



Editorial

>> Marc Cheves, LS

THE American Surveyor

A FOOT IN THE PAST... AN EYE TO THE FUTURE

www.amerisurv.com

Volume 6, No. 1 January 2009
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PUBLISHER Allen E. Cheves
allen.cheves@chevesmedia.com

EDITOR Marc S. Cheves, LS
marc.cheves@chevesmedia.com

ASSOCIATE EDITOR Joel Leininger, LS
ASSISTANT EDITOR Jacalyn Cheves
ASSOCIATE PUBLISHER Jason Metsa

CONTRIBUTING WRITERS

Dale Beeks	Jeff Lock
Joseph Bell, LS	Dan Martin
Joe Betit, LS	John Matonich, LS
Shawn Billings, LS	Jerry Penry, LS
J. Anthony Cavell, LS	Al Pepling, LS
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Thomas Liuzzo, LS	Rj Zimmer, LS

The staff and contributing writers may be reached via the online Message Center at amerisurv.com

GRAPHIC DESIGN LTD Creative, LLC
WEBMASTER Joel Cheves
ACCOUNT EXECUTIVE Richard Bremer
CIRCULATION Mirta Ryker

The American Surveyor (ISSN 1548-2669) is published monthly by Cheves Media LLC. Editorial mailing address: 905 W. 7th St., #331, Frederick, MD 21701. Tel: (301) 620-0784.

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Subscriptions prices in the U.S.: Free for qualified professionals. Canada: 1 year \$56.00 US; international subscriptions \$72.00 per year (Airmail), U.S. funds prepaid. Back issues (subject to sufficient stock) are available for \$4.95 + S/H.

New subscription inquiries and all other address changes should be sent to *The American Surveyor*, P.O. Box 4162, Frederick, MD 21705-4162. Fax: 301-695-1538. Subscribe online @ www.amerisurv.com

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Passive Monuments and Dynamic Changes

In response to a long-standing request by NGS to the Geomatics Industry Association of America (GIA), and under the auspices of ACSM, a two-day symposium was held at NGS's legendary Corbin, Virginia facility in December. The purpose of the NGS-Geomatics Vendor Summit was to explore ways in which NGS can coordinate its development of data products and services-- such as geoid models and OPUS--with the software and hardware manufactured by the members of GIA. The event, hoped to be the first of many, was held to foster cooperation so the products used by surveyors can take advantage of the technology developed by NGS.

Among the more than 40 people in attendance were representatives of Leica Geosystems, Magellan, Riegl, Sokkia, Topcon, Trimble and others interested in seeing such a cooperation take place. A series of presentations by NGS experts, moderated in a lively fashion by GIA Technical Committee Chair **Joe Paiva**, gave the manufacturers an opportunity to learn where NGS is at with its current and future developments, and included a lot of open discussion.

NGS Director **Dave Zilkoski** remarked in the opening session, "The mission of NGS hasn't changed in 200 years, but how NGS carries out its mission has." The number of full-time employees has dropped from 278 in 1995 to 212 today, and NGS has been forced to carefully examine not only its role, but also where it places its efforts. It has extensively polled its customers to determine where best to put its limited resources.

To that end, Zilkoski and NGS Chief Geodesist **Dr. Dru Smith** spent a fair amount of time discussing the recently completed Ten Year Plan. Responding to a sea change brought about by CORS and the fact that users are shifting from "brass cap" passive monuments to active positioning--even though NGS still publishes the data for nearly a million passive marks, it has no way to physically maintain them, and by attrition, mark recovery reports have winnowed the number down to around 70,000--we learned that NGS has shifted to be more customer-focused and outcome-driven. Positioning infrastructure is no longer enough; there must also be appropriate models and tools. As an example, Zilkoski reminded the audience of the critical importance of an accurate geoid model for flood mapping. And with the rapid growth of RTNs, the manufacturers are taking more responsibility for infrastructure.

Dr. Yan Min Wang, a Research Geodesist for NGS, revealed news about the next national hybrid geoid model, tentatively referred to as GEOID09. Based on a combination of satellite and terrestrial gravimetry as well as GPS observations and geodetic leveling, the new geoid will incorporate ellipsoid heights from the recent adjustment of NAD 83 (NSRS2007). Plans call for GEOID09 to be released around the time of the Salt Lake City ACSM conference next month, with a beta version released this month. It was stressed that the datum algorithms the manufacturers are using need to be in step with the algorithms being used by NGS. Examples were presented about people still wanting to keep their data in the NAD 27 and NGVD 29 datums, and the difficulties (and inaccuracies) that result from using transformation software such as NADCON and VERTCON. New geoid models are needed not because the geoid is changing, but rather because our understanding of it is changing.

Dru Smith gave an extensive presentation about the 10 Year Plan and the state-of-the-art in geodesy. In addition to being stewards of the National Spatial Reference System (NSRS), NGS's goal is to be a global leader in geospatial activities. The magazine has extensively discussed the fact that the rest of world—most notably western Europe and Japan—has taken the free GPS and run with it, but this does not mean that NGS or U.S. surveyors have been idle. The belated rapid growth of RTNs in the U.S. is one example of this.

One thing I find amazing, and something that came through loud and clear in the meeting, is that the Earth is dynamically changing. Passive monuments, as soon as they are positioned, start moving, and it's the GNSS that has allowed us to understand velocities (the movement of the tectonic plates). As stated above, our reliance on passive monuments will lessen, and the incorporation of CORS and a highly-accurate geoid will enable whole new groups of positioning users.

The opening statement of the 10 Year Plan says that the NSRS must be more accurate that all the activities that make use of it. The report states that the 1-10 meter users are expected to be the fastest-growing group, but the precise community will also be well-served. Smith said that because the cost to re-level the NAVD 88 lines at the current contractual rates (which excludes most of Alaska and all areas in the Pacific and Caribbean) has been estimated at over \$2 billion, re-leveling is not an option. Hence the need for more cost-effective methods of defining and accessing the vertical datum are required. This is the crux of the GRAV-D project, which lays out plans for NGS to redefine the vertical datum by 2018 using a gravimetric geoid and GNSS technology. Getting the geoid right will require a lot of work including cleaning up existing gravity data and collecting new data (such as air and space-borne gravimetry). GRAV-D has already begun and is expected to cost under \$40 million. It will cover the entire nation including all of Alaska, plus the Pacific and Caribbean regions of the United States. The project plan is available at: <http://www.ngs.noaa.gov/GRAV-D/> and will take seven to ten years to complete. Smith said it will be the largest project for NGS since the NAVD 88 adjustment.

Another key component of the 10 Year Plan is something NGS is calling foundation CORS. This system of NGS owned, operated or directly-controlled CORS across the continental U.S. will be active and part of the move to time-dependent positioning. The exact number has not yet been determined but the positions will include not only the horizontal and vertical information but an epoch tag—meaning at what date and how fast is it moving—as well. These stations will be tied directly to the ITRF, and used as the basis for positioning all other CORS in the network. Driving this focus on CORS accuracy is the fact that the NSRS will no longer be defined by passive marks. Passive marks will still be tied to the NSRS through CORS, but NGS will primarily support access to the NSRS through the CORS only. The ultimate goal (in 2018) will be to provide 1cm access to the NSRS for GPS users with less than one hour of observations anywhere in the United States. To achieve this, the points that define the NSRS should have an absolute accuracy well below 1 cm. This will mean parallel efforts to improve GNSS satellite orbit accuracy, as well as research on removing other positioning error sources that exceed 1 cm.

Joe Evjen, the Chief of the Geodetic Standards and Applications Branch, discussed enhancements to OPUS and showed how it provides a draft XML output in an effort to make it machine-readable. The goal is to be able to use the information to feed a geodatabase. Another intriguing idea was presented: because the GPS receivers and data controllers are IP devices, it has been proposed that these devices could be used to communicate directly with NGS, eliminating the need for e-mailing information.

A new OPUS publishing feature has been launched to augment (and, is hoped, replace) the blue booking process, facilitating submission of data to NGS -- you may have heard it called "OPUS-DB".. We saw how this new service serves up a cool new data sheet that includes a picture of the passive mark as well as an interactive Google map. Because passive marks will no longer define the NSRS, the terminology of the future will be that passive marks are not *part* of the NSRS, but rather *tied* to the NSRS. Also discussed was the need to move away from traditional orders of accuracy (which described how

surveys were performed) to local and network accuracies (which describe the coordinate accuracies on points). Several of the attendees said that many contracts still call for the existing terminology, but it was agreed that this is an educational need.

Bill Henning, the NGS Senior Geodesist leading NGS's real-time program, led the vendor collaboration and support discussion and reminded the manufacturers that the meeting was not just about what the manufacturers want, but also about what their customers want. Zilkoski chimed in, "Remember, for the most part, NGS does not use its own data! We simply process it and provide access to it." Henning mentioned the 75+ RTNs operating in the United States and repeated that they are a way to access the NSRS, but only if they are providing coordinates consistent with the NSRS. He discussed the partnerships within the CORS network and we learned that GIS people are locating photo control points. A bit of controversy arose when Henning mentioned the NGS plan to start streaming GPS observables from the CORS stations. It was pointed out that the private sector (most notably agricultural) has established differential services. Zilkoski said that the stream will not include correctors and therefore will not compete. He said it's just a new way of distributing data—the difference being when—and that the goal is to provide real-time access to the NSRS.

Dave Doyle, NGS Chief Geodetic Surveyor, gave an extensive presentation on datums and reminded the group that this was one of the primary reasons for the meeting: software manufacturers often include unnecessary or out-of-date transformations, and users are not knowledgeable as to what is what and why and when they should use a particular transformation, or, for that matter, even understand coordinate transformations: they just hit the button. Doyle started by defining the different types of datums: 2D, or horizontal such as NAD 27 or NAD 83, defined by eight parameters; 1D, or vertical such as NGVD 29 or NAVD 88; 3D, or geometric datums that include ellipsoid heights; and 4D, which include velocities. He discussed the difference between vertical datums based on tidal marks, such as NGVD 29, based on 26 tide gauges, and NAVD 88, based on one tide gauge,

and geodetic vertical datums based on the geoid. He pointed out that GPS revealed the essential wackiness of vertical datums based on tide gauges.

Doyle discussed the fallacy of believing that transformations (e.g., NAD 27 to NAD 83) will maintain accuracy and said that the only way to maintain accuracy is to readjust with the original observations. The group lamented that most often, the goal is simply coordinates and the original observations are discarded. Doyle gave examples of the characteristics of different datums: NAD 83 (1986) is passive; NAD 83 (199x) is passive; NAD 83 (CORS96) is active; and NAD 83 (2007) is passive. A great deal of discussion ensued about the history of WGS 84 and it was revealed that there are four different versions. The DMA/NIMA/NGA has different requirements and goals for its uses and has its own separate way of sharing and updating its data. NGS geodetic toolkit contains transformations for all available realizations of WGS 84.

Dr. Gerry Mader, the Chief of the Geosciences Research Division for NGS, gave a presentation on the move to absolute antenna calibrations. Previously, the calibrations were relative to a Dorne-Margolin choke ring antenna. He gave a fascinating account of the phase center variation for the antennas on the Block II-A satellites and said they were chasing a 14 parts-per-billion error until they learned that the phase center for the satellite's antennas, and thereby the orbit, is about a meter closer to the Earth than they thought. Also interesting was the fact that IGS can now determine the phase center variation for each individual satellite from Earth. With the move to the absolute models comes a problem: to avoid a ± 2 cm vertical error, users cannot mix antenna calibration models, and as the RTN operators move to using absolute models, users that employ relative calibration models could incur the 2cm error.

Paiva wrapped up the meeting by assigning various tasks to the participants. Everybody agreed that the meeting was worthwhile and should be continued on a regular basis. One participant said that he was encouraged because NGS will communicate better about its programs and this will allow the manufacturers to incorporate changes faster in their field gear. 