Paper Title
Cook County, IL: Enterprise GIS

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Paper Abstract
Cook County, Illinois is one of the most populous counties in the U.S. with one of the highest parcel counts. This paper will review aspects of the workflow integration between multiple agencies, the scope of the conversion, as well as what it takes to keep this information up to date. Finally, the technology used will also be addressed.

Paper Body
In 1998, Cook County, Illinois embarked on a countywide GIS. The primary goals of this massive undertaking were to establish an accurate and uniform database that would support the vast majority of GIS applications, increase the efficiency of work within the County, and to improve the distribution of that information to the public and extracounty government entities.

The concept, design, and implementation of this countywide GIS would be truly multi-departmental. Personnel from the Assessor's Office, the County Clerk, the Highway Department, and the Department of Office Technology were all recruited to form a Land Information Committee to identify the goals and requirements of this project. While most offices had been maintaining only hardcopy maps, the Highway Department had been utilizing an ArcInfo Workstation GIS to maintain and map its street midlines, right-of-way edges, and municipal boundaries since 1987. This database would be completely regenerated from planimetric data obtained from a comprehensive set of orthoimagery collected in the Spring of 1998. This orthoimagery would serve as the reference for all subsequent data collection.

One of the most daunting prospects in creating this GIS was the automation of the County's tax mapping procedures. The scale of the County's land division operations is unusual in many respects. The sheer size of the County is only one factor. With a population of over five million, Cook is second only to Los Angeles County in population. The County has historically maintained over 8,800 tax maps comprising nearly 1.7 million parcels across approximately 960 square miles. Moreover the County contains over 130 municipalities and over 800 total taxing districts.

The County's tax maps are at the core of a property taxing system that incorporates several County departments. The offices of County Assessor, County Clerk, County Recorder of Deeds, and County Treasurer work together to maintain an extremely complex tax assessment and collection process. The GIS is intended to be a tool to streamline the transfer of information between these various agencies in order to facilitate their day-to-day operations.

Phase One: Data Conversion

The first step to automating the property tax procedures was to capture all of the data contained on the tax maps. In addition to parcels, the tax maps contain information pertaining to section, township, and range, subdivisions, blocks, and lots; along with associated annotation. All 8,800 tax maps were scanned and digitized. They were then converted to polygon coverages, followed by feature attribution, before final migration to a geodatabase format. This process, begun in late 2000, required eighteen months to complete, and included a subsequent scanning performed to reflect more recent updates of the original maps.

In addition to the issue of the large volume of tax maps, is the sheer complexity of the cadastral information that must be designed and automated as a viable database. While simple parcels, known as "base parcels", represent the majority of property in Cook County, there are also condominiums, leaseholds, and elevated parcels, including elevated subdivisions. Some urban areas are so dense that it is impossible to represent parcels legibly at the standard scale. Additionally, Cook County is nearly 175 years old and a significant amount of historical information must be retained on the tax maps.

Each parcel is identified by a 14-digit Permanent Index Number or PIN, which contains information about the Public Land Survey System (PLSS) as well as the specific location of the parcel. The basic PIN structure is thus:

AA-SS-BBB-PPP-UUUU

Where the first two digits (AA) refer to the Area number, which represents the PLSS Township and Range.

The second two digits (SS) refer to the Section or Sub-Area. A given Area contains up to 36 Sections, each of which is approximately one square mile in area. Sections 1 to 36 in each Area are laid out according to the PLSS.

The next three digits (BBB) refer to the Block in which the parcel resides. Blocks range from the '100' to '600' series.

The next three digits (PPP) represent the actual parcel number.

The first ten digits listed above are sufficient to identify most parcels. Only condominium units and leaseholds utilize the last four digits (UUUU). For all other parcels these digits are '0000'.

Condominiums on any given tax map have historically been represented with only the 10-digit base PIN while a table identifying individual units is displayed in the margin of the relevant map. Leaseholds are also represented by a 10-digit PIN and the range of leases is merely annotated on the map.

Cook County has condominiums with thousands of units and its two major airports have hundreds of leases. The decision was made to capture only one parcel polygon for each 10-digit condominium and leasehold PIN. Individual condominium units and leases would be captured in

a comprehensive PIN Table. Each 14-digit PIN record would also contain a 10-digit PIN field that would act as a reference to the parcel geometry represented on the map. This method also solved the problem of elevated parcels and subdivisions. In addition, a number of subtypes were created to identify specific parcel classifications.

Additionally, dense urban areas and elevated subdivisions needed to be represented graphically apart from the standard tax map. Cook County has routinely displayed this information using additional map pages known as "flyleaves" or "flysheets" in association with a given tax map. Dense areas can be displayed using insets that turn layers off in the main map while displaying detail in the margin of the map. A separate feature dataset called Flyleaf was created to hold the features pertaining to elevated subdivision floorplans represented on the flysheets.

Phase Two: Maintenance
The data maintenance phase of the project began upon the completion of the database which had been loaded onto an ArcSDE 8 server. Cook County performs over 2200 land divisions a year, resulting in the termination and creation of more than 35,000 parcels. Unlike most other counties, Cook County does not reuse PINs. When a parcel is affected by a division, its PIN is retired and the newly formed parcel(s) is given a new, previously unused PIN.

ESRI worked with members of the County Assessor's Office and the County Clerk's Office to create a custom application to manage all steps in the land division process. This required the tracking of each individual land division; from its initiation in the Assessor's Office, through to potential map updates and PIN assignments performed in the Clerk's Office, and then returning to the Assessor for evaluation by their field crews.

In addition to capturing all of the information that traditionally passes from department to department, it was crucial that this custom application allow both departments to view each job at any step of its workflow. Conversely, it was also critical that only the department that currently "owned" the job would be able to edit it.

The County needed an application that would enable managers to assign individual jobs to specific employees. The capacity to review each job before it was passed from one department to the next was also a requirement. The System would also need to act as a conduit of communication between the departments, so that each office would be notified when new jobs were ready to be worked.

Perhaps most importantly, this new application had to be easy to use. Existing County staff, who for years had processed land divisions manually on paper worksheets and Mylar-and-ink tax maps, would now have to relearn their jobs using customized software. For many of these employees, the change would be doubly intimidating due to their relative inexperience with the technology.

Transforming this paper-intensive, complex process into a streamlined system began with an object-oriented design based upon County-defined use cases. ESRI programmers and County staff worked closely to create a state-of-the-art comprehensive Spatial Maintenance System that

encompassed all of the traditional elements of the County land division process with enhancements facilitated by the enterprise GIS.

An ArcIMS interface (See Figure 1.) was created to manage all steps from job initiation to version management to map production. A series of business tables were added to the SDE geodatabase that would organize all of the various types of data necessary to manage the land division process.
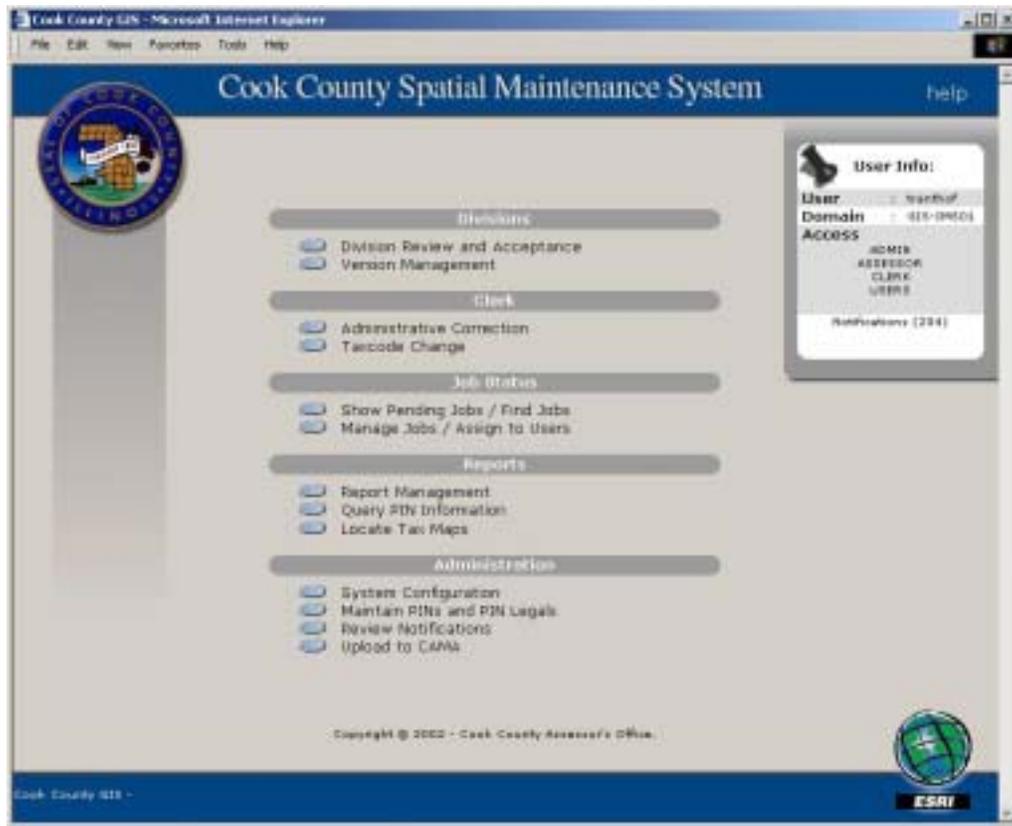
Figure 1. Cook County Spatial Maintenance System Main Interface

At the core of the County's new division process is the Division Entry Form (See Figure 2). This interactive web page is connected to a job from initiation through version management. It can be viewed at any point in the division process and contains all of the information necessary to complete map updates. It has links to various business tables relating to everything from job status to associated documentation to individual tract legal description and taxpayer information.

Figure 2. Division Entry Form

Several simple controls are built into this form that eliminate the potential for a number of common mistakes. The first, and most important, is the validation of PINs. As Assessor's Office staff add PINs to a job, the application verifies that they are valid PINs for the given tax year and that they are not already associated with another job. The job is then automatically filed into the correct tax year and township.

Internal quality control has also been built into the Spatial Maintenance System. Following the completion of the Division Entry Form by the Assessor's Office, each job must first be reviewed by another member of that department before it is sent on to the Clerk's Office. The reviewer must then commit the job in order for it to progress to the Update Tax Map stage of the process. Because the System records the user-id of the employee who commits each job, it is not possible for an employee to accidentally send his work to the Clerk's Office without independent review.

Once a job has progressed to the Clerk's Office, the Spatial Maintenance System generates a unique SDE version for each job. The Division Entry Form can now be opened through ArcMap and viewed and updated by the map editors. As new parcels, lots, and subdivisions are generated, they can be linked interactively to the Division Entry Form. The object-id of each feature is recorded on the Form (See Figure 4.) and as the Form is saved, those features are attributed in ArcMap with the data previously entered into the Division Entry Form by the Assessor's Office. In addition to saving time and eliminating redundancy, this prevents simple typographical errors that have the potential of causing serious problems later in the assessment process.

As a map editor opens a job from the Spatial Maintenance System, ArcMap opens with the relevant parcel and tax map polygons selected. ArcMap zooms to the extent of the job and automatically copies the existing parcels into a "Parcel History" feature class along with the job number and the tax year of the job. These steps eliminate the need to manually zoom to the correct area and prevent the wrong parcel(s) from being edited.

In addition, a custom Editor Assistant (See Figure 3.) has been created to guide users through the steps needed to complete each type of division as identified on the Division Entry Form. The Editor Assistant is an interactive XML-based tool that performs oft-repeated tasks such as setting up snapping and opening the Division Entry Form as well as reminding editors which tasks are required to complete each job. A specific workflow has been created for each division type and these workflows are fully customizable by the Clerk's Office.

The Editor Assistant serves the additional function of protecting data integrity, by establishing steps to ensure the coincidence of overlapping features. Because Cook County has not yet defined topological rules, it is important to maintain *operational* topology until such time as the core ArcGIS topology tools can be utilized.
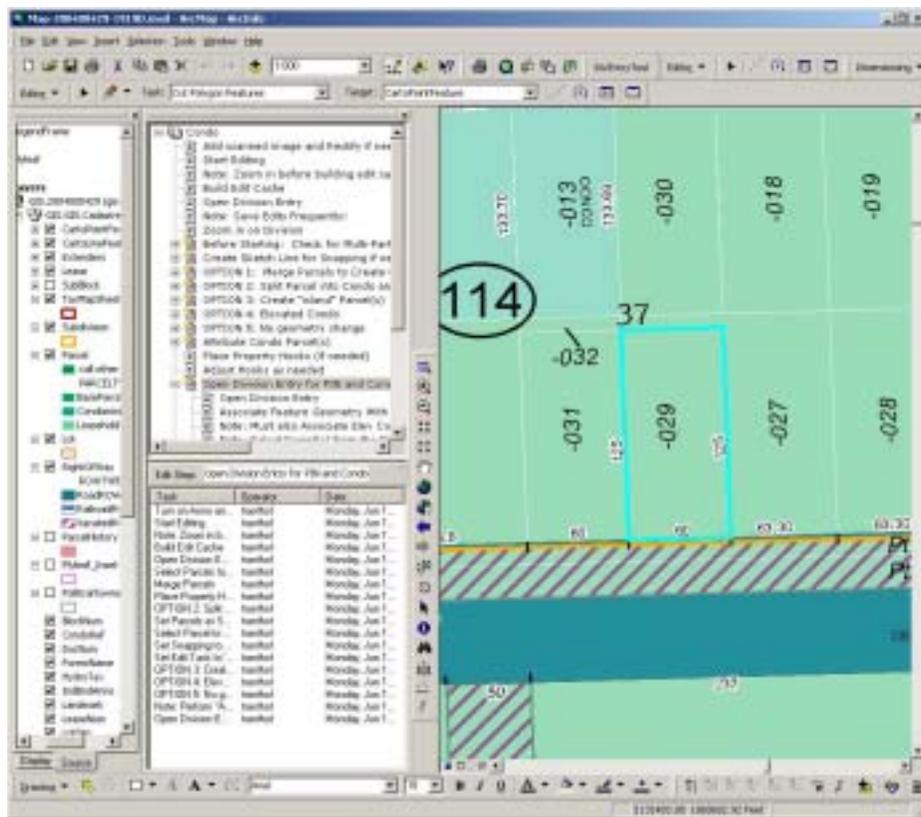

Figure 3. Tax map editing performed in ArcMap using Editor Assistant

A number of custom tools were created to automate common tasks, such as annotation and cartographic feature placement. Other tools were created to facilitate tasks not yet supported in COTS ArcGIS 8 environment such as creating traverses and determining the midpoint between existing segments. Custom tools were also needed to manage flyleaf map edits. Map editors are

able to create new flyleaves and set an interactive scale separate from the standard scale of the primary tax map. Features on the flyleaves are automatically linked to the associated tax map.

Another function of the Division Entry Form is the generation of PINs for the newly created parcels (See Figure 4). In the past, the Clerk's Office relied on color-coded logbooks to manage the assignment of new PINs. The Division Entry Form can instantly determine the next available PIN for a given area, eliminating the potential for reassigning previously used PINs.

Figure 4. Division Entry Form opened from ArcMap records object-id of relevant parcel feature and generates new PINs

Again, there is an internal review step built into the System before each job is sent back to the Assessor's Office to be uploaded to the County's mainframe. The Clerk's Office is able to post jobs (versions) en masse on a township basis (See Figure 5.) and custom tools have been created to allow multiple edits to be accepted during conflict resolution.
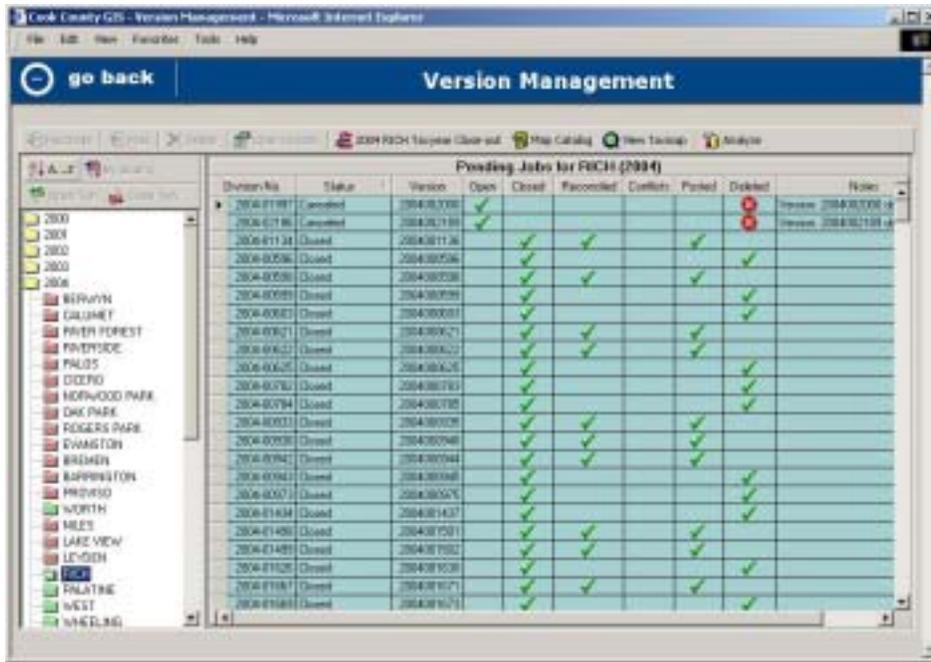
Figure 5. Version Management Interface

Phase Three: Map Production
Cook County has traditionally performed land divisions and many other governmental functions
on a township basis. For that reason, the Spatial Maintenance System organizes all jobs so that
and both the Clerk's Office and the Assessor's Office are able to identify and prioritize jobs
based on tax year and township.

After all of the jobs in a given township have been reconciled and posted to the parent version
for that tax year, the tax maps can be generated. The Spatial Maintenance System provides tools
for the County to generate the legend information for each map. This may include descriptions
for all subdivisions referenced by a given map, condominium unit tables, and any existing insets
or flyleaves. This process can be batched to update the legends for all tax maps within a
township or to only update those maps which contain updated information for the given tax year
(See Figure 6).
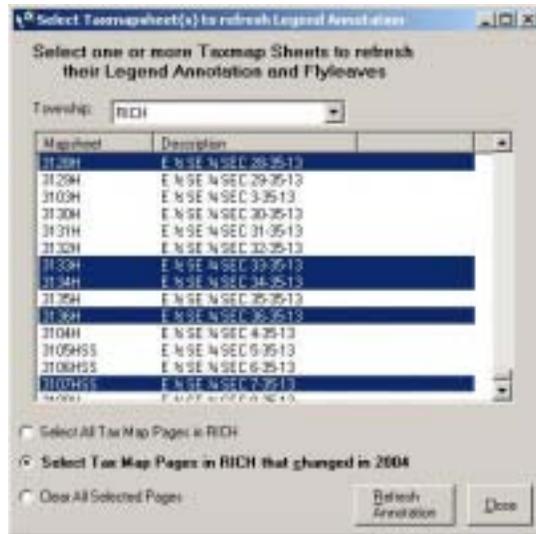
Figure 6. Update Legend Annotation Interface allows user to select a single map, all maps, or only updated maps within a township.

Following the creation of legend information, the maps themselves are generated at a standard scale of 1:1200. Again, maps can be created for entire townships, individual pages, or for all updated areas (See Figure 7).

Figure 7. Print Tax Map Interface allows user to generate tax maps in PDF format for single maps, all maps, or only updated maps within a township

In addition, the Spatial Maintenance System has the capacity to create a comprehensive Map Catalog (See Figure 8). Once this catalog has been produced, users are able to search for specific tax maps by keying in the PIN of a desired property. This catalog is in help file format and is easily exportable.
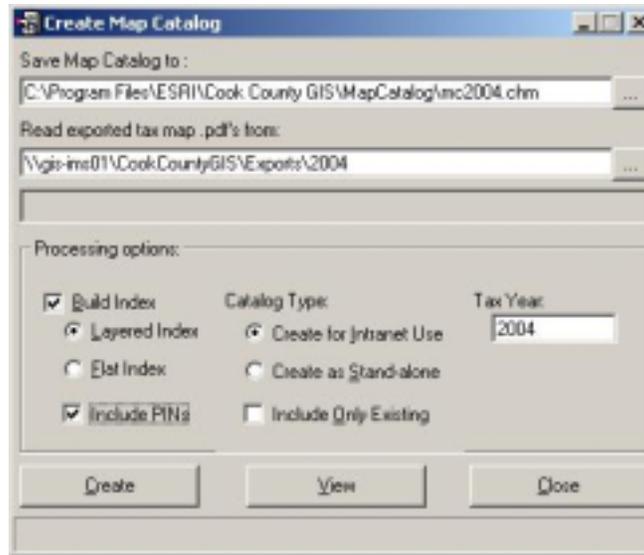
Figure 8. Map Catalog Interface has option of creating Intranet or stand-alone Map Catalogs which are layered by Area or flat

The Spatial Maintenance System has tools to create other custom products as well. Using Crystal Reports, County staff can produce a number of reports and form letters. The Assessor's Office can create receipts or rejection letters pertaining to specific jobs. Overall status reports and log statements can also be generated.

Summary

Cook County, together with ESRI and its subcontractors, has designed and implemented a functioning Enterprise GIS. Tax year 2004 is well underway, with 30% of the land divisions completed as of June 2004. Both the Assessor's Office and the Clerk's Office are relying completely on the Spatial Maintenance System to perform the essential steps required to maintain a large and extremely complex property tax system. Other County offices, such as the County 911 Communications Center and the Zoning Board of Appeals, are utilizing this comprehensive database to perform their daily functions, as are several external agencies including the City of Chicago.

Future Developments

After the database is fully updated, attention will be paid to migrating the application to ArcGIS 9. The issues of topology, annotation development, 3D visualization, map production, and editor assistance will be reviewed in light of advancements in ESRI's toolset since the initial phases of the building of the application. Extensions such as Maplex, MapPublisher, and ArcGlobe may prove useful in further streamlining the current set of tasks.

In addition, the County has plans to make this data more widely available to the public. It is envisioned that several offices will have kiosks for taxpayers to research their properties in person at County offices and satellites. A web-based application that will allow information to be viewed via the Internet is currently being written. The intention of the County is to provide taxpayers with fast access to accurate information in the most convenient format possible.

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