The Geodesy Corner
GPS Applications Continued

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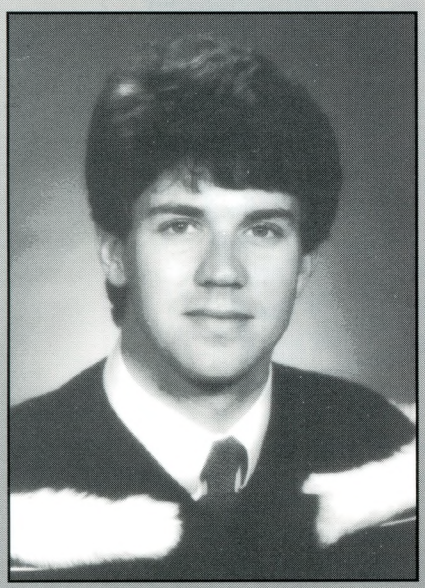

Well summer is finally upon us, and we can sit back and enjoy the sun while opening up another issue of the AOLS Quarterly. If you remember back to the last *Geodesy Corner*, I began a piece about day to day applications of GPS, useful for practicing surveyors. I discussed using GPS as an EDM, as well as using it for azimuth determination and control. I'd like to continue the topic of applications in this issue, and once again I will be outlining the application along with the basic principles that make it possible to apply GPS to that particular problem.

GPS as a Locator

We must not forget that GPS was developed primarily as a navigation tool and, as such, it is very useful for survey applications that may require course positional accuracy (30-100 metres). Using GPS in this fashion requires only one receiver in a "stand alone" mode and will give you absolute or point positions normally in the satellite frame of reference - WGS84. Internal transformations to a local system such as NAD83 are possible with some receivers, but these positions will be only as accurate as the WGS84 position. Course positioning in this fashion is quite flexible, since we can do whatever we like between required position "fixes", and the need for continuous monitoring of at least four (4) satellites for a relatively long period of time (i.e. more than a minute or two) is not necessary. In addition, it may be possible to attain a decent 2-dimensional position (latitude, longitude) if only three (3) satellites are visible. Some of the applications we've seen for absolute or point positioning are:

Locating existing geodetic control:

Some of the existing control stations that are required for survey work may be overgrown and difficult to find. GPS will bring you to within 50 metres of the site, making it much easier to perform a detailed local search. We've used GPS to find sites that would never have been found using the available description.

Starting Coordinates for Astronomic Observations:

Instead of scaling coordinates from a topographic map, they may be obtained by GPS to about 50 metres. Even with the transformation from WGS84 to the local system (NAD83 or NAD27), your initial coordinates will be adequate for reducing astronomic observations.

Initial location of evidence for boundary retracements:

Many times it is not economical to tie found evidence with conventional traversing, especially if you are in the preliminary investigation stages of a retracement. Using GPS as a 50 metre positioning device, it is possible to obtain a realistic idea of how found evidence fits with the original survey. Even though the overall positioning accuracy is at the 50 metre level, it is quite likely that between absolute position fixes you may achieve 10-25 metre relative accuracy's. Once you ascertain which evidence is in the "ball park", you can proceed with more accurate forms of survey.

Other uses of GPS at this level of accuracy will become evident to you the more you use GPS. Note that at this time (June, 1993) it is possible to buy a GPS receiver for the above applications for about $1,000.

GPS for Relative Positioning - With or Without Geodetic Control

The basis of "relative positioning" using GPS is the determination of the distance and azimuth, among other quantities, between pairs of points occupied with GPS. With this technique, it is possible to derive GPS positions accurate on the sub-centimetre level, using GPS equipment that is capable of receiving the requisite information from the satellites. Performing relative GPS positioning is perhaps the most practical form of GPS for surveying applications; and there are many diverse ways to apply this technique. One of the most useful aspects of relative positioning is its ability to be ap-

plied to a survey problem with or without the use of existing geodetic control. For instance, if a boundary corner is deemed to be the starting point of survey, it is possible to occupy this location with a GPS receiver and have all other points related to it in a relative way. You can then assign arbitrary coordinates (or use WGS84) to the initial corner, and propagate positions throughout the survey using the vectors calculated between pairs of points. Of course, if a point in your survey is coordinated with control values (NAD83 for example), then you can orient your local survey to this system using a transformation or adjustment process. A few of the uses of relative GPS positioning are:

Boundary retracements:

Use relative positioning to tie found pieces of evidence after you have used "absolute" positioning to get an initial idea of how it fits together. Once the relationships between points is known, it may be possible to retrace the boundary line without the need of "trial lines". In rough townships this can save time and money.

Subdivisions:

Large subdivisions generally require a perimeter control network for initial survey, stakeout and building verification. Using GPS relative techniques it is possible to create a local system with an arbitrary coordinate system. One of the possible advantages of GPS over more traditional methods is the ability to place the control stations in areas that will not be disturbed with construction. Using the latest rapid or fast static GPS methods, it is possible to survey a small control network in just a few hours. Although the minimum number of receivers for relative work is two, it is generally recommended to use at least three for more efficient surveying.

Street lines:

Establishing street lines is essential when performing legal surveys (i.e. surveyors' real property reports) and GPS can be a very effective tool in carrying out this task. Using a couple of GPS receivers, you can obtain street lines by observing survey evidence (property corners, street corners etc.) in a sequential fashion. This method is similar to traversing, where receivers are moved in a "leap frog" manner.

One word of caution when using GPS in this "traverse mode" - there is no real check on the reliability of the computed vectors between pairs of points, and it would be wise to observe each pair of points at least twice. To perform relative GPS positioning requires at least two receivers, and current costs (June, 1993) range from about $ 15,000 to $ 50,000 per receiver depending on the sophistication of the receiver and the acquired hardware/software options.

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The next column of the Geodesy Corner will continue with GPS applications, and will focus on the following items:

* Combining GPS and Conventional - the power of them together
* GPS for vertical displacement
* GPS for profiling
* GPS for Mapping/GIS data capture
* GPS in Flight

Please write to me, care of the AOLS, if you have any comments, or would like to see an item of special interest in *Geodesy Corner*. Have a happy and safe summer season.

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