Standing DFIRM

An engineering and surveying firm leverages new GIS technology to streamline a labor-intensive flood insurance rate mapping process.

By Zekrollah Momeni, PE, CFM and Kendrick Logsdon, Jr., EIT

In 2003, the U.S. Department of Homeland Security Federal Emergency Management Agency (FEMA) initiated a plan to push Digital Flood Insurance Rate Map (DFIRM) production work through regional indefinite delivery/indefinite quantity (IDIQ) contracts rather than through a national contractor, as the agency had in the past. As a FEMA contractor, Dewberry was interested in strengthening its local presence in FEMA's multiple regions to support the upcoming procurements.

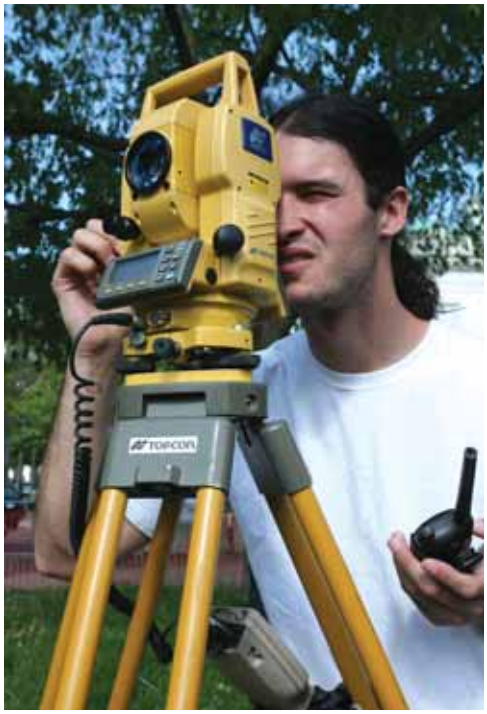
But while this sounds straightforward, it would prove no small task. A large engineering, surveying, and GIS firm headquartered in Fairfax, Virginia with offices around the country, Dewberry secured multiple contracts and faced managing $22 million in DFIRM projects with geographically dispersed teams. Over 200 Dewberry staff members in six offices, contract partners in eight offices, and multiple FEMA clients would execute the work across the United States.

To handle the challenges of increased work and decentralized staffing, Dewberry developed GeoFIRM, a GIS-based approach to hazard engineering and mapping that relies on technology and automation to produce DFIRMs out of a centralized spatial database or geodatabase. Acting as a work center where all project team members would have immediate and simultaneous editing access to all project data, GeoFIRM would enable centralized management for the geographically dispersed production teams.

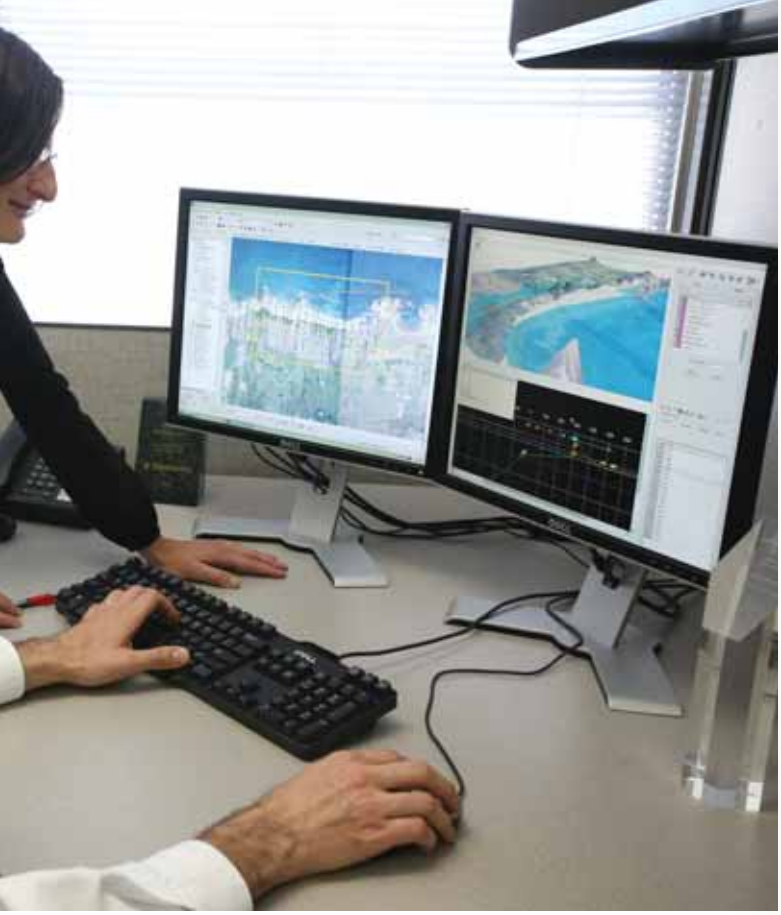
This paradigm required collaborative management components that would allow the project manager to maintain production oversight throughout the project life-cycle. The project manager would be able to:

- Initiate the project geodatabase
- Identify team members and their permissions
- Deliver consistent data to the team
- Standardize the working environment
- Maintain data integrity throughout the project life-cycle
- Track and record project milestones
- Provide for infused and on-screen quality control
- Deliver DFIRM products that meet FEMA's guidelines and specifications

▲ More than 200 geographically dispersed professionals use GeoFIRM to work simultaneously and have real-time access to project data



▲ Kris Noel, a surveyor with Dewberry, takes measurements for use in a flood insurance rate map. FEMA requires that data from technologies such as LiDAR be supplemented with traditional survey techniques.



Dewberry essentially automated the production of DFIRMs within ArcGIS/SDE 9.x software. The firm also wrote and developed automated GIS toolkits—terrain, survey, hydrology, hydraulics, and mapping for riverine and coastal projects—within ArcGIS as an enhancement to the existing product.

Over the last two years, Dewberry has helped FEMA protect the lives and property of almost 40 million people, or 13 percent of the nation, by producing more than 11,000 DFIRM panels. FEMA has recommended the system to other engineering firms producing DFIRMs and has asked the Dewberry teams to implement training.

Engineering Toolkits

As it set up the GeoFIRM system, Dewberry engineers also sought a way to automate many of the traditional hydrologic and hydraulic modeling processes used in DFIRM production. Before GeoFIRM, an engineer would move in and out of multiple programs, taking the results from one and feeding them into the next. This was a tedious and time-consuming process fraught with possible error.

The engineering toolkit works within the GeoFIRM engineering and mapping GIS platform and facilitates the modeling process automatically by managing the input and output requirements for each model or task. It is used across all studies to help engineering teams manage digital conversion, redelineation, approximation of zone A, and detailed study tasks within a project. Using the toolkit increases engineering accuracy and quality while drastically reducing cost and time to complete.

The engineering toolkit is also designed to pause at critical engineering junctures to allow staff to apply engineering judgment and quality control results. Using the toolkit, modeling decisions are stored within the single project geodatabase, and models are created on the fly and on demand. The engineering toolkit supports the following tasks, in batch or step-wise mode, that comply with FEMA's guidelines and specifications:

- Incorporate survey data
- Merge survey data with light detection and ranging (LiDAR) data
- Hydroenforce LiDAR/digital elevation model (DEM) data
- Implement terrain processing
- Create stream geometric network
- Create watersheds and pour points
- Calculate runoff curve numbers (RCN), time of concentrations (Tc), land uses (LU)
- Create hydrologic modeling system (HMS)/national flood frequency (NFF) model
- Perform hydrology (HMS, NFF)
- Create cross sections
- Match profile/floodway data table (FDT) data with cross sections
- View and modify cross section profile
- Create mapping/flow sections
- Quality check effective data against DEM data
- Create flowlines
- Create river analysis system (RAS) project files
- Create Hydrologic Engineering Center River Analysis System (HEC-RAS) model
- Perform hydraulics (GeoRAS, HEC-RAS)
- Perform datum conversion
- Create 3-D surface and geoprocess
- Delineate floodplain boundaries
- Remove islands and voids
- Smooth boundaries
- Create base flood elevations (BFEs)
- Populate DFIRM database

By infusing LiDAR technology into GeoFIRM, Dewberry can provide FEMA and other clients with state-of-the-art automated bare-earth, hydroenforcing, and quality control analysis techniques. The firm can also automate identification features such as coastal obstructions and roadway structures.

Putting Toolkits to Work

Immediately following Hurricane Katrina, Dewberry was tasked with mapping the coastlines of Mississippi and Louisiana, representing 19 counties or parishes and crossing almost 1,200 panels. GeoFIRM Coastal Tools enabled the project team to statistically analyze field survey data and high water marks. The resulting data was used with advisory base flood

▲ Following Hurricane Katrina, Dewberry used GeoFIRM coastal tools to produce more than 1,200 high-resolution flood recovery maps covering the coasts of Mississippi and Louisiana in three months

elevations to establish the inundation and debris limits and develop contours necessary to speed the recovery effort. The team's performance helped FEMA increase its post-disaster mapping service and response to the affected public and community planners.

For Westchester County, New York, Dewberry completed a 140-panel countywide DFIRM project that included over 130 miles of new detailed study and 100 miles of approximate/limited detailed study mix. The project team, geographically dispersed throughout the East Coast, collaborated using GeoFIRM to perform both engineering and mapping that met FEMA Multi-Year Flood Hazard Identification Plan (MHIP) Section 7 requirements.

In the heartland, for Crawford and Ellsworth Counties, Kansas, Dewberry engineers modeled over 1,300 miles of stream in an unprecedented seven weeks to generate Zone A's for these two counties. Using best available digital topography and automated engineering and mapping tools, GeoFIRM seamlessly weaved together multiple engineering toolkits. The completed delineations met MHIP Section 7 requirements and the submittals were auto-generated.

Merging the Traditional with New Technology

As a newer airborne laser imagery technology, LiDAR can generate mass points effectively through most vegetative cover. The mass points are processed to determine the bare earth returns, which represent ground elevations. This data is increasingly used to provide the majority of the topographical data used in DFIRM production. FEMA also requires that this data be supplemented by traditional surveys of bridges and stream bank cross-sections.

Using data collectors in the field, surveyors can capture measurements in digital form using standard nomenclature within a prescribed data dictionary. GeoFIRM then can scan through and easily read the survey data points into the GIS platform. By augmenting LiDAR technology with traditional surveying methodology, GeoFIRM seamlessly merges the data to create the basis for a higher quality DFIRM.

With this combination of technologies implemented by disparate people ranging from GIS practitioners to surveyors to government officials, all spread cross the country, GeoFIRM can produce quality flood insurance rate maps as fast as possible. As a result, we can better respond to flood events and prepare for future ones.

Zekrollah Momeni, PE, CFM, *serves as an engineering director on Dewberry's National Flood Insurance Program contract with FEMA. He supervises a staff of engineers and hydrographers in the preparation of Flood Insurance Studies for various communities nationwide. Momeni oversaw the firm-wide implementation of GeoFIRM.*

Kendrick Logsdon, Jr., EIT, *is Dewberry's director of technology integration within the Hazard Engineering Resources Department. Logsdon served as project manager for the GeoFIRM implementation. He also leads an ArcGIS development team that supports multiple departments' project managers and project teams.*

GeoFIRM's collaborative work environment is designed to produce DFIRM products that meet FEMA's publication specifications. Highlights of GeoFIRM's management tools include:

Project Setup Database is used to coordinate and communicate team setup, database and dataset settings, and data life-cycle issues across the team. The project manager, project team, database team, development team, and IT use this tool as they work on the project together.

ArcSDE is the gateway where all GIS project data is stored and versioned to maintain data integrity. All who access the project immediately know edits across the firm. A FIRM panel layer is used to determine work responsibilities; topology rules are used to enforce correct construction and attribution; and toolkits are used to streamline engineering and map production.

DEM is used to catalog, prioritize, quality check, and deliver consistent elevation data across the project team. The toolkit ensures that the data is prepared correctly once and then reused throughout the project, almost eliminating data prep error and rework.

Remote project members can securely access project data via the Web. Quality control can be performed on-screen with results immediately published to the team. Clients can also access projects to view ongoing progress.