GIS Implementation at the City of Falls Church, Virginia

Abstract:

The City of Falls Church,Virginia is situated a few miles southwest of Washinton D.C. bordering Fairfax and Arlington counties. Although only two square miles in area with 9,500 residents Falls Church has a local government organization and infrastructure similar to cities with much larger populations. This paper focuses on planning, design, and implementation of the City's GIS, and development of the first four applications: zoning, real estate assessment value analysis, property owner notification, and historical site management.

Successful implementation of GIS applications at the City of Falls Church within a relatively short period can be directly attributed to the commitment of City government to this new technology; effective management of the GIS implementation program by the City and its prime consultant; appropriate selection, support, and retention of qualified consultants throughout the needs analysis, systems selection, data acquisition, GIS database design- implementation and appliction development phases of the project; excellent coordination and cooperation among the various agencies involved; and the timely provision of needed information and support to the GIS application development effort.

Introduction:

The City of Falls Church, Virginia is situated a few miles southwest of Washington D.C., bordering Fairfax and Arlington Counties. Although only two square miles in area, with 9,500 residents, Falls Church has a City Council organization and infrastructure similar to cities with much larger population. The average household income in Falls Church is among the highest in the nation. The City currently provides water services for an area fifteen times larger than the City itself. They share other services with the bordering counties, for example , 911 despatch, fire, housing and human services, among others.

In 1994, a commissioned study identified city-wide GIS needs for geographic data, hardware and software. The study investigated existing computer systems and the City's individual departmental functional requirements, and recommended GIS hardware and software configurations, and data acquisition requirements for the City. Following the recommendation, the City acquired initial GIS hardware and software, and contracted out acquisition of digital photogrammetric and cadastral data. Meanwhile, more than 20 personnel from different departments within the City were sent for ESRI's GIS training.

In 1995, the City contracted out for GIS database design and development services, and four key applications to demonstrate the practical implementation of the design. The design incorporated elements of the Spatial Data Transfer Standard to facilitate data exchange between federal government, the neighboring counties, and the City. Attributes for individual data layers were listed and key attributes for relational linkage identified. A comprehensive data dictionary was compiled. Many to many relationships among parcels, ownership, buildings, addresses, and tenancy were resolved. Redundancies and data duplication were eliminated through a normalized relational design.

The four applications selected were Zoning, Real Estate Value Analysis, Automated Homeowner Notification, and Historical Site Management. In the zoning application, City zoning codes were defined within the zoning coverage and existing zoning patterns reproduced in ArcView. A zoning map was created by overlaying the zoning and parcel coverages. The real estate application was developed by establishing linkage between the the City's financial database on the IBM AS400 with the GIS. Real Property Code (RPC) number was the unique key utilized to set up linkage. Residential and Commercial property values were thematically mapped. Patterns of high and low property values were clearly distinguishable for different districts within the City. Automation of property owner notification around a 150' annulus of a targetted parcel was achieved using the same RPC linkage and theme by theme queries in Arc View. Homeowner names and addresses were accessed, a mailing list generated, and a wordprocessor used to merge each notification with the related mailing label. The Historic Site Management system was developed to create a site map, to help manage the City's inventory of historical sites.

This paper describes the City's GIS hardware and software configurations, discusses database design issues, and provides technical details of the key application development process. GIS implementation experience gained during the first phase of development, and strategy for future development is discussed in the conclusion.

GIS CONFIGURATIONS

Hardware, software, data acquisition, staffing and managment structure are components of the City's GIS configuration being discussed.

Hardware:

The IBM AS/400 system is the mainstay of the computer system currently being utilized for information services at the City's Finance Department. The Real Estate Database resident on the system is shared by most of the other departments within the City. Others databases maintained on the AS/400 include water billing, traffic sign inventories, fire hydrant data, crime records, etc. For GIS purposes, three IBM RS/6000 AIX workstations were acquired. They are separately located at the departments of Finance (the server), Public Works and Utilities, linked through a local area network. Other departments can access the RS/6000s through their personal computers over the same network. Linkage of the primary GIS data to Real Estate Data downloaded from the AS/400 has been established on the RS/6000. An HP650C ink-jet plotter and a 36"x48" Altek digitizer are also connected to each of the RS/6000s.

Software:

ArcInfo and ArcView were the software platforms selected for the City's GIS. An Oracle relational database was designed for full-scale implementation. However, Oracle has not yet been installed, and Info tables are currently being used relationally for all application development. Other software on the network include AutoCad, DBase V and a specialized Real Estate Appraisal package, among others.

Data Acquisition:

The GIS base data at the City was acquired through photogrammetry at a map scale of 1"=100' and 2-foot contours for generation of topographic maps. The photogrammetric base layers include:

Topography Utilities Transportation Recreation
Buildings Traffic signs Woodlands Hydrology
Parking SurveyControl Grid Systems

Cadastral data was converted from the existing 1"=100' City parcel maps.
The related layers are:

Parcel/Lots Addresses Easements Zoning Jurisdictions

The GIS data was originally delivered in 23 tiles, corresponding to the existing map tiling system at the City. During the course of GIS implementation, it was decided that the initial photogrammetric and cadastral data would be easier to maintain in a single composite format due the relatively small size of the City, and the irregular shape of its jurisdiction. The composite was made by joining all individual tiles together for each of the coverages involved.

Staffing and Management:

The City's GIS is currently being managed by the Finance Department. The Director of Finance coordinates all GIS activities with other City agencies, citywide users, and outside jurisdictions, like neighboring counties and federal sources of information. Specific staff within the department have not been assigned solely, on a full-time basis, for GIS implementation during the first phase. Most of the work has been conducted on-site by an outside consulting team, with City departmental staff providing assistance on a project basis. On completion of each application project, the processes are maintained by the departmental staff involved.

DATABASE DESIGN:

The database design process was divided into two components: logical and physical design. Data layers and work flow among City agencies were mapped as part of the logical design. The physical design implemented these logical relationships on the ArcInfo GIS platform.

Logical design:

Two important factors were critical to the logical design. The first was compliance with the Spatial Data Transfer Standard (SDTS) in order to ensure shareability of data resources both internally within the City, and globally with other local governments, regional government, federal agencies, the private sector, etc. The other was the aspect of data functionality for the variety of user departments, which has resulted in an application-driven orientation to design that ensures that the GIS will support future applications. During the logical design phase, all GIS data was categorized into nine groups:

1) Control and Grid Systems
2) Planimetric
3) Cadastral
4) Administrative
5) Facilities
6) Planning
7) Environmental
8) Routing
9) SDTS Metadata

The functions for each department were identified and GIS information requirements discussed and listed. Data category and sources were classified, and their associated attributes specified. Potential applications for each department were determined. As a result, over fifty applications were identified for user departments. Flow of data between various City agencies was mapped to ensure efficient implementation of data sharing principles.

Physical Design:

The Physical Database Design document was developed on the basis of the logical database design, and established the logical relationships specifically to meet the physical layout requirements of the ArcInfo system. Attribute tables were linked to graphics, and to each other through key index elements. Although originally specified and designed for implementation of the relational modelling principles of Oracle, the design was robust enough to be implemented within INFO, keeping all entity relationships intact. Entities were specified for data dictionary definitions (based on SDTS - Level 3 principles), and attribution with key relationship indeces, domains, and data characteristics. Data integration and
sharing between GIS and non-GIS users was also accommodated through relational linkage of each entity to metadata tables. All data features and tables specified for each data category in the logical design were listed. This document provided a comprehensive framework for the subsequent physical implementation stage of the City's GIS.

KEY APPLICATION DEVELOPMENT

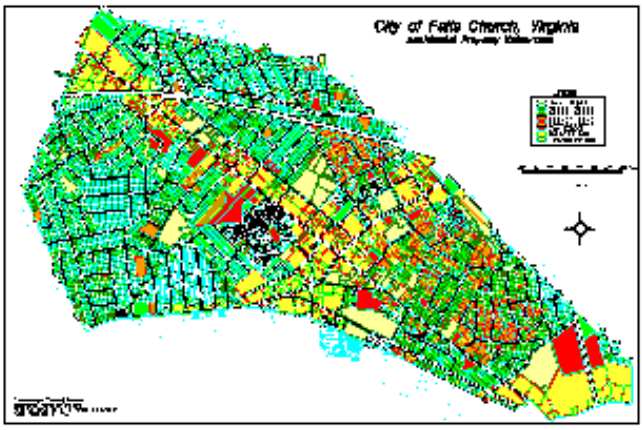
As described in the logical database design phase, over fifty applications were identified to meet the strategic GIS needs of the City. Among them, four key applications were chosen to test the database design and data integrity, and to
demonstrate GIS capability in supporting the day-to-day City management decision making process. These four were: Zoning, Real Estate Value Analysis, Automated Home Owner Notification and Historcal Site Management.

Zoning:

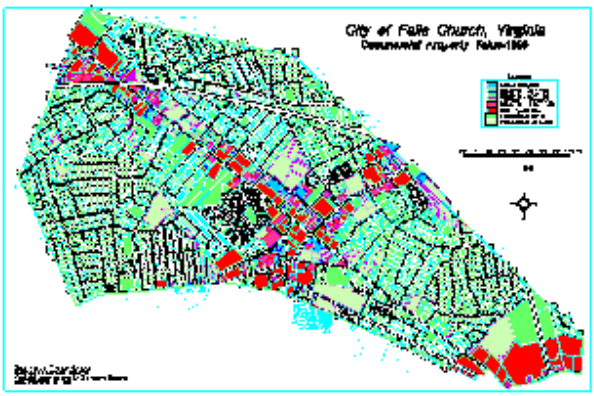
The Zoning application was designed to use digital zoning data to create zoning maps to replace those that were currently being maintained manually. To create these maps, a zoning attribute lookup table classifying different zone categories was created, and each zoning polygon populated on the Zoning coverage. The data was thoroughly checked and edited, to ensure compatibility between map products generated by the two systems (automated and manual). Some zoning changes had been implemented after the zoning coverage was first automated, so the coverage was updated accordingly. Color and shade patterns similar, as far as possible, to the original manual drafting specifications, were selected to represent each zoning category on the map. For greater visual effect and analysis, the zoning coverage was overlaid on the parcel base coverages. The final map was processed using ArcPress and is ready to be plotted in any time, utilizing a simple command routine.

Real Estate Value Analysis:

Parcel polygons were the principal source of spatial data for the real estate value analysis application. The City maintains its Real Estate Database on the AS/400. A unique field named Real Property Code (RPC#) is utilized as the primary element to link all parcel-related information within the City. To derive parcel value data, a linkage was established between the Real Estate Database and the GIS parcel coverage. The digital parcel base, however, contained numerous problems, partially because the source parcel maps didn't reflect the latest land ownership exchanges. As a result, the data had to be thoroughly investigated and edited, before it could be used for real estate value analysis.



In order to create a linkage between the spatial data coverage and the value attribute data, the parcel attribute table was populated with the RPC index numbers. The manual effort to populate the approximately 4,000 RPC numbers was critical to establing the link between the GIS and all existing cadastral data currently being maintained at the City. Assessment values for all properties could thus be automatically linked in this manner, and utilized to create thematic maps for value analysis.



Real estate property is divided at the City into commercial, residential and non-classified categories for the purpose of separate analysis. The first set of thematic maps created were for commercial and residential value analysis. The parcels were first identified by category, and then classified for different value classes through a process of relational joining. To represent different property value classes, colors were assigned to different value ranges, to enable rapid identification of concentrations of properties with low and/or high property values, clearly and distinctly displayed throughout the city separately for residential and commercial lands (see Figures 1 and 2). These maps are being used by the City's real estate assessor to identify land assessment-related problems.

Automated Property Owner Notification:

The City is required to notify all property owners within a 150' annulus of a parcel before approval of construction or zoning changes can be permitted for that parcel. Complete address information on land ownership was also available within the real estate database, and could be directly accessed through the linkage of established RPC index numbers. Once relational joining was set up, all parcels within the 150' annulus of the targeted parcel were selected by a Theme By Theme Query. Address information was downloaded from the real estate information to a DBase file, which is then utilized by a mail merge utility

using word processing to generate the associated letters and mailing labels. Many man-hours are being saved, with improved efficiency and accuracy for this routine administrative task.

Historic Site Management:

This application was developed to manage the City's historical sites. A map, generated from the GIS, was used to identify all buildings certified to be of historic significance. Each historic site was identified on the system based on information furnished by the City Planning Department. The building attribute table was linked to historical data, including certification dates. A shape file distinguishing historic sites from other buildings within the City was created in Arcview. Finally, a map displaying each historic building with distinguishing color characteristics compared to other buildings, was produced. The map demonstrated the general distribution of historical sites within City limits. Since RPC numbers could be linked to the historical buildings, other parcel-related information for those sites can now be retrieved and analyzed.

Conclusions:

Successful implementation of GIS at the City of Falls Church within a relatively short period of approximately one and a half years, can be directly attributed to the commitment of City government to this new technology, effective management of the GIS program, appropriate selection, support, and retention of qualified consultants throughout the needs analysis, system selection, data acquisition, database design and key application development phases of the project. Coordination and cooperation among the various agencies involved, was also critical. Key applications developed were not just for demonstration, but for real-time problem solving, and solutions derived focused on full implementation of a few applications on a City-wide basis. The maps exhibited underlying trends, previously undetected patterns and distribution of resources. The future development of the City's GIS program lies in integrating the GIS with other databases existing within the City and/or with other agencies, properly setting up data updating and maintenance procedures and methods, and direct involvement by individual user departments in continuous application development activity to support decision-making, and to improve efficiency, accuracy and productivity, of all related acivities in City management.

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