as a template for planning a GIS system.

Utility Graphics Consultants for Winnebago County, WI. (1990, September). *Winnebago County Geographic Information System (WINGS) Multiparticipant GIS Study Conceptual Design/Implementation Plan and Cost-Benefit Analysis.* Englewood, CO: Utility Graphics Consultants.

The most important section of this document deals with the design of a cost/benefit methodology used to estimate annual operating costs, cumulative costs, and payback point for the WINGS countywide GIS system.

Warnecke, Lisa et al. *State Geographic Information Activities Compendium*. (1992). Lexington, KY: The Council of State Governments.

This compendium details over 200, state-by-state GIS activities in the United States as of the late 1980's. Be forewarned that because inclusion in this compendium is voluntary, and project descriptions are submitted by the respective agency personnel, there is an extreme breadth in both the format of presentation and the included level of detail. A useful directory of state geographic information officials is provided as an appendix.

Yi, Gi-Chul, et al. Development of Ohio's GIS-based wetlands inventory, (1994, January/February). *Journal of Soil and Water Conservation*, **49**(1) 23-28.

This research article describes a state-of-the-art integrated GIS/image management system that has replaced the Ohio Division of Wildlife's use of national wetlands maps in the management of natural resources. The system used data from several databases, including Thematic Mapper satellite imaging data.

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