GISMatters

By Rj Zimmer, LS

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The Power of Place

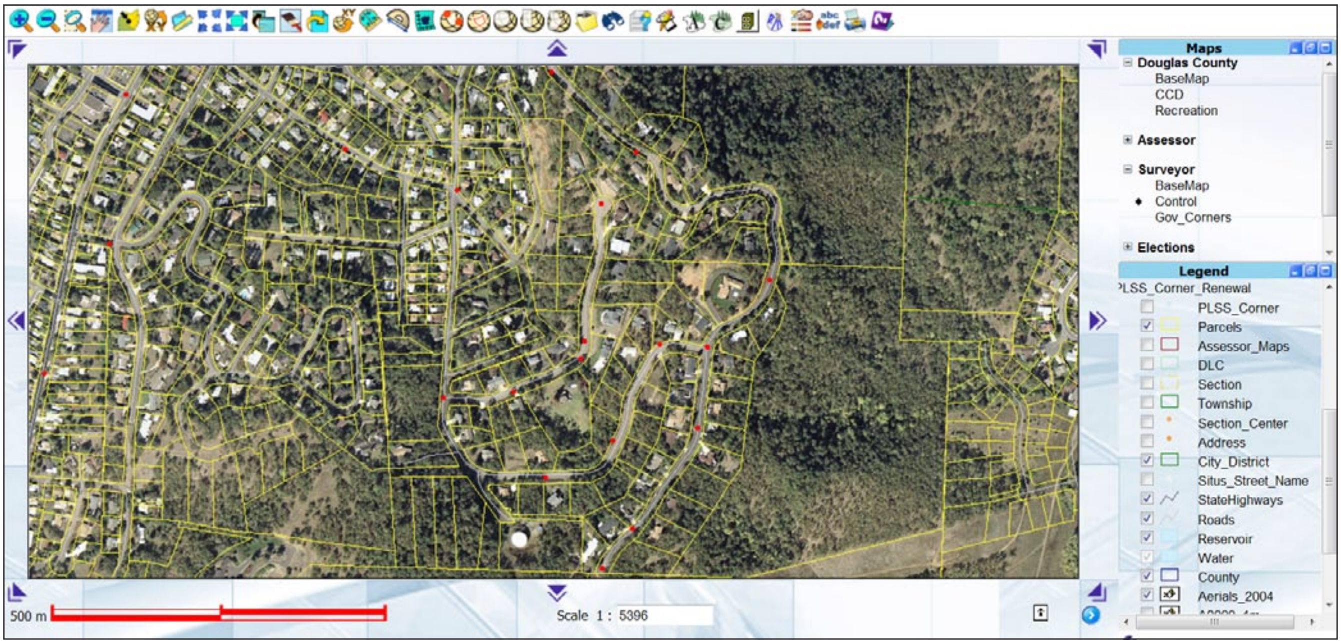


Figure 1 Douglas County Oregon's online map research tools

Geographic Information Systems–the powerful combination of visualization tools and spatial data–are ubiquitous today. People use GIS for many applications such as online searches for retail sources of products and services, as navigational aids in cars, planes, and boats, for hiking and hunting, health care services, and a myriad of industries. Many GIS software are now easy to use and the supporting data are now more available with sufficient standardization to be useable in many applications. In fact some GIS software, such as Google Maps work that works in a web browser, or TomTom navigation products that work in a car or on an iPod (GIS in the palm of your hand!), are so simple to use that people may not even realize that they are using GIS.

Because *location* is what surveying is all about, GIS is a great tool for land surveyors as it provides easy access to information in a spatial context. Surveyors use GIS in the office to manage survey databases such as control data, project locations and other information-related project sites. GIS also helps land surveyors with estimating potential projects by providing access to terrain information (such as digital terrain models and USGS topographical maps), aerial photography, land ownership, roadway access, institutional constraints (such as zoning, floodways, wetlands, etc.) and the built environment. Additionally, many public agencies provide online access to survey records using a GIS mapping interface as an aid to performing records research (**Fig. 1**). All this information comes together in a single graphical map interface, typically along with some simple tools for performing queries against the GIS databases that may be associated with some or all of the GIS features.

Data Sources

GIS data come from many sources and it is now fairly straightforward to integrate one's own GIS data with data from other sources for purposes of mapping and analysis. Many federal programs create, update, and maintain GIS datasets with nationwide coverage, which are public resources. Industry, the public, and all

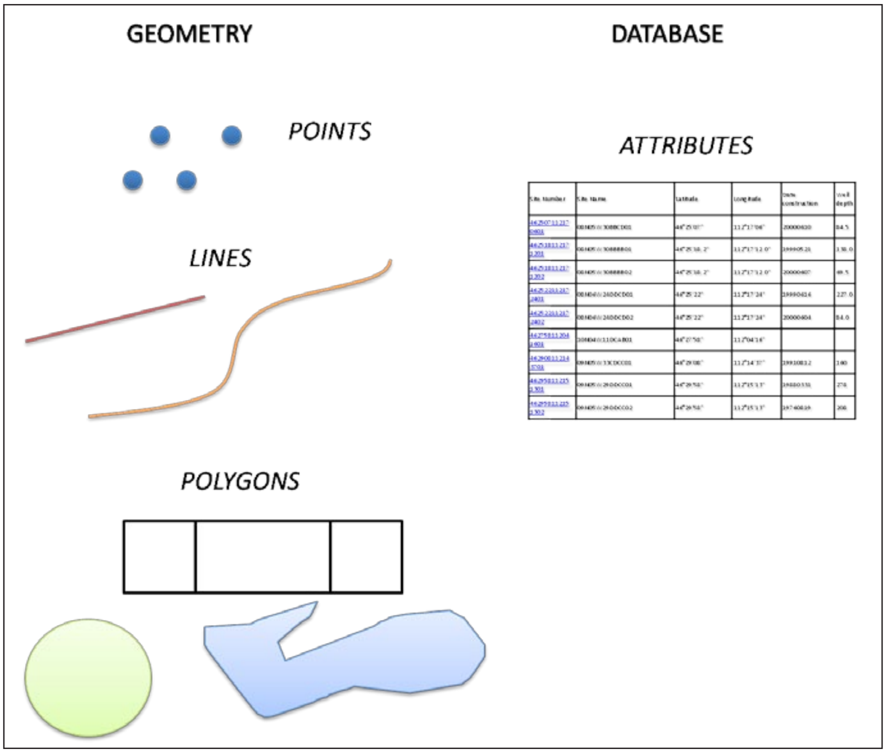


Figure 2 GIS geometries and data

levels of governments use these federal datasets to perform their own work, to provide services for others, and aid in their understanding of our complex world. Some examples of federal GIS data are the National Agriculture Imagery Program (NAIP) that provides spatially referenced aerial photography nationwide, the US Census Bureau's population data that get a lot of use by governments, non-profits, and industry for many purposes, the U.S. Department of Agriculture's soils data and watershed data, and many more. Some private industries enhance some of the basic public datasets for resale by improving the scale, geometry and associated data, and, in some cases, packaging the enhanced data with software that simplifies access and use. In addition to the federal datasets, state and local agencies also create and maintain GIS data for their internal purposes which increasingly also has value to the public, their community, and when done right, may foster economic development. The supplements to these public data are commercial datasets that businesses create or enhance and repurpose for sale or distribute for free. GIS users, such as land surveyors, may consume these data in a variety of ways. Today, one may physically transfer data via hard drives or disks, or download data through the Internet or e-mail, or connect to an Internet map service to connect directly to distance GIS data, or use an Internet browser client that consumes GIS content and provides tools to perform certain GIS analysis or business functions (Service Oriented Architecture, or SOA).

Depending on the task, these existing sources may contain all the information that is needed or not. For instance, the aerial photography in Google Earth may show everything one wants to know about access to a boundary corner in a forest, such as where the roads are, the terrain, the vegetation. However, the existing data can also be used as a basis to create one's own data and as context for overlaying the data. For example, a county's parcel data and high-resolution aerial photography might be used as a spatial reference upon which to build an index map of a company's survey projects, or PLSS coordinates may be loaded from the Bureau of Land Management's Geographic Coordinate Database (GCDB) into a GPS to help surveyors navigate to a section corner.

GIS Power

The power of GIS derives from three fundamental components of a spatial dataset: a picture; a location; and a database. These three components define where, what, when, why, and how of each item of interest and of a collection of items.

The picture, or graphic, helps us to see what something is. Because our brains process symbolic information very rapidly, GIS presents an answer to the question of *what* something is by using representational geometry. The GIS graphic also helps us to see *where* something is more quickly than by merely looking at a table of text and numbers or coordinates. The location information makes the data special because *where* something is located is as important as *what* it is. Location means a lot to people, as surveyors well know. Additionally, the juxtaposition of one feature to another based on respective locations allows for spatial analysis. The types of spatial analysis that GIS enables may consist of:

- *Counts of things* such as the number of control points within a county
- *Intersections of things* such as the total acreage of spotted owl home range that might be disturbed by a highway re-alignment project's clearing limits
- *Optimization of tasks* such as calculating the shortest route between two points along a road network
- *Finding and counting the number of nearest neighbors* such as how many control points are within one-quarter mile of a project area
- *Other location-based analyses*

Location information in GIS can take a few different forms. Coordinates are one of the most common means to locate or place a GIS feature. A point has a single coordinate set, but more complex geometries like lines, polygons, and raster data (such as digital elevation models, and photography) have multiple sets of coordinates that define their locations and their geometry. The various GIS software specifies the allowable datum, coordinate system, projects, and units it will allow. Some software can re-project coordinates on the fly into a different project, datum, coordinate system or units, in order to overlay in a single map, multiple datasets with different spatial references.

Although all GIS data are coordinate based, GIS software can use other types of location information to map new data to the proper place, the best example of which is street addresses. With special software, a process called *geocoding* relies on an existing reference dataset that is already in GIS coordinate space and that has road names and address ranges. The reference dataset is the basis for locating a new dataset by calculating points along

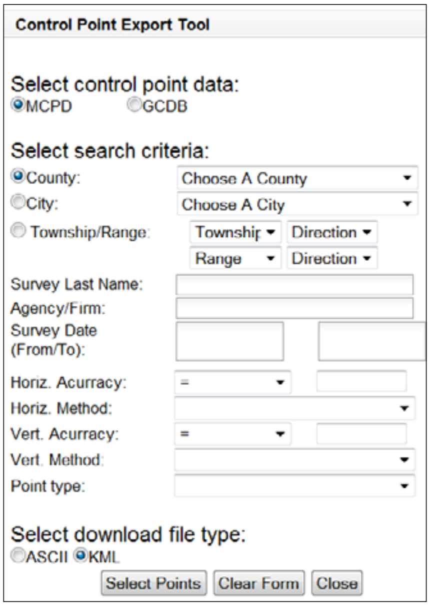
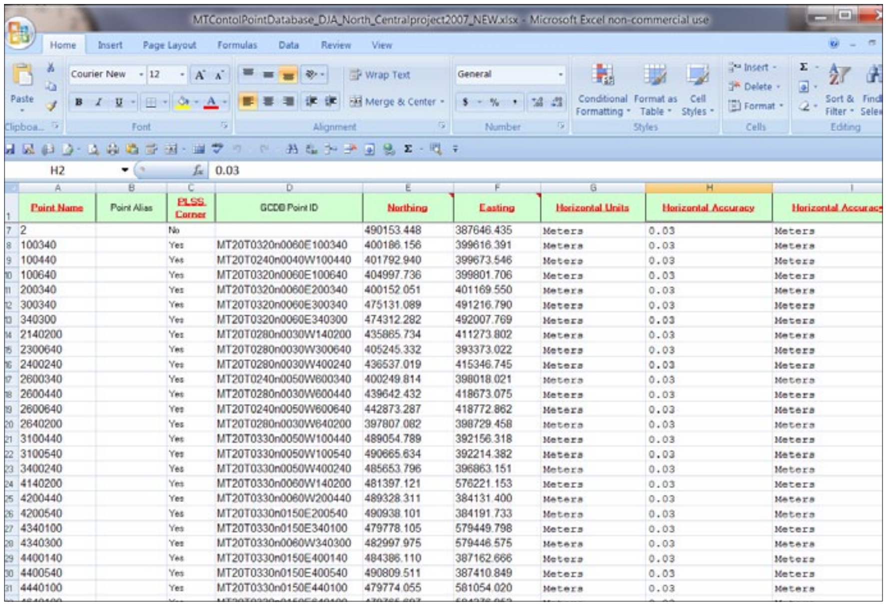


Figure 3 Example query



	Point Name	Point Alias	PLSS Corner	GCDB Point ID	Northing	Easting	Horizontal Units	Horizontal Accuracy	Horizontal Accurac
7	2		No		490153.448	387646.435	Meters	0.03	Meters
8	100340		Yes	MT20T0320n0060E100340	400186.156	399616.391	Meters	0.03	Meters
9	100440		Yes	MT20T0240n0040W100440	401792.940	399673.546	Meters	0.03	Meters
10	100640		Yes	MT20T0320n0060E100640	404997.736	399801.706	Meters	0.03	Meters
11	200340		Yes	MT20T0320n0060E200340	400152.051	401169.550	Meters	0.03	Meters
12	300340		Yes	MT20T0320n0060E300340	475131.089	491216.790	Meters	0.03	Meters
13	340300		Yes	MT20T0320n0060E340300	474312.282	492007.769	Meters	0.03	Meters
14	2140200		Yes	MT20T0280n0030W140200	435865.734	411273.802	Meters	0.03	Meters
15	2300640		Yes	MT20T0280n0030W300640	405245.332	393373.022	Meters	0.03	Meters
16	2400240		Yes	MT20T0280n0030W400240	436537.019	415346.745	Meters	0.03	Meters
17	2600340		Yes	MT20T0240n0050W600340	400249.814	398018.021	Meters	0.03	Meters
18	2600440		Yes	MT20T0280n0030W600440	439642.432	418673.075	Meters	0.03	Meters
19	2600640		Yes	MT20T0240n0050W600640	442873.287	418772.862	Meters	0.03	Meters
20	2640200		Yes	MT20T0280n0030W640200	397807.082	398729.458	Meters	0.03	Meters
21	3100440		Yes	MT20T0330n0050W100440	489054.789	392156.318	Meters	0.03	Meters
22	3100540		Yes	MT20T0330n0050W100540	490665.634	392214.382	Meters	0.03	Meters
23	3400240		Yes	MT20T0330n0050W400240	485653.796	396863.151	Meters	0.03	Meters
24	4140200		Yes	MT20T0330n0060W140200	481397.121	576221.153	Meters	0.03	Meters
25	4200440		Yes	MT20T0330n0060W200440	489328.311	384131.400	Meters	0.03	Meters
26	4200540		Yes	MT20T0330n0150E200540	490938.101	384191.733	Meters	0.03	Meters
27	4340100		Yes	MT20T0330n0150E340100	479778.105	579449.798	Meters	0.03	Meters
28	4340300		Yes	MT20T0330n0060W340300	482997.975	579446.575	Meters	0.03	Meters
29	4400140		Yes	MT20T0330n0150E400140	484386.110	387162.666	Meters	0.03	Meters
30	4400540		Yes	MT20T0330n0150E400540	490809.511	387410.849	Meters	0.03	Meters
31	4440100		Yes	MT20T0330n0150E440100	479774.055	581054.020	Meters	0.03	Meters

Figure 4 Sample spreadsheet

a road where street addresses belong. Geocoding is a means to map many legacy databases into GIS. Other types of reference data that one can use to place data into geographic space are the a parcel dataset, or river, or the U.S. Public Lands Survey System of the western states. The resultant GIS dataset may take the form of points or polygons, or even lines.

Database

GIS is very powerful because it is more than just a pretty map. Because GIS provides linkages from the graphics to a database (**Fig. 2**), it is possible to add tables of information to each feature in a spatial dataset. The database part of a GIS dataset is the tabular information, which might be numbers, text, or hyperlink strings to other information such as a scanned document. GIS data may have any number of associated information, including links to other databases, and the ability to access those databases allows the selection of features with particular characteristics. As shown in **Fig. 3**, a database of control points may have information on when, where, and how the control was established, the coordinates' accuracy, the type of monument and other things. A GIS dataset of waterlines may have an associated database of pipe diameters, materials, and flow measurements. One can perform sophisticated queries and analysis against the database and have the results of those queries and analysis visually displayed to provide more meaning and context.

The tabular data for a GIS dataset may already exist in some type of database. Existing data may need to be converted from some non-digital form such as paper records, or data may need to be created from scratch. I discussed above some methods for mapping existing databases into geographic space. The most common methods for converting hard copy records into digital form are scanning and manual data entry. Hard copy information can be converted directly into a GIS database or into an intermediate data format such as a spreadsheet (**Fig. 4**), which can then be connected to the GIS data in a separate step.

The preferred method for creating new GIS data is with GPS data collectors. GPS data collection automatically combines information gathering in the field with coordinate information derived from the GPS satellites. With the right equipment and field collection software one may enforce good data structure and consistent data content. In future articles, I will discuss GIS databases in more detail.

GIS provides access to location information together with tabular data–a powerful combination. My next article will compare some of the free GIS programs to see how they can help the surveyor estimate a project and manage survey data.

Bear Tales

On our honeymoon, my wife Tulasi and I hiked to the Scapegoat Wilderness in Montana (up the road from our home in Helena) in order to camp on Steamboat Ridge for our wedding night under the stars. The trail starts in the National Forest on the Rocky Mountain Front and climbs somewhat gently for the first two miles, passing through thick forest and open meadows, and crossing a couple streams before splitting at the wilderness boundary to climb the ridge. About midway through the hike we were hiking up out of a creek, crossing an open meadow. I was in the lead by about 100 feet, and as I neared the top of the meadow, approaching the trail junction, I saw a bear–a grizzly–at the trail junction directly ahead of us. I was about 300 feet away from the bear and the bear had not noticed me yet. I watched for a minute as the bear sniffed around the trail, stood up on its hind legs with its nose to the trail sign that was nailed to a tree. It looked like the bear was reading the sign! I turned to my wife who was still hiking up the meadow, with her head down watching her footfalls. I called "BEAR!" to warn her. "GRIZZLY!" She stopped where she was, and I turned back to look at the bear. The bear stopped reading the sign, got down on all fours, and moved toward me a few feet to see what the commotion was about. Since we were far enough away not to be an imminent threat, and the bear *was* in our way, I shouted at the bear to go away. The bear stood up on his hind legs to get a better look at me, and that must have been enough to scare him off. Fortunately for us, he ran down the *other* trail–the one that we were not taking–so we continued on our way up the ridge for our honeymoon adventure.