Highway Attributes Pinpointed with GPS

N
eatly stacked objects are easy to count, but most of
the things highway departments need to inventory are
spread along miles of roadway. Consequently, answering questions like: "How many culverts are under the
highway between Rapid City and Pierre?" or "Is there a guardrail around the curve at mile 91?" can
often be answered only by driving there and looking.

Traditionally, inventory was a laborious process. According to Ken Marks, Senior Engineer with South Dakota's Office of Data Inventory, the state's highway attribute data
was recorded in the field on paper, brought back to the office, keyed
into the computer, then edited. Finally, maps were drawn. But Mr. Marks and Rudy Persaud, a
Transportation Analyst, became interested in global positioning sys­
tems (GPS) to increase speed and accuracy.

At first glance, complex GPS
technology may seem like overkill
for highway culverts, guardrails and
stop signs. After all, most highways
have mile markers along them for
reference. But according to Mr.
Marks, that's not always the case.
For example, in South Dakota,
county roads don't have a consistent
reference system. And according to
Darrel E. Peterson, of GeoResearch Inc., departments of transportation
(DOTs) in many states have missing
or inaccurate mile marker posts. He
said that there are also federal
requirements to record data based
on latitude and longitude. "GPS is
the only real way to do that with any
kind of efficiency and cost-effective­ness," he explained.

Recently, efficiency and cost-
effectiveness have become even
more important. Federal highway
money has brought with it increased information and reporting require­
ments. "We're being asked to collect
more information than we ever have before," said Mr. Marks.

So the Office of Data Inventory began a pilot project to reference
highway attributes with GPS.

RAPID CITY PILOT

The project began with a look at
what DOTs were doing in Idaho and
Montana. "Then, late last fall, Rudy [Persaud] talked to the GeoResearch
people and they came and gave a
couple of presentations," said Mr. Marks. In December and January the
agency worked out what types of
data they wanted to collect, and the
pilot was run in April on 17 miles of
road near Rapid City.

A van was equipped with a
Trimble GPS receiver and roof­
mounted antenna. The GPS receiver
was connected to a laptop computer
running GeoResearch's GeoLink

What is GPS?

Technology for pinpointing loca­
tion has advanced significantly since
aviators in biplanes followed roads
and rivers to get where they were going. Surveyors — until recently —
depended on ground-based line-of­
sight systems to measure angles and
distances, sometimes requiring them
to chop tunnels through underbrush
to see their markers.

Global Positioning Systems (GPS)
changed all that. Today, anyone,
holding a small instrument called a
GPS receiver, can press a button
and see the latitude, longitude and
elevation or altitude displayed on a
screen to an accuracy of a few
meters. The required line-of-sight is
with overhead satellites. And while
the technology behind GPS is incred­
ibly complex — it includes orbiting
satellites, atomic clocks, computers
and transmitters — the "business
end" of GPS is small enough to fit
into a hand-held package.

GPS is easy to use, it is rela­tively inexpensive and it is revolu­tionizing navigation, surveying, map­
ping, dispatching and a wide range
of location-dependent activities. GPS provides the locational raw
data for many GIS applications and is
rapidly gaining employment by state
and local government agencies.

By Wayne Hanson
Feature Editor
What's the Differential?

GPS depends on very accurate measurement of the time it takes a signal to travel from a satellite 11,000 miles above the Earth to a location on the ground. Since light travels about 186,000 miles per second, you can't time it with grandpa's pocket watch.

GPS receivers are incredibly accurate, but atmospheric conditions and other factors can affect the speed of the signal, giving an inaccurate reading. One way of compensating for these errors is differential correction. For example, when the South Dakota Department of Transportation collected GPS positions of highway attributes, they had another van parked at a "base station" several miles away. The location of the base station was known exactly through means other than GPS.

Any inconsistencies between the base station's location — as given by the GPS — and its known position could be calculated. The difference between the two positions (the margin of error) was then applied to the highway attribute positions to bring them within an accuracy of 3-5 meters.

software. GeoLink is a tool for collecting GPS coordinate data and building a database of information for GIS use. It is used in a number of state and local governments for highway attribute collection and street map routing for emergency planning.

One person drove the van, another worked at the laptop and others called out attributes. For example, as the van travelled down the road, someone might say "Stop sign, wooden post." The person at the laptop would push several "hot keys" to enter the attribute information. The software would then combine the attributes with the exact GPS location.

Information on bridges, culverts, highway surface and signs was entered. Bridge data included structure number, types of guardrails on the approaches and mileage reference marker (MRM). Sign attributes included lettering, type of support and MRM. Highway surface data included surface type, number of lanes, and width of lanes and shoulders.

The actual collection (driving both sides of the highway) took several days, and included hands-on experience for South Dakota DOT staff. "We got to learn a lot about GPS that week," Mr. Marks said. "It was very interesting and well worth our money."

As this went to press, GeoResearch was doing post-processing of the data, in which differential correction procedures were employed to improve the accuracy.

FUTURE

Mr. Persaud said the agency has money budgeted for GPS equipment, and a road inventory system should be established by late fall. After talking to DOT staff in Idaho and Montana, and participating in the pilot, he is convinced that GPS is very effective for road attribute collection.

Mr. Marks said they hope to use some of the features they saw in Idaho's system, including input by touchpad, keyboard and a six-channel Trimble GPS receiver. The $6,800 paid for the pilot project included a copy of the GeoLink software. He anticipates that the GPS attribute data will eventually be included in a full-scale GIS system like the state's Intergraph Modular GIS Environment (MGE).

Currently, said Mr. Persaud, a user can pull up a plot of GPS latitude and longitude points with attributes marked as symbols. The GIS would expand the flexibility of the data and give a more complete to-scale picture of the information.

South Dakota's GPS pilot was conducted using a 286-type laptop computer with a 20 megabyte hard drive, and 640 K of RAM. According to Mr. Peterson, there should be a good LCD display screen to compensate for various lighting conditions and glare.

With GeoLink software, he said, the user can pre-program function keys and build very elaborate macros of information. "As you pass a road sign, you would want to know what kind of sign, what condition it is, etc. Rather than having to type in all that information on the fly, you can pre-program the function keys to query you for answers to these various questions.

"You can also use what we call pick lists, which are database files that have been transported from other database programs and list all of the featured types and attributes. You can program those into the function keys and simply select from this information."