The Development and Implementation of a GIS System for Sunde Land Surveying, LLC.

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Abstract

This paper outlines the exploration of Geographic Information Systems (GIS) being used by land surveying managers. Using ArcGIS 9.0 (ArcView), ArcCatalog, Autodesk Land Desktop and other mapping software, a survey identification application was created for Sunde Land Surveying, LLC. in Bloomington, MN. The goals of this project were to create a server based application that would give Sunde Land Surveying managers the ability to view and query information about past surveys, and secondly, to demonstrate the effectiveness and efficiency that is gained from having such an application.

Introduction

The evolution of surveying technology is truly remarkable and exciting. In recent years the surveying industry has witnessed rapid change and because of evolutions like the total station and GPS, data acquisition times have been substantially decreased (Gibson, 2006). This rapid growth in technology has placed increased pressure on surveyors to have a GIS system that is capable of containing and organizing all of the aforementioned information. Sunde Land Surveying, LLC., is one such company that has recognized the competitive advantage that can be gained from a fully integrative GIS system.

Sunde Land Surveying managers believed that an interactive map that could visually represent every one of the surveys Sunde Land Surveying has completed since its incorporation could help save time. A majority of Sunde Land Surveying's work has been accomplished in the 8-county metropolitan area of Minneapolis and Saint Paul. These counties include Anoka, Carver, Dakota, Hennepin, Ramsey, Scott, Washington and Wright counties.

The amount of survey work completed in this area has translated to an increased volume of field notes and half section breakdowns. A half section breakdown is an 11 x 17 sheet of paper that shows a half section. An example is the north half of section 5, township 27, range 24. Increased paperwork and field notes require a lot of office space and good organization to ensure that items are filed away correctly. The reason for incorporating all of this information into a GIS is so Sunde Land Surveying managers can have quick access to all of their past survey records. Having an interactive map that contains all past surveys and their attribute information would allow Sunde Land Surveying project managers to make quick and accurate bids to potential clients because

they would have the ability to quickly access information about surveys that have already been conducted in a given area. This is important because many times potential clients want fast answers about how long a job will take and how much it is going to cost. If a survey company is able to give a quick and accurate bid, the chances of receiving the job are improved.

Background

Sunde Land Surveying was established in 1975 by Edward H. Sunde. Over the years, Sunde Land Surveying has grown in size and in work capacity. Since 1975 Sunde Land Surveying has been involved in over 13,000 projects. Today, Sunde Land Surveying is recognized as an industry leader and was recently named Minnesota's preferred land surveying vendor for the year of 2006.

Software

For this project, a number of software packages were used. ESRI's (Environmental Systems Research Institute) ArcView 9.0 and ArcReader 9.1, including the ArcPublisher Extension, were utilized for map creation and distribution of data resources. Autodesk Land Desktop 2004 was used to isolate and extract boundary shapefiles. Microsoft Access was used to store and manage survey project information. Microsoft Excel was used to convert information in Microsoft Access to a recognizable GIS format.

Preparation of Data

In the initial stages of this project it was apparent that there would be a need for a

number of different data sources. This process was simplified by making a list of the data that would be required and possible sources of the data. Details of the data requirements and steps to organize and format the data are described in the following sections.

Projection

All data analyzed was projected using the following projection:
Projection: Transverse_Mercator
Parameters:
  False_Easting: 500000.000000
  False_Northing: 0.000000
  Central_Meridian: -93.000000
  Scale_Factor: 0.999600
  Latitude_Of_Origin: 0.000000
Linear Unit: Meter (1.000000)
Geographic Coordinate System:
Name: GCS_North_American_1983
Angular Unit: Degree
(0.017453292519943299)
Prime Meridian: Greenwich
(0.000000000000000000)
Datum: D_North_American_1983
  Spheroid: GRS_1980
    Semimajor Axis:
6378137.000000000000000000
    Semiminor Axis:
6356752.314140356100000000
    Inverse Flattening:
298.257222101000020000

Data Collection and Assembly

A number of different sources were used to acquire data for this project. Much of the basemap information was downloaded from the Minnesota DNR Data Deli (Figure 1). These data layers included: township and section boundaries, rivers, lakes, streets, major roads, railroads, and municipal boundaries. Aerial photos were acquired

Figure 1. 8-County Metro Overview Map.

from the United States Department of Agriculture National Aerial Imagery Program. Parcel data and all attributes were obtained from various county GIS offices including Anoka, Carver, Dakota, Hennepin, Ramsey, Scott, Washington, and Wright. All of the layers acquired from the DNR Data Deli and counties consisted of ESRI's shapefile format. Once all of the data was acquired, a number of steps were taken to form the base map. The base map for this project was created by selecting the aforementioned 8 counties out of the statewide county shapefile and exporting them to a new shapefile. The 8-county shapefile was used to clip the remaining statewide data layers including the township and section boundaries, rivers, lakes, major roads, railroads, and municipal boundaries. The streets layer, which was only

available on a county by county basis, was created using the append tool.

Survey Polygon Creation

Two major steps were taken to create the survey shapefiles. The first of these steps was to extract the boundaries of all Sunde Land Surveying jobs completed on a county coordinate basis. This task involved opening up each Autodesk Land Desktop drawing and checking to see if it had an assumed or a county coordinate system. This was important to determine, because if a survey was not completed on a county coordinate basis, it would not project correctly into the GIS. If a drawing had coordinates that were on a county coordinate system, the boundary for that survey was isolated and exported to a shapefile format (Figure 2).
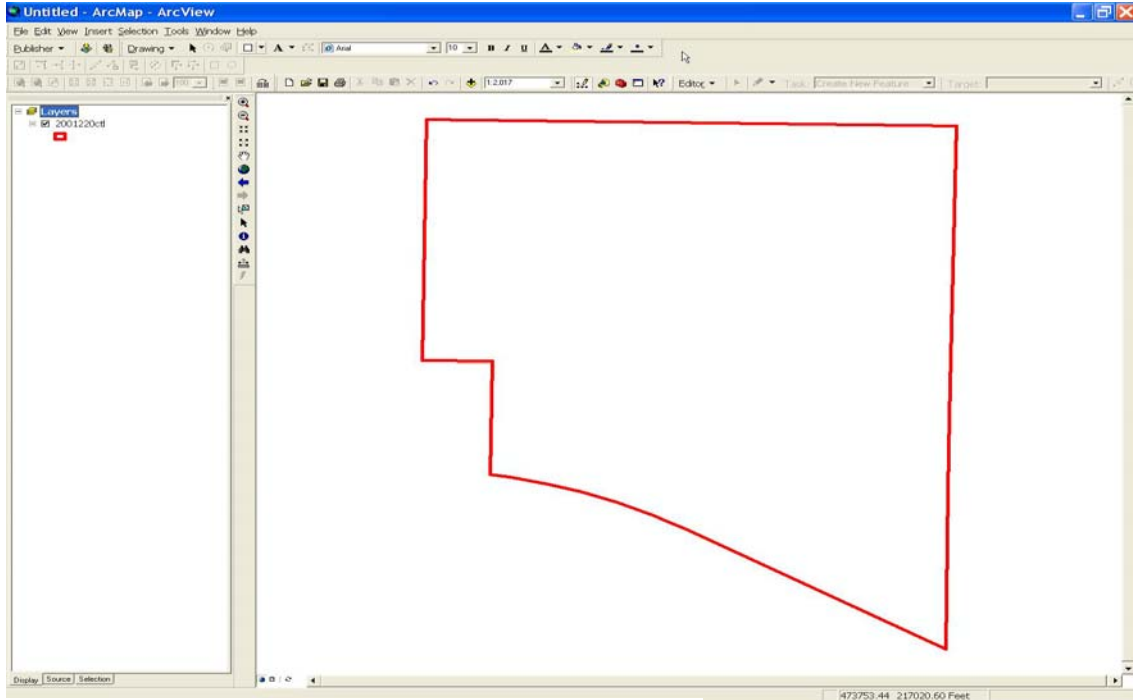
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Figure 2. Boundary shapefile extracted from AutoLand Desktop.

After extracting the specified boundaries from the Autodesk Land Desktop drawings, the next step was to open ArcCatalog and project the shapefiles to their county coordinate system. Once the shapefiles were projected, a text field called project number was added and populated with that survey's unique project number. Attributing each shapefile with a project number field allowed SLS's Microsoft Access database to be joined to each individual survey polygon. The Access database was added to the survey polygon shapefile by exporting the Access database into an excel spreadsheet. This Excel spreadsheet was then converted into a database file, DBASE IV format. Ultimately, a polygon shapefile was created that included all survey information for each individual polygon, as well as a hyperlink which opens the most recent Autodesk Land Desktop drawing for that particular survey area.

Survey Point Creation

The second step involved creating a point shapefile for all of the other surveys that were not completed on a county coordinate basis. Sunde Land Surveying uses color coded half-section books to visually display all of their past survey areas. Within the shaded areas in these half-section books, project as well as book and page numbers are listed. In order to incorporate this information into the GIS, a point shapefile with fields called project number, dwg, and link were created. The next step was to go through each half section book and plot a point in the GIS wherever a survey was shown. After each point was plotted, the project number as well as a link to the most recent Autodesk Land Desktop drawing was added to the project number and link fields. Once all the points were plotted and attribute data was updated, the database file was joined to the shapefile. This completed

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the initial creation of the data for the GIS.

Analysis

Search Application Development

The final piece for the GIS was to create an affordable application that could be usable for all members of Sunde Land Surveying. The solution was a free downloadable program found on the ESRI website called ArcReader 9.1. This program had all of the appropriate functionality requirements needed for Sunde Land Surveying employees to make effective use of the maps. Important functionality that was needed was the ability to query and identify specific features of the map as well as having the ability to link to drawing files in Auto Land Desktop. ArcReader is only able to read published maps. As a result, Sunde Land Surveying made the decision to purchase the ArcPublisher

extension which allows ".pmf's" (publish map file) to be created. With the use of the extension, a map of the 8-county metro region was created (Figure 3). While testing the searching capabilities of this application, problems were encountered which would cause the ArcReader application to freeze, forcing the user to close out of the ArcReader program. Initially it was thought that this problem was being caused by incompatibilities between the ArcGIS 9.0 map file and the ArcReader 9.1 published map file, but after further troubleshooting it was found that the published map files storage size was the root of the problem. This problem was solved first by indexing each shapefile by its dominant searchfield. Indexing the shapefile was completed in ArcCatalog by right-clicking the appropriate shapefile and selecting properties. Once properties were selected, information about indexing is found. Indexing each shapefile by its
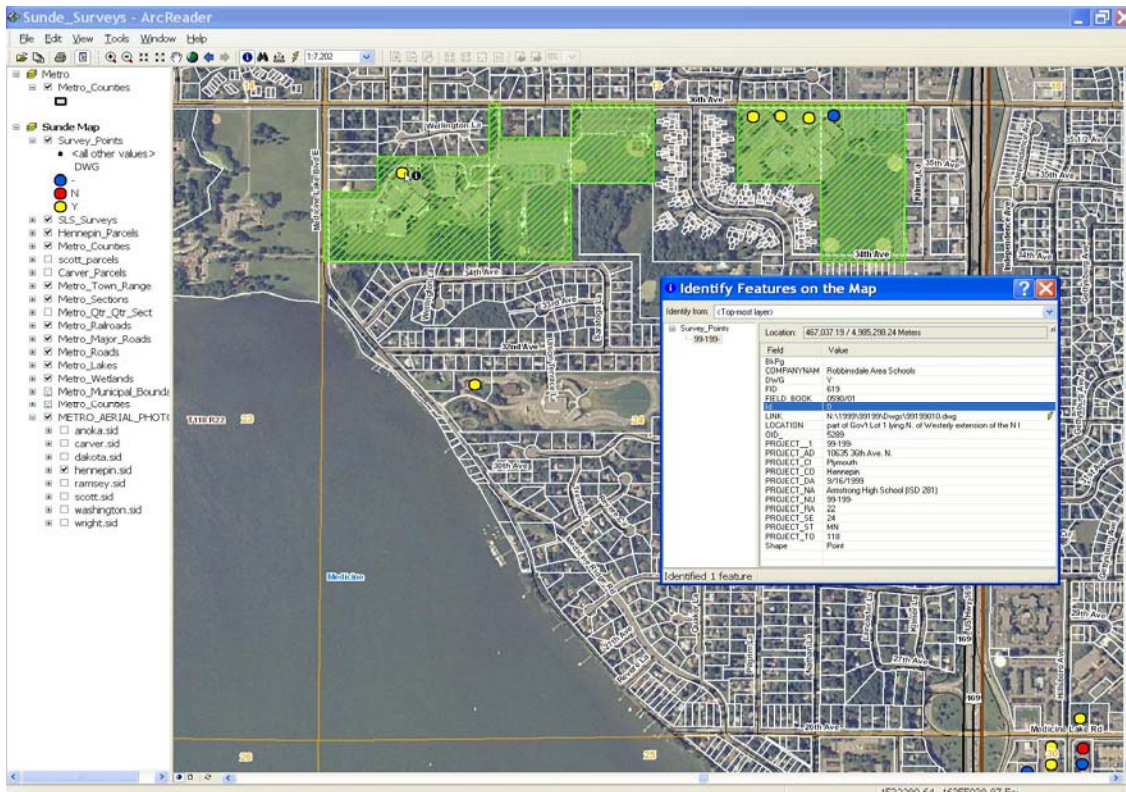

Figure 3. Sunde Land Surveying ArcReader.

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dominant searchfield is important because it helps to guide a query towards the information that is being searched (ArcGIS Help, 2005). The second part of the solution was creating a subset of maps for each individual county. After these two adjustments were made there was a visible difference in the functioning speed of the application.

Viewer Enhancement

Several improvements were made to the published map files in order to increase processing speed when viewed in the ArcReader browser. The first enhancement made was by choosing to use scale dependent rendering. This seemed to be a logical step such that if a user zoomed in to a large scale, small scale layers would not be drawn. This was most evident with the digital ortho quadrangle's (DOQQ). Each of the DOQQ's was approximately 140 megabytes (MB) in size. This is a lot of data for the server and application to interpret and draw. For this reason, the image catalog was set to only be visible at a scale less than or equal to 1:20,000. One other change made to the datasets was deleting unnecessary fields from some of the shapefiles. An example was the Carver county parcel layer, which contained seventy-two fields. Of these seventy-two fields, only a few contained relevant information that Sunde Land Surveying needed to search information by. The fields that were needed included owners name, owners address, plat name, and parcel identification number. Many of the other fields that were deemed unnecessary for the purpose of the application were deleted.

Cost Analysis

After the viewer was up and operational, Sunde Land Surveying's management was interested to learn what type of effectiveness and efficiency was being gained from the viewer application in comparison to their older method. The older method involved locating the correct address. This was completed by opening the counties website and searching their parcel viewer. After locating the address a person would then walk to the half section book where completed survey information including book and page as well as project number could be found. The effectiveness and efficiency of the viewer was tested by using a stopwatch. In order to accomplish this, the older method was tested first. It was determined after three timed trials that the average time it took to derive the information about a potential survey area after knowing only its address was nearly twelve minutes. In comparison three timed trials were completed using the viewer application. The same criterion of knowing only the address was used for the viewer application. Upon receiving the address of the proposed property it took the viewer application an average of two minutes and thirty-five seconds to locate the necessary information about the same potential survey area. Based on this information, analysis was done to see what the cost benefit is to having the ArcReader application (Table 1).

Table 1. Time Trial Chart.

	Old Method	New Method	Time Saved
Trial 1	10:28	1:57	8:31
Trial 2	13:46	2:55	10:51
Trial 3	11:45	2:22	9:23
Totals	35:59	7:14	9:35Avg.

It is projected that Sunde Land Surveying's application over the course of a year will create a time savings of $12,500 (Table 2).

Table 2. Time Savings Chart.

Average Time Saved Per Day	1 hour 58 minutes 20 seconds
Average Salary of User Per Hour	$25.00
# of Work Days Per Year	254
Total Time Savings	$12,500
*Note Projections based on 3 Project Managers using the application a total average of 12 times per day.	

Data Maintenance

Even though occasional problems were encountered with both the data and the software, data maintenance should prove to not be a problem. If changes and updates were continually made to the records within the Access table, the viewer application shapefiles could easily be updated. Updates are made by adding new points and polygons to their respective master shapefiles. The attributes of project number and link will always be added to the new points and polygons, at which point the shapefiles can be rejoined to the updated access database table. The final step of the updating process was to replace the old shapefiles in the ArcGIS 9.0 map file with the new shapefiles containing updated attribute information.

Discussion

This project shows how GIS can be used to visually represent and analyze data. Sunde Land Surveying is realizing that

GIS can be a very useful tool. The interactive maps allow all individuals in the organization to have equal access to the information contained within the GIS. Every department of Sunde Land Surveying is realizing benefits from the GIS. Field crews like the ability to quickly create maps so that they are able to visually see an overhead photo of the area they are surveying. The CAD Draftpersons like the GIS because they are able to use it to help them interpret the areas they are drafting. The third group benefiting from the GIS is the Sunde Land Surveying managers. The managers benefit from the fact that they can not only see all past surveys on a single map, but that they also have the ability to find information on any survey through the use of GIS. This project has shown that there is a great deal of potential growth for GIS within the surveying community. The application explored in this paper is just one example of what impact a GIS can have in the surveying community. GIS is sure to become an important part of all surveying organizations in the future.

Results

During the course of this project, a number of problems with data and software were encountered. Despite these problems, the initial delivery of Sunde Land Surveying's GIS proved to be successful. The managers of Sunde Land Surveying have found the ArcReader application to be a very beneficial tool. The application has helped to expedite researching of past projects by a quarter of the time. In terms of product development, this project has proved that using ArcReader as a forum for GIS delivery is very efficient and cost effective**.**

Acknowledgements

References

Gibson, T. 2006, August. Diving Into Surveying. *Professional Surveyor.* 4.

ESRI ArcGIS 9 Help File. 2005. Environmental Systems Research Institute INC. (ESRI) Redlands, CA