

## Managing Cadastral Data in a GIS (paper TS-60.5)

Michael Ellick (Australia)  
email [elflick@bigpond.com](mailto:elflick@bigpond.com)

Tim Hodson (South Africa)  
email [thodson@esri.com](mailto:thodson@esri.com)

## Outline of Paper

- GIS and Survey systems – general discussion
- Software requirements for Surveying
- Software Requirements for GIS
- Implications for GIS from technology changes in positioning methods
- Changes in design for GIS
- Implications for surveyors

## GIS and Survey Systems

- GIS an essential part of the land management process
- Few surveyors use GIS
- Surveyors provide data but do not use GIS .
- Surveying software is structured quite differently to GIS.
- Surveying software is focused on computation rather than display

## Surveying Software Systems

- Each point has an identifier (ID) such as a point number
- A point is an "object" with attributes such as ID, type, coordinates etc.
- Objects such as land parcels or polygons are defined by the point ID at each corner .
- Matching is by point ID and there is only one coordinate for each point.
- There is no concept of topology in the GIS sense.
- There is no concept of Layers in a GIS sense

## Surveyor's Requirements

- **Dimensional record Measurements**
  - Must remain unchanged by system
  - Weighted according to survey process
  - Used in least squares processing
- **Cadastral Data Management**
  - Thorough tracking of source and history required
  - Data has a legal evidentiary purpose
  - Unit of work is a parcel

## GIS Systems

- Each point is defined by a coordinate
- Two corners are coincident if they have similar coordinates.
- Integer arithmetic is used to facilitate matching.
- Job extents define working units and accuracy.
- "Topology" requirements can degrade accuracy.
- Positional accuracy is often limited by the GIS system rather than the needs of users

## GIS Cadastral Data

- Cadastre often built from digitized maps.
- Has been upgraded by various methods.
- The problems associated with inaccurate cadastral data are widespread.
- No Magic Bullet – limit to what can be done with mathematical gymnastics

## Current GIS Systems

- Cadastral layers in GIS do not use survey accurate data
- Accuracy limited by hardware and GIS software design
- GNSS and new GIS technology allow new approach.
- The future is with accurate coordinate based systems
- Point based survey systems are replacing measurement.
- An accurate cadastral GIS database is necessary.

## Changes to GIS

- Use of 64 bit integer technology
- New systems will remove accuracy constraints
- Ability to integrate survey and cadastral data.
- Able to carry out detailed design and precise calculations.

Will require spatially accurate data if they are to be used anywhere near to their potential.

## Survey Data and GIS

- There are problems in generating GIS data directly from survey information
- They stem from the different types of logic in the two systems.
- They must be addressed so that survey data generates a topologically correct GIS layer.
- Survey calculation and data manipulation processes need to be part of GIS.

## ESRI developments

- In 2006 "Survey Analyst" extended to manage cadastral networks using data from survey plats
- The new processes provide:
  - *Data entry and analysis of cadastral survey data,*
  - *A database structure for dimensional data,*
  - *Management of coordinates for cadastral networks*
  - *Adjustment of GIS Features from cadastral data.*

## ESRI Survey Software Products



- **Survey Analyst**
  - **Survey Editor (Built by Leica)**
  - **Cadastral Editor (Built by ESRI & GeoData)**

## Cadastral Editor Solution

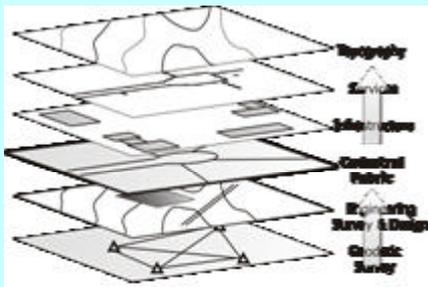


Figure 4: Building a Basecamp Layer

## Survey Analyst's Cadastral Editor Solution

- This solution is built for a metes-and-bounds land tenure system (Australia, New Zealand, North America, Bahamas, Jamaica, )
- ESRI and GeoData development Alliance
  - Based on a working solution ~ 15 years
  - Geodata provided:
    - Conceptual Workflow
    - Cadastral Least Squares Adjustment technology
    - Data model

## Cadastral Editor – Data Model

- Data model for a Cadastral Information System
  - Introduces the notion of a Cadastral Fabric
  - Cadastral Fabric is a **continuous integrated collection of land record information**.
  - This includes:
    - Control points
    - Dimensional record information
    - Parcel information
    - Plans that hold a legal description and defines parcels

## Cadastral Editor - Tools

- Specialized editor for parcel editing
  - The parcel is the "unit of work"
  - Maintains and works with data from subdivision plans
- Uses least squares to get high-precision parcel coordinates
  - Control points (from GPS and field surveys)
  - Parcel line record values
- Fabrics are used as base layers for core editing
- Integrated into ArcGIS
  - GeoDatabase extension and editor environment

## Operation of the new system

- Survey processes fully integrated within a GIS
- System can be built directly from accurate survey data
- Survey data kept in database tables in a secure environment
- Survey data generates and manages the GIS layers
- GIS layers adjusted by movement of the survey data.

## Changes for GIS Managers

Accurate position based data poses both an opportunity and problems for GIS managers.

- Difficulty in merging it into existing data sets.
- Necessary to adjust layers to match the ground truth in position.
- Increased focus on data quality
- Must hold information regarding positional accuracy.

Running a GIS is not an end to itself  
GIS should be judged on the width and depth of its use.

## Working with Surveyors

- Understand the way that surveyors work and have a respect for their information.
- Survey data should be used to control layers and not be corrupted with topological processes.
- Focus to move from manipulation and fitting new work to adopting the new and let the system carry out the merging and upgrade process.

## Actions for GIS Managers

- Tailor the GIS for particular users so that they are not confused with a plethora of apparently meaningless options.
- Set up systems to encourage surveyors to use GIS in a dynamic way as part of their day to day activities.
- Understand the processes that surveyors use in their normal activities and then set up the appropriate menus and tools for their applications.
- There is no point in simply saying 'here is the system – go use it'.

## Implications for Government

- Cadastral boundaries are a fundamental data set.
- High quality cadastral data is essential to match in position the information held on other data sets
- This system can be built and maintained directly from the metes and bounds data.
- There is no "magic bullet" and the initial cost of the transition is quite considerable
- Benefits both in reduction of overall maintenance costs and increase in utility make the exercise very worth while.

## The Role for Surveyors

- Surveyors provide the base data for projects
- Their data must be in a geodetic framework.
- GNSS technology is the reference system for the future

The long term benefit from having all jobs on the one datum greatly outweighs the technical difficulties in some computation procedures.

Surveying not an end to itself

## Boundary Surveying

- Currently labour intensive and requires skilled people.
- Can we afford to continue with a system based on measurements taken from ground marks.
- The new GIS tools provide the means to build and manage an accurate coordinate based cadastre from survey data
- New processes and technology can now allow a complete rethink in this area.

## Where are we heading

- GIS systems can provide the management tools needed to process manage and store surveying data sets.
- Surveyors will have to embrace GIS technology as a core element in their processing and storage of data
- Cadastral Surveyors should show the lead in making the transition to a coordinate based system.
- There are considerable business opportunities that will develop during the conversion process.

## Conclusion

- Change is always difficult
- The survey world has been subject to considerable technological upheaval over the past 30 years.
- No sign that this rate of change is slowing
- Future GIS systems will have fabrics built and managed from real data rather than being pictorial representations from derived data of dubious quality.
- Surveyors will have to adapt and lead in the use of GIS technology if they are to survive as a profession.