GIS 101 for Surveyors

By David M. Horwood, O.L.S.

I have delivered a GIS 101 for Surveyors seminar now to five regional groups covering the basics of GIS in the context of surveying. It covers the fundamentals of GIS, compares GIS with Computer Aided Design (CAD) and looks at how GIS impacts and can benefit surveying now and in the future. It is impossible to fit all of GIS into a two hour seminar, so this seminar is necessarily a shallow dive into the concepts and concentrates on the areas of GIS that relate to surveying. This article covers some of the highlights.

We tend to forget that computers are not what they were 25 years ago. I remember (and I realize I'm dating myself) working on the first IBM PC/AT in the mid 1980's and running a PC version of Esri's ARC/INFO on a COMPAQ 386. Both of these computers would be blown away by your mobile smart phone. It is now possible to assemble and maintain jurisdiction-wide parcel maps and use techniques like least squares to adjust and readjust them holistically, something not possible on a PC with 640K of memory.

Geographic(al) Information Systems or GIS evolved from work in the 50's and 60's. The idea of portraying data on maps in layers and relating things graphically has been around much longer than that, well before computers. The popular terms for this science or discipline have changed over the years and now include Geospatial Information Science (mostly in the U.S.), Spatial Information Science (in Australia) and Geomatics, although this usually refers to more disciplines than just GIS. From Wikipedia, a GIS is a "system designed to capture, store, manipulate, analyze, manage and present all types of geographical data." Basically it boils down to maps connected with data.

Geography is the science of mapping the earth and GIS is a system used to manage and exploit this information. There are three fundamental representations in GIS;

- Features – objects on or near the earth's surface (point, lines, polygons or combination)
- Attributes – descriptive information of features (e.g., identifier, owners)
- Imagery – a picture or grid (e.g., orthophotography, satellite, LiDAR, scanned map)

GIS representations are normally organized by theme or layer and are usually presented as a map. In fact GIS is very closely related to Mapping.

Another important concept in GIS is topology. Topology refers to the spatial relationship between features, identifying connectivity and adjacency. For example, topology ensures that parcel edges are coincident with parcel boundaries and the ends of parcel boundaries are coincident with parcel corners. So when a corner is moved, the boundary lines are automatically moved and the parcel area adjusted. Topology is normally implemented as a series of rules, .e.g., parcels cannot overlap or have gaps, boundaries cannot intersect except at end points. Topology can also be used to navigate connectivity, e.g., finding the boundaries intersecting a corner or tracing a public works network upstream from a break.

Analysis is a key capability of GIS, in fact this is primarily why a GIS is created. Analysis normally involves combining existing themes or layers into a new layer using overlays or performing computations based on the GIS attributes (or both). Analysis is developed using scripts or models so that the same analysis can be run again and again with changing conditions. The possibilities for analysis in a GIS are endless and extend across many sectors. This is why a GIS is normally multipurpose and may be captured and maintained by agencies other then the primary users.

A GIS also needs to have a data model. There are standard data models available for different sectors or the data model can be constructed from scratch. Then the GIS needs to be loaded with data to be useful. There are tools in GIS software as well as specialty suites like Safe Software's FME. Finally, once loaded it is extremely important that the GIS be kept up to date, normally by some sort of transaction (e.g., a new survey plan in a parcel map). In fact you should think about updating before you finish your loading. Metadata (information about the data) needs to also be maintained to record the source, accuracy, projection, representation and other characteristics of the data so that it can be discovered and used by others.

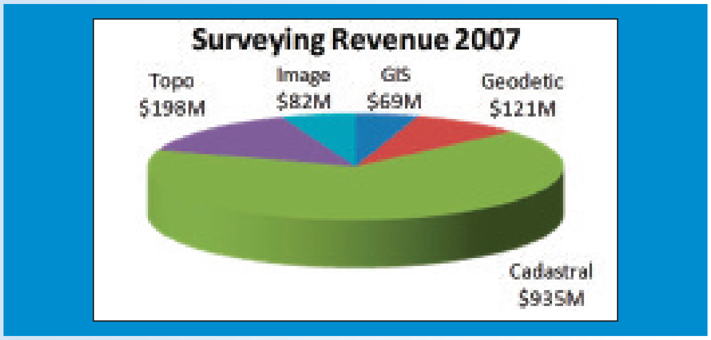
Map projections are also extremely important. GIS must be portrayed on the earth and the earth is not flat but round (actually ellipsoidal). In order to flatten the earth for display and analysis, a map projection must be used. All map projections have some distortion and the distortion is normally characterized by what is preserved; conformal (shape), equal area (area), equidistant (distance). Web maps use a projection called Web Mercator which is quite different than UTM and MTM. And don't get me talking about datums and epochs.

GIS is very different from CAD. There is some overlap, most CAD software has some GIS capability and most GIS software has some CAD capability, but they are entirely different approaches. CAD is predominantly a design tool whereas GIS is an information management tool. A CAD drawing is normally produced for a single purpose with fixed symbology and annotation, whereas a GIS is multipurpose with attribute driven symbology. CAD is normally project-based in individual drawing files whereas GIS is enterprise-wide with a continuous centralized database.

This is why it is hard to get CAD information into a GIS. If we look at a survey plan prepared by CAD, the end product is a printed plan. However if we are to use this information in a GIS (e.g, a parcel map), the information contained on the plan needs to be extracted and captured. Since this was not the plan's original purpose, most plans present a number of issues. These issues include non-standardized layers, lines not split at parcel corners or worse lines clipped at bar symbols (affecting topology), dimensions not connected to lines (just text adjacent to the line), narrow parcels widened for visibility, separate detail areas not drawn to scale, curve parameters in a separate table. As a result, many times these plans are recalculated from scratch, since capturing the information from CAD would take longer.

Some jurisdictions have submission standards that address some but not all of these. It is important that the standard be a cooperative effort between the agency requiring the submission and the suppliers (in this case surveyors) to ensure that specifications do not impose undue effort on the suppliers and provide the necessary information to the agency in a streamlined format. In order to address these issues I've developed a stand-alone Plan Validator application which will both independently validate the plan and capture the essential plan information from CAD or scanned plans (www.planvalidator.com).

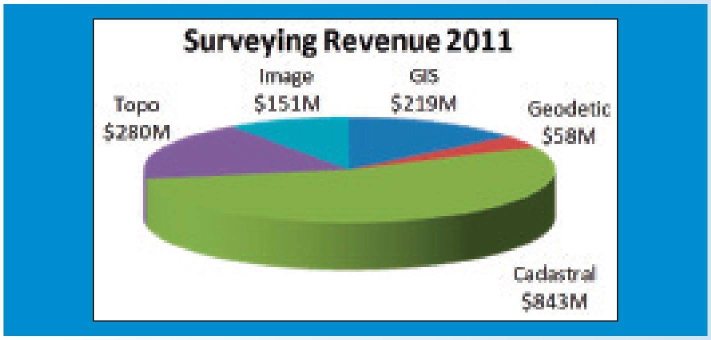
GIS has not been embraced by the surveying community in the past. This is in part because GIS relies on background context data for analysis, and this data was not readily available. Also, the computers at the time were not powerful enough to exploit the power of GIS. However this has changed. There are a number of trends in GIS that are making it easier for the smaller company to play with the big boys. The Cloud and web maps bring GIS technology to the desktop, allowing a small company to have a worldwide presence on the web. The move towards Open Data and standard data models is providing base data for GIS, so that a GIS with data can be deployed. There is also a move towards digital submission, where the GIS database gets updated directly from the source information. This is in fact a GIS best practice, to collect data closest to the source.



GIS can also be used in a survey office. Surveyors can georeference their jobs and create their own in-house SRI, something I did for my father's company 15 years ago. From their projects they can develop an in-house cadastre or parcel map, this is in fact how some large cadastres got started. Surveyors can also add value to open or other data and provide these as products extending their product offering beyond cadastral. Finally they could capture (and possibly maintain) data for municipal and / or provincial GIS.

Some surveying firms are already doing this. Statistics Canada keeps a statistics on the surveying industry as part of professional services. Between 2007 and 2011, cadastral surveying revenue in Canada declined by about $100 million. However GIS revenue in surveying increased by $150 million, which accounts for the total increase in surveying revenue over the same period. GIS revenue in surveying increased continually between 2007 and 2011 even through the recession. The results for 2012 will be published in early 2014, it will be interesting to see if this trend is continuing.

GIS is a vibrant and growing industry that has been steadily expanding over the past 25 years. Both GIS and surveying capture the world as it is and there is a part of GIS that is related to surveying. Surveyors definitely could position and capture GIS information, but only if this is captured in a way that it can be efficiently used in GIS. Surveyors could also possibly maintain a GIS for other agencies or could present and distribute GIS information. They could also possibly perform GIS analysis or software development, but this is more industry specific. Finally surveying can expand the surveyor's current product offering, providing additional products and services. Some surveying companies are obviously already doing this, are you?



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