Computer Mapping: There's Nothing To Be Afraid Of

by Johnny Pitts

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The thought of having to use computers scares some people to death, not to mention actually having to use one to produce maps. The possibility of having to lay down the drafting pens we have come to know and love throughout our working career, and replace them with a computer, mapping software, and a mouse, is unheard of. And what about all those acronyms they use in the computer mapping world like CAD, GIS, GPS, DLG, TIGER, CAM, AM/FM, DEM, etc. It's enough to drive you crazy!

Let's say your boss comes into your office and puts you in charge of computerizing the mapping efforts for your department. No problem, you say. Why, you've been using a computer for a year now. You can access the clock and the calendar on your computer with grace and precision. But what about mapping software? How hard can it be to select a mapping package that fits your needs? And of course you'll need to have all the paper maps you have stuck away in the file cabinets converted to computer maps. And the converted maps will need to fit the base map data you are going to buy. Data? What in the world is that?

Once you've recovered from the realization of the responsibility that has just been bestowed on you, you'll need to get busy. So take a deep breath, and let's walk through some suggestions for automating your mapping efforts and talk about some of the technology available.

The automated mapping world is becoming more and more user friendly, and utility companies are taking advantage of this breakthrough. Utilities, specifically pipeline companies, have realized the long-term cost savings of converting their maps to computers, and the ability to keep up with maintenance, inventory, damage to the pipe, and other pertinent information.

Formulate A Plan

In order for you to make intelligent decisions on hardware, software and data purchases, you need to have a plan. Sit down with people in your department who will be the ones to use the system and the digital maps, and discuss what needs to be achieved. Discuss which data files (computer maps) will be built by your people from scratch, which data files will be converted from your in-house maps, and which data files will be purchased from third party vendors. Many companies take a backwards approach to this process–they buy their hardware, then their software, and worry about data last. This has proved to be the opposite of how it should be done. The first group of questions to ask are: what maps do you want to be able to produce? Do you want to be able to store information about your facilities in a database that is connected to the map? Do you want to be able to ask questions about the map and have the answers displayed in map form? How much data are you going to keep online? The correct way to approach this is to first decide what the end products will be, then select software that fits those needs, and then buy a computer with enough horsepower to work efficiently, with a big enough hard disk to store the amounts of data you plan to have online. Once you have a plan in mind, implement a pilot project. Pilot projects give you the ability to test your ideas, and allow you to make changes in your plan, if necessary.

Data Conversion

Data conversion (taking paper maps and converting them into digital maps) and purchasing data will be your biggest expenses. Keep this figure in mind–80 percent of the total cost of computerizing will be spent on data and data conversion. You would be surprised how many people think that once they get their computer plugged in and their software loaded on, that maps and data magically appear on the screen.

Rule number one in the computer mapping environment is to tie your maps to "real-world coordinates." Before any conversion is done, you have to ascertain that your in-house maps can be related to the real world. What are real-world coordinates? These are coordinate systems that have a position on the earth. Latitude and longitude, state plane coordinates, Universal Transverse Mercator, etc., are examples of such systems. These coordinate systems allow the computer to handle your maps as if there were no geographical border, or as if they were seamless. It also allows, for example, a specific pipeline valve to have a unique coordinate that relates to a base map showing sections, roads or other cultural features. This lets field personnel use maps they can relate to.

There are several ways of converting paper maps to digital form. The most common ways are digitizing, scanning, and coordinate geometry. Digitizing is probably the most popular form of conversion. It's the cheapest and the fastest way to convert existing maps into digital vector form, but it is also the least accurate. However, it may suit your particular needs and specifications. Scanning is rapidly becoming a popular way to convert drawings to digital form. This approach has proven to be a good way to automate engineering drawings and schematics. For mapping, however, you still must do some sort of vectorization to the drawings to enter some intelligence in the data. Coordinate geometry (Cogo) is a very accurate procedure for automating existing maps. Precise measurements, such as bearings and distances are input in the computer with the aid of Cogo software. Although using Cogo is more accurate, it is consequently more expensive than digitizing because it takes longer.

However, with the availability of Global Positioning Systems (GPS) to the private sector, GPS is rapidly gaining momentum as an accurate, cost-effective way to capture digital geographic information. One of the things you must decide is the degree of accuracy of your existing maps, alignment sheets, plats, etc. A rule of thumb to remember: "Garbage In-Garbage Out." Converting inaccurate paper maps to digital form will not increase the accuracy. If it's wrong on paper, it will be wrong in the computer.

Continued on Page 10

Computer Mapping

Continued from Page 9

GPS

Probably the most exciting thing to hit the mapping world in a long time is GPS. This technology allows for the user to walk their line (pipeline, powerlines, fiber optics, etc.) and map it in real-world coordinates at the same time. It also allows you to collect coordinates on other features such as valves, pig launchers, tanks, wells, poles, etc. Once the data is collected in the field, it is downloaded into some type of computer-aided mapping or drafting package that will allow you to begin to produce maps. Accuracy levels of plus-or-minus one centimeter can be achieved with the appropriate equipment, but in the energy industry, GPS receivers that maintain an accuracy of two to five meters are commonly used.

How GPS Works

The basic concept of GPS is simple: satellites are used as reference points for triangulating positions somewhere on the surface of the earth. There's a lot of technical details that are taking place simultaneously, but you don't need to understand that aspect of GPS in order to use it.

GPS was a big hit during Desert Storm. The technology inside the smart bombs that so accurately hit their targets was based on GPS. During Desert Storm, private companies had a difficult time getting GPS receivers in a reasonable amount of time because they were all being shipped to the Middle East for military use.

GPS works by determining positions on earth and measuring how far they are from satellites. There are currently 20 satellites that are considered functional today. The plan is to have 24-hour, 3-D coverage for the world available in 1993. Each satellite orbits the earth twice a day. The GPS receiver must lock onto at least four satellites in order to get the desired 3-D reading (latitude, longitude and altitude). Equipped with two atomic clocks and radio transmitters, each satellite transmits precise time, position and satellite condition information on special frequencies. One frequency is encrypted for exclusive military use by the United States military. A second is intended for civilian use. One item that GPS must contend with is selective availability (SA). SA affects the positioning accuracy and velocity components of many GPS receivers. SA is a method of degrading the accuracy of GPS that was implemented by the Department of Defense. In the event of a war, SA can prevent an enemy from using GPS to guide missiles to targets. It can reduce GPS accuracy as much 300 meters, but differential processing of GPS data can compensate for this reduction in accuracy. With differential post processing, you are then able to achieve the accuracy that the manufacturer specifies.

How GPS Is Being Used In Mapping Facilities

One way to understand how GPS works in the field is to think of it in this sense: a person is assigned to go to the field and walk his company's pipeline, powerline, etc. He has the GPS receiver and is basically "human digitizing" the line and the cultural features around his facilities. He physically stands on a point, flips a toggle switch, and gets a reading in latitude and longitude of where he is standing. Once the line has been mapped using GPS and the data has been differentially post-processed, the location data and any labeling done in the field are then downloaded into a CAD or GIS package. The data can then be combined with land grid data, cultural data, TIGER data, or any other inhouse digital data that is based on real-world coordinates.

One Call Applications

This technology is going to offer a great deal to the One Call community. States like Texas that are not set up on the Jeffersonian survey system (section, township and range) don't have the luxury of nice, square sections to use as the basis for their One Call grid. Instead, the Texas Excavation Safety System (TESS) has adopted a grid system based on 30 seconds of latitude and longitude (roughly 1/2 mile square). People calling in excavations use a 13-digit number relating to the latitude and longitude of the grid where the excavation will take place. This makes TESS members prime candidates for incorporating GPS into the mapping.

It's possible that in the future contractors will no longer call in grid numbers or quarter sections, but call in a latitude/longitude of where the excavation will take place. Utility companies would then be able to use GPS to navigate to the point to flag their lines. Instead of using grid numbers or quarter-sections, One Call operators could send messages to member companies showing the lat/long of proposed excavations. This would especially benefit states that have no grid system at all, and consider the county boundary as the grid. No longer would the One Call center operators be concerned with driving instructions for determining the location of the excavation. Communications costs would be cut drastically because less time would be spent on each call. Screening software will be able to work more efficiently by having precise coordinates of excavations. Many companies will be using GPS technology to track their field vehicles.

The technology for surveying and mapping is changing so fast it's hard to keep up with it, even when you're in the business. Don't be overwhelmed by the vast amounts of information being thrown at you. If you feel uncomfortable making decisions about surveying, mapping, hardware, software, GPS, GIS or any of the things that go along with automating, seek out consultants that can get you headed in the right direction from the start. IRWA