# GIS – The Bridge Into the Twenty-First Century

*By Lieutenant Colonel Tim Rensema, Mr. Craig Erickson, and Captain Steve Herda*

*"Terrain visualization is the responsibility of commanders and staffs across the spectrum of today's Army. To effectively see the impact that terrain has on units conducting and supporting military operations, all commanders and staffs must be aware of the effects of terrain. The terrain expert is the engineer."*

*Major General Robert B. Flowers*
*Commandant, U.S. Army Engineer School*

It is the responsibility of engineers to advise leaders of the effects that terrain may have on unit operations. The U.S. Army Engineer School offers valuable training in understanding these effects and the tools that are available to analyze terrain. Among these tools is the PC-based TerraBase II, version 3, which performs terrain-evaluation functions such as line-of-sight displays, weapons fans, slopes, oblique and perspective views, fly-throughs, sunlight/moonlight data, and distance measurements. Army topographic units have the Digital Topographic Support System (DTSS). Engineer terrain-analysis teams (military occupational specialty 81T) use the DTSS to provide Geospatial Information and Services (GIS) support. The terrain teams are the critical support element for terrain complex analysis in support of the military decision-making process (MDMP). The terrain teams are currently allocated down to each division in the Army. In the digital force, the DTSS has a much-expanded role that includes digital terrain data management and dissemination. In the expanded role, terrain teams and equipment are allocated to each maneuver brigade.

High-end GIS tools like the DTSS combine remotely sensed data, conventional ground surveys, and cartography on various computer-based systems. The Army's GIS, which continues to evolve, relates real-world positional data from the battlefield to positions on a known grid reference so that attributes such as slope, vegetation, and bridge capacity may be analyzed. The GIS databases can be accessed, manipulated, and transformed in an interactive process that allows commanders, decision makers, and planners to explore the battlefield and obtain the range of consequences of a plan before mistakes are irrevocably made.

For the majority of units in the Army Reserve Component, access to the benefits of GIS may seem out of reach. However, this capability to move from acetate and grease pencils to a computer-maintained, digital spatial-management system is within our grasp today.

## Advantages

The potential advantages of the GIS go beyond just viewing terrain information. By using spatial data from a variety of sources, GIS programs can reduce analysis time, simplify complex decisions, and reduce the time on the objective for reconnaissance teams. GIS data layers afford additional functionality in expediting various decision matrixes required by staff elements. As an example, these programs could support obstacle-plan development, route reconnaissance, force protection, and other tactical operations.

Another benefit of the GIS is its ability to evaluate all available data (including elevation), which increases the potential to provide spatial decision criterion to commanders. Additional data can be incorporated into the GIS database to allow more accurate analysis at tactical operations centers.

Integrating administrative data layers with the tactical requirements of maneuver commanders is a concept worth testing. The Integrated Training Area Management (ITAM) program has already established an experienced operator base with the equipment to apply GIS to environmental, facility, and training-site management. Most installations already have ArcView® to analyze data layers for their training areas. Through ITAM, active and reserve installations can provide spatial-analysis systems to maneuver commanders wanting to expand their battlefield-analysis capabilities.

## Testing the System

The Minnesota Army National Guard at Camp Ripley has one of the most advanced GIS databases in the Army National Guard. Personnel there have created more than 75 data layers to better support training-site personnel. During its 1999 annual training at Camp Ripley, the 164th Engineer Battalion (C)(M) from Minot, North Dakota, used a Mississippi River crossing operation conducted by its 957th Engineer Company (Assault Float Bridge) from Bismarck, North Dakota, to develop and test the concept of using administrative GIS data layers to support tactical operations. Camp Ripley's hardware, software, and personnel were used to develop this exercise. Using Field Manual (FM) 90-13, *River-Crossing Operations*, as a reference, battalion personnel identified data necessary to determine the best crossing sites.

Pertinent evaluation information for river crossings includes slopes, soil types, river width and depth, current velocity, vegetation cover, obstacles, and the enemy situation.

Working with the Minnesota Army National Guard GIS staff, 164th personnel reviewed existing data layers to determine the support data that was available for developing a river-crossing scenario, using the analytical ArcView® capabilities with the spatial-analyst extension. We found that most of the evaluation information needed was available within existing data layers obtained through remote sensing. While the capability to determine water depth and current velocity is currently not available, software is constantly being improved to obtain these variables based on factors such as drainage basins, slope, and discharge of the river.

Figure 1 shows a layout for the river-crossing exercise that was produced by using the GIS. It depicts the corridor considered for river-crossing site analysis—a 3-kilometer buffer of the main river channel adjacent to Camp Ripley training sites. This buffer defines the area to which analysis programs will be limited. While the entire area could undergo analysis, this buffer area reduces analysis time and represents all possible crossing sites.

The second analysis phase involved developing crossing-site evaluation criterion. We applied a suitability analysis method that combined slope, taken from a digital elevation model (DEM), and soil texture data to evaluate areas along the entrance and exit banks that met FM 90-13 requirements. Figure 2 shows the terrain-rating layer, the resultant data layer of this analysis.

From the terrain-rating data layer, the best river-crossing sites were visually identified. Other potential analysis requirements for site selection were identified also, such as river width, road networks, cover and concealment, and salients in the river course.

River width was taken from satellite data provided by the National Imagery Mapping Agency. Road networks, which define how well a site can support a maneuver-unit crossing, and cover and crossing area. Figure 3, page 36, depicts the area of operation and captures all of this data, with the exception of the weather, and identifies what we determined to be the best river-crossing site. Analyzing data layers using the GIS may never completely replace the need for ground reconnaissance, but it can reduce the time spent at the site.

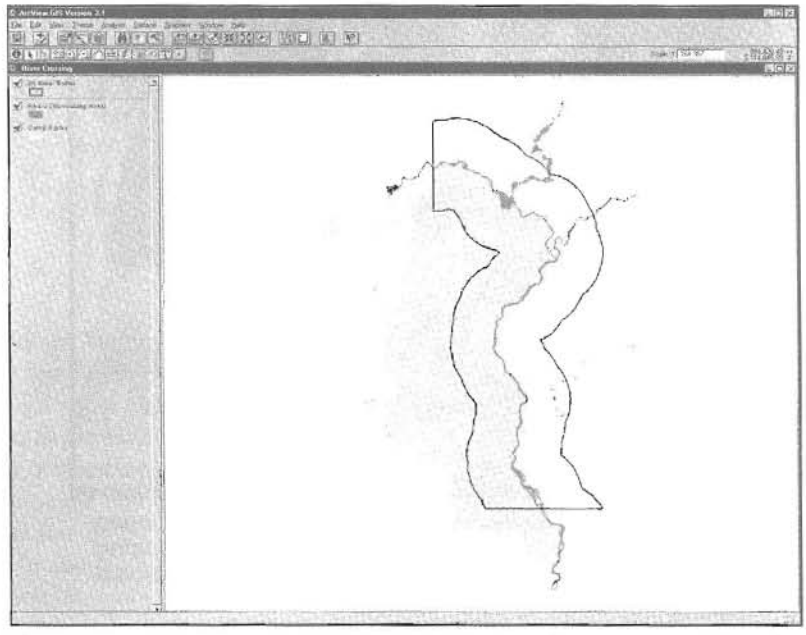

**Figure 1. The corridor outlined in black depicts the area considered for river-crossing site analysis; this area is a 3-kilometer buffer of the main river channels adjacent to Camp Riley training lands.**

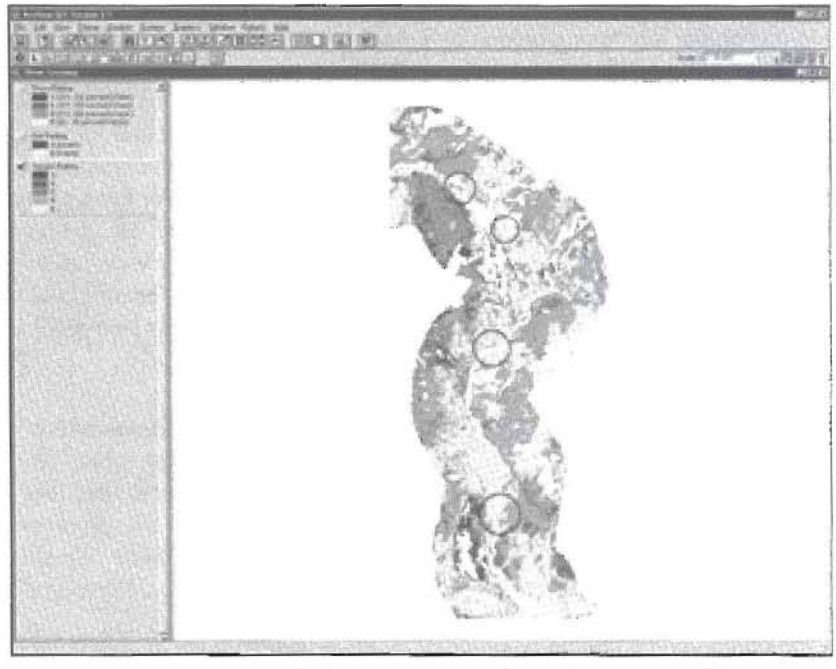

**Figure 2: This terrain-rating layer, created from slope and soil-texture data, was used to evaluate the area along the entrance and exit banks that met slope and soil requirements. The circled areas were considered potential crossing sites.**

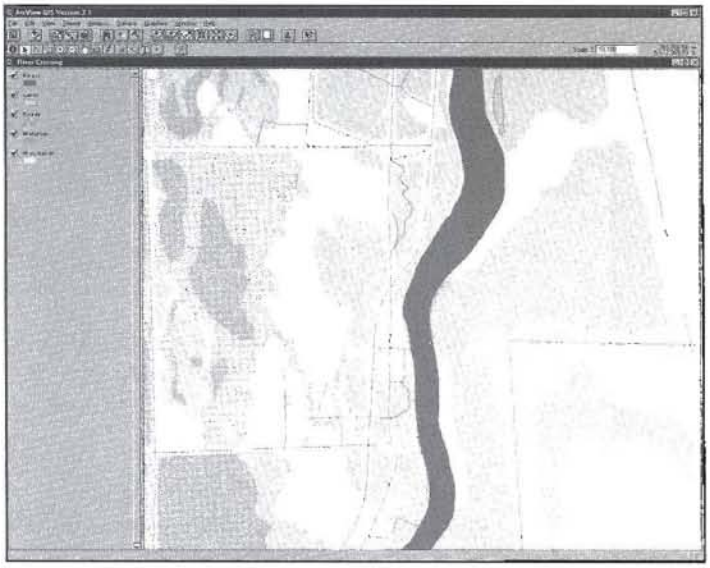

**Figure 3. Road networks, lakes, rivers, wetlands, and woodlands were used to individually evaluate potential crossing sites. This is a close-up view of the southernmost potential crossing site.**

Other helpful information used in determining risks was obtained through DEMs. This included line-of-site analysis, which enabled us to determine where the bridge site was exposed to enemy direct fire and to identify enemy positions in defilade on the opposite shore. Once enemy emplacements of artillery and mortar were known, the artillery range could be overlaid on the project location using the GIS program. We used this tool to determine whether our crossing site came under indirect fire from known enemy divisional and regimental artillery groups. Our selected site was out of the effective range of the regimental artillery group but within the divisional artillery group range. Our friendly fire support also could have been included as a data layer to determine the direct- and indirect-fire-support coverage we could expect.

Especially crucial to the success of this test was having the proper requirements in place, such as a well-defined operational scope, appropriate hardware and software, a GIS-competent operator, and a resident database.

## Conclusion

The Deputy Chief of Staff for Operations has organized regional support centers to provide a consistent database for training-site management. It contains "core" data layers that are also conducive to tactical operations. With the addition of layers and modifications provided by analyses of other units, many different tactical scenarios can be "played" using existing GIS operations. TerraBase II provides terrain-evaluation tools based on elevation data, digital imagery data, and digital map data. For more complex analysis requirements, an interactive GIS program like ArcView© can help maneuver commanders benefit from GIS even if the DTSS has not been fielded to their units.

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1943, the peak year of training at Fort Leonard Wood. The interior of one of each type of building has been restored. Also, the interior of one barracks building has been restored to interpret basic training barracks in 1967. This Cold War interpretation dramatically illustrates the adaptive reuse of World War II temporary buildings to support the training boom of the Vietnam conflict.

Other restored buildings in the complex house a variety of exhibits supporting the history of Fort Leonard Wood. One restored dayroom has a display dealing with the life and career of MG Leonard Wood, the installation's namesake. In another restored barracks is an interpretation of the German and Italian prisoner-of-war camp, which operated at Fort Leonard Wood from 1943 to 1946. The most recent addition to this area is a historic chapel. By preserving this collection of World War II buildings, Fort Leonard Wood has created a time capsule of the history of the training experience from 1941 to the present.

## Regimental Store

Located in the lobby of the museum, the Regimental Store (which is operated by the Army Engineer Association) offers a unique line of gifts. Merchandise primarily features engineer regimental crests and the engineer castle. Proceeds from the store help support the adjacent engineer Regimental Room. Steeped in engineer history, the Regimental Room proudly displays colors and special plaques of deactivated engineer units.

Come and visit your Engineer Museum.

*Mr. Combs is the Engineer Museum curator.*

*Located at the corner of South Dakota and Nebraska Avenues, the museum is open to the public, free of charge, from 1000 to 1600, Monday through Saturday. The telephone number is (573) 596-0780 (DSN 581-0780), the e-mail address is combsk@wood.army.mil, and the web site is www.wood.army.mil/museum.*