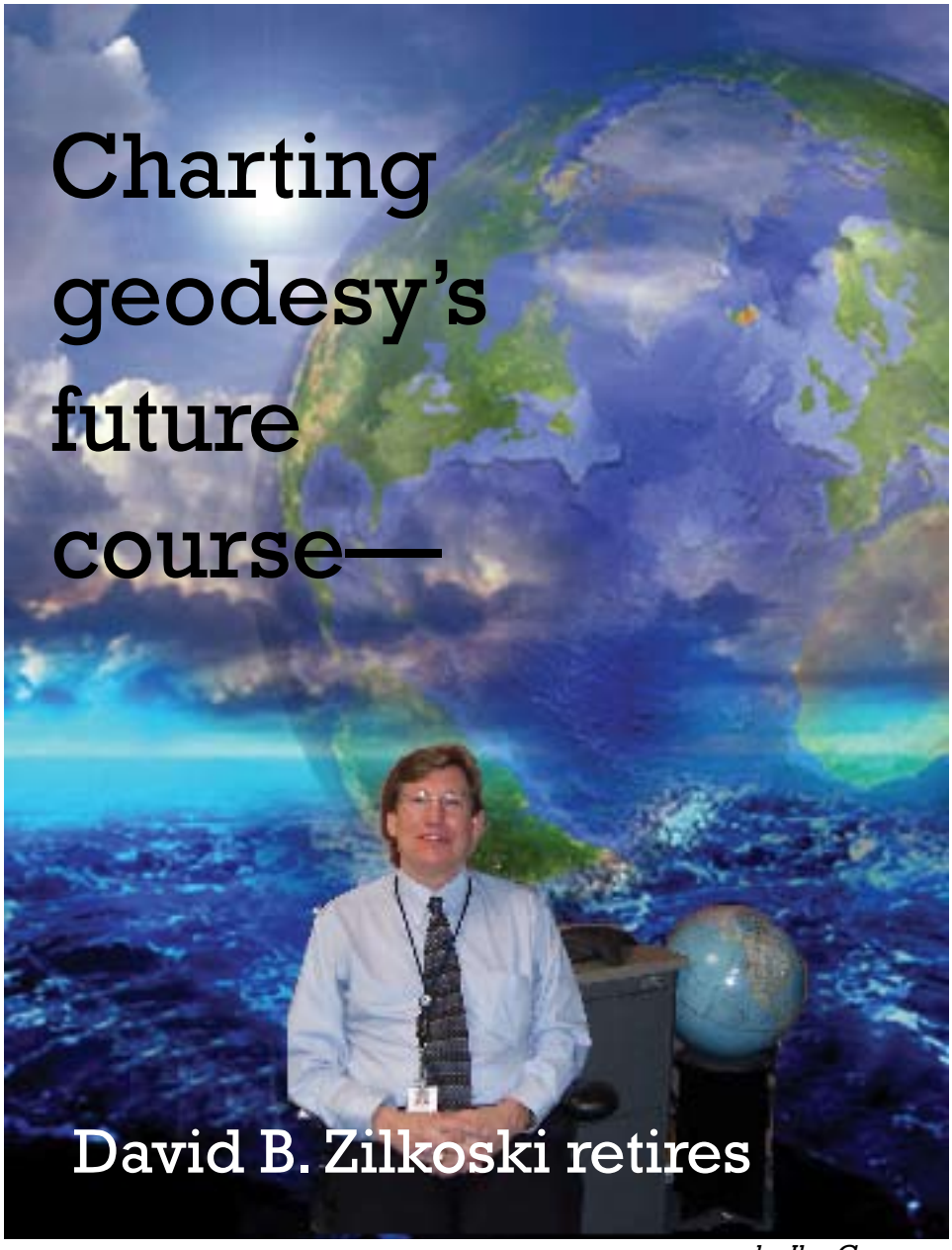


—by Ilse Genovese

After 34 years of service as geodesist and Director of the National Geodetic Survey at NOAA (National Oceanic and Atmospheric Administration), Dave Zilkoski retires with a sense of extraordinary accomplishment—geodesy has positioned itself as the foundation for all geospatial positioning.

The road leading up to this feat has been marked by several important milestones. The most obvious is technology. When Zilkoski joined NGS in 1974, horizontal control was done with theodolites and Bilby towers, the "compensator" level was the "in-instrument" for levelling, and labor-intensive punch cards ruled data analysis. Then, gradually, automation swept in. The computer, unwieldy as it was in those early days, and NGS' web-based geodetic tool kit that came two decades later, banished the punch cards, a digital barcode level replaced the compensator level, GPS revolutionized horizontal and vertical positioning, and theodolites gave way to automated total stations in data collection. Those were the halcyon days of technology on the march—and geodetic surveying marched right along.

The new technology shaped geodesy's work force: local field crews grew exponentially while NGS' work force decreased as others at the state and community levels began collecting local data. NGS staff specialized in delivering key products and services in support of local surveying work.

The web is the means of serving up these products and services to users. CORS (Continuously Operating Reference Stations) data sheets and transformations, and OPUS (Online Positioning User Service) which returns analyzed GPS observations in a day, all flow freely through the cyberspace to surveyors and professionals working in fields dependent on geospatial information.

Obviously, GPS and new information technology has drastically changed the way we can "do geodesy" these days, said Zilkoski. The increased productivity achievable through GPS has been augmented by unprecedented connectivity. Still, some contend, not too happily, that "GPS [and the Internet] has made geodesists out of all of us."

True, popularization of technology can have its pluses and minuses. The growing realization of geodesy's vital role in construction in coastal areas, in environmental protection along our waterways and coastlines, in building accurate GIS databases for rapid response to natural disasters; in building roads and bridges and constructing utility grids; in aviation, and much more is a definite plus. All these activities have much to benefit from incorporating vertical and horizontal data during planning and implementation.

On the other hand is the spectrum of misused tools and technology. "A group of people has emerged, called the 'buttonologists,' who know how to push all the right buttons without really understanding the differences in data that their work can result in and how they can inform or misinform a project manager. This is a major concern," admits Zilkoski, "that's why it's imperative that field crews are adequately trained in the use of new geodetic tools and products."

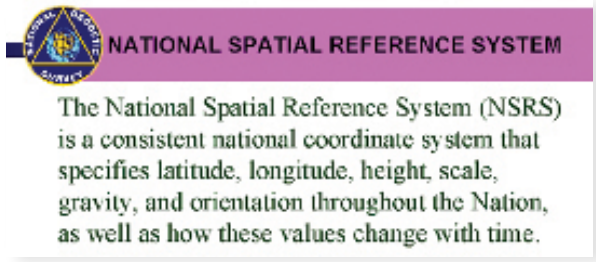
In fact, this is the third major change that NGS has experienced in the more than three decades that Dave Zilkoski has been part of the organization. NGS staff have become trainers rather than being the doers. But that's not to say that NGS will never again conduct a piece of geodetic work on its own. On the contrary, the smaller and leaner work force will retain those core capabilities that are essential for maintaining a national spatial reference system, establishing accurate height measurements, and supporting all manner of environmental initiatives.

Defining Moments

The major re-adjustments of the 1980s—NAD 83 and NAVD 88—, the development of software for VLBI (Very Long Baseline Inferometry) and GPS, the definition of the Shallow Water Positioning System (SWaPS), the establishment of CORS and the creation of products that relate to the use of CORS—OPUS and the geodetic toolkit—, and, of course, research on defining a more accurate geoid, are all examples of work that has enabled NOAA to continue the legacy built by its predecessor, the Coast and Geodetic Survey, as a premier federal scientific organization.

"The completion of the re-adjustment of the horizontal and vertical datums was a major achievement of my time at NOAA/NGS," said Zilkoski. "With this work we took a giant step toward maintaining a reliable National Spatial Reference System (NSRS)."

The two datums re-adjusted over a million monuments"



—which in itself was a significant accomplishment for the world to see. The work involved the use of mathematical techniques at a scale never done before. "The readjustments were major undertakings," said Zilkoski. "We had to 'gear up'—hire the right scientists, develop the right algorithms." There were many visiting scientists from around the world working at NGS in those days; it was a time when colleges couldn't produce the number of geodesists NGS needed fast enough, and when young scientists clamored to work at NGS. It was a time when NGS scientists published "with vengeance." Their research filled the pages of many academic and professional journals, including the then *Surveying and Land Information Systems* and the *ACSM Bulletin*.

It's not surprising that the former chief of Geodetic Research Division and later deputy director and director of NGS should be passionate about the 1980s and the 1990s. Geodetic research was being redefined while it was in the process of redefining our use of geospatial information.

Zilkoski's professional growth was being redefined as well—by his work within NGS and outside. He took two temporary assignments at the National Ocean Service (NOS) to, as he put it, "better understand what people need from NGS." This understanding led him to develop a theory that for NGS to continue to be successful, it needs to be "customer focused and outcome driven."

"NGS is part of NOS which, in turn, is part of NOAA," explains Zilkoski, "but their work yields different outcomes.

At NGS, we produce coordinates; one of NOS' outcomes centers around better management of coastal activities so as to keep oceans and coasts safe, healthy, and productive. So, the question is how does NGS collaborate with other NOAA programs to produce products and services that are useful to non-geodesists. Specifically, What is geodesy's role in coastal management?"

Focus on the customer now drives much of the work performed at NGS. "For instance, we've been working on linking tide gauge water level information with the geodetic framework [NSRS] to enable emergency managers to develop better inundation models and evacuation routes. If and when flooding occurs, we work with our NOS counterparts as well as with coastal managers. They are our ultimate customers; the outcome is an inundation map used by emergency managers and coastal planners. Geodesists don't create the map; they create the information that goes into that map. The geodesist is not done until the inundation map is done and used by managers." And that's Zilkoski's point about being outcome driven and customer oriented—surely a highly defining moment in an organization's way of doing business.

Follow-up and New Projects

Several projects that Zilkoski worked on or shepherded through while at NGS will continue well into his retirement. This includes involving and training coastal managers in the use of new geodetic technology, models, and tools to measure "true" sea level rise. Major work will also be done on the vertical datum; provision for a new NVD has been included in NGS' 10-year plan. The datum will be geoid based, which means that users will be able to deploy a geoid model along with GPS data to obtain accurate vertical heights. "People should read NGS' 10-year plan," said Zilkoski, "and become familiar with its various parts because there will be substantial datum changes—both horizontally and vertically."

There is also a plan to limit data sheet retrieval in subsidence regions. The first region designated as a

subsidence region to implement the new directive was southern Louisiana where many monuments older than three years will no longer be published. The more dated information will however be available through NGS. The next subsidence regions to institute the same limitation will be in Texas. Under the leadership of Ron Neighbors, General Manager of the Harris-Galveston Subsidence District, HGSD has developed one of the best subsidence monitoring networks in the Nation. This network will enable NGS to publish 4-D coordinates for the region.

North Carolina, through the leadership of Gary Thompson of NCGS, has played a major role in developing and advancing the National Height Modernization Program. The program will continue, largely through involvement at the state level. Mississippi, Texas, California, Washington, and Louisiana all have spatial reference centers that are helping to implement the National Height Modernization Program. Louisiana, for instance, which uses CORS data for its height mod effort, operates a spatial reference station at LSU. Mississippi, Texas, and Alabama have installed stations in areas they need such stations most. In addition, NGS is pursuing densification of CORS in southern Louisiana and elsewhere in the country as a way of implementing the National Spatial Reference System (NSRS).

The data collected by CORS stations along the Gulf Coast and elsewhere are fed into inundation models used by weather forecasters and emergency managers in coastal communities. Through CORS, geodesists at NGS have also been able to forge a working relationship with NOAA's Office of Oceanic and Atmospheric Research. CORS stations are instrumental in measuring water vapor and predicting space weather.

"NGS geodesists have a good synergy going with scientists concerned with oceans and the atmosphere and with those in the NOAA National Weather Service," Zilkoski remarked. The synergy between NGS and NOS is particularly important; Zilkoski personally spent a decade trying to identify the positioning requirements of NOS and other parts of NOAA.

The National Ocean Service—which is historically closest to NGS—is heavily involved in coastal zone management, and its navigation services support maritime trade by maintaining accurate nautical charts. The coastal zone management part is critical. Construction along the coast and other human activities need better spatial information. They all need to be tied in to the National Spatial Reference System.

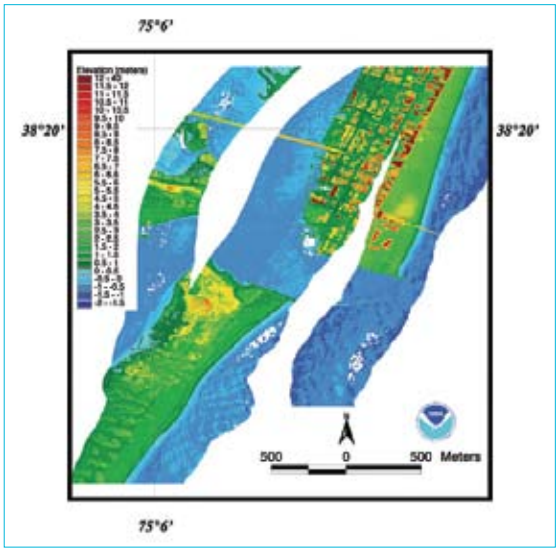
With climate change becoming an issue, Zilkoski sees an urgent need to determine its impact on the ecology of the shoreline and the people who live there. That's one of the reasons for NGS' involvement with NOS in measuring sea level rise, by supplementing tide measurements with GPS measurements and developing inundation models that would help in predicting sea level rise and the effect on the local community. This work is both customer oriented and outcome driven. Working with NOS has made it possible for NGS to engage with non-traditional users of geodetic information—something that Zilkoski sees as a major modus operandi for NGS in the near future.

But it's not only the changing circumstances of the coastal areas that have preoccupied NGS of late. Geodesy

spans from coast to coast, across the huge inland of the country and its inner waterways—the Mississippi, the Missouri, and the Ohio. These mighty rivers all drain into the Gulf of Mexico, and precision agriculture in their watersheds has emerged as an urgent task for managers. Horizontal and vertical data from NGS can dramatically improve fertilizer use and so minimize runoff into these rivers and ultimately the Gulf where it can potentially affect fisheries.

Zilkoski firmly believes that "the coast, the rivers, and the climate belong together with geodesy." Climate change may cause flooding in areas that have never flooded before; we need appropriate geodetic information for these areas to anticipate future events. Climate change may cause droughts in areas that used to have plenty of rain. Do these areas have the appropriate spatial information to help ameliorate the possible impacts of drier climate? The dynamic relationship between rivers and seas and geodetic datums is becoming more critical than ever before. Hence the growing demand for GPS CORS and other positioning products and services provided by NGS.

"The National Geodetic Survey has always been a partner," said Zilkoski, "but in the last decade we have become more of an integrator—by integrating technologies that require geodetic and remote sensing expertise and, in the process, providing the foundation to



Topographic map generated from a September 1997 LIDAR survey of the Ocean City Inlet. [Source: Cindy.Fowler, NOAA; www.esri.com.]

a variety of projects ranging from environmental protection to agriculture to transportation.

The Future

For Zilkoski personally that future involves his family and a continuation of efforts promoting the importance of geodetic information in geospatial activities. He has been asked to chair two committees, precisely because of his background in geodesy. He will chair the Transportation Board's research committee on Geospatial Data Acquisition Technology in Design and Construction and the Marine Technology Society's Marine Geodetic Information Systems Committee.

On the agenda of these committees will be issues Zilkoski has attempted to find an answer to during his professional career at NGS—How can we best utilize machine guided control? Where and how would it make sense to apply precision agriculture? What type of spatial information will help us build better roads? Can we derive more accurate maps by integrating LIDAR with geodetic data? What are the issues involved in providing geodetic information to the huge community dependent in their work on accurate positioning in the ocean.

Beyond these two committee commitments, Zilkoski will continue to support the American Association for Geodetic Surveying. He plans to work with the North Carolina Society of Surveyors and stay in touch with the national society.

His goal is to help people better understand the importance of geodesy in our lives, and to understand that it's important to be outcome driven and customer focused. Sometimes one gets hung up on doing what one thinks is right and one forgets about the customer, one forgets what's important. How will the customer use this? Over the past five years, NGS has been moving toward building more outside capacity, by enhancing their models and tools, and training others.

Zilkoski believes that NGS needs to continue building that capacity by working with ESRI, NSGIC, GIAA, and other communities of users of positioning information, and he intends to do his part outside NGS, in a retirement mode, He also believes that AAGS, long focused on the narrow niche of geodetic research, would do well to reach out to users of geodetic data and information.

"It's always good to have more members," said Zilkoski. "But to grow, you have to give people a good reason to join. One group that I think we should definitely reach out to are coastal managers. They may not want to be members but even if they were merely associated with AAGS, the possibilities for collaboration would be enormous. AAGS and NGS would do well to reach out to these communities. I might be able to help with that because part of my strategy has always been to bring science and users together. [Send comments to davezilkoski@gmail.com.]

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