Geographical Information Systems in EMS

By William E. Ott

If you aren't familiar with Geographical Information Systems (GIS), you should take a look at what GIS can offer you as an EMS manager. GIS, when combined with a database that stores response information, can show you in a matter of seconds things that are hard to conceptualize. *Example:* A GIS-linked system can show you response patterns that would otherwise take hours of time for someone placing push pins into a paper map.

Infinite modeling possibilities exist, but in EMS, GIS systems typically illustrate things like response locations by unit, response times by unit, comparison of response times for a given unit for different hours of the day or different days of the week or all responses over a certain time parameter.

The development of modern GIS has paralleled that of the PC. As PCs have become more powerful, so has the ability to produce useful mapping tools. GIS software is based on initial surveyed locations, typically road intersections, buildings or other landmarks. Once a number of surveyed locations have been entered, the software can, in the simplest of terms, connect the dots. Street centerline files are the base layer of GIS coordinates used by public safety agencies as they show the center or 'crown' of every street and road in a given area. GIS departments nationwide are now making the street

centerline files extremely accurate using GPS surveying techniques (actually driving all the roads and recording the exact location of the road every few meters). Detailed maps containing the majority of U.S. roads and their topography are now available.

The standard in the GIS business is a product called ArcInfo from ESRI. ESRI was founded in 1969 as Environmental Systems Research Institute and functioned as a land use analysis company. In 1981 ESRI released Arc/Info which was the first PC based GIS product. Most people knowledgeable in the subject consider ESRI to be the founder of the GIS industry. ArcInfo allows you to build maps and view them in layers (street centerlines, sewers, water mains, flood zones, EMS districts, fire districts, etc.). However, the map layer creation process requires skilled GIS technicians.

ESRI also makes a GIS viewing tool called ArcView. Once the layers exist, average users can effectively use ArcView or other GIS viewers in conjunction with their data. The layers may be viewed in any manner. A typical EMS setting would include the streets, then EMS districts and maybe EMS station locations. In an EMS setting, we need a target, if you will, something definitive that the GIS engine can use to actually plot the locations of responses or events. Typically, this will be a numbered street address or a GPS coordinate. With one or both of these, the GIS software can place a symbol on the map at that position.

Microsoft has a GIS product called MapPoint that makes data modeling easier than with most GIS products. Naturally, there are tradeoffs in the customization that can be performed, but MapPoint is typically adequate for EMS response and location modeling and is easy to use and automate in conjunction with Microsoft programming languages and the Microsoft SQL server database engine. MapPoint contains the entire U.S. highway and road system, current as of 2001. Quarterly updates add new roads to the database. MapPoint also displays the speed limits and road topography. Although not as powerful as the ESRI tools, MapPoint works well for public safety response modeling.

I've produced some sample GIS maps featuring Wilson County, N.C., data (see Figures 1–3). For the curious, Wilson County is a rural area located in east-central North Carolina, approximately 60 miles east of Raleigh. Interstate 95 runs north/south through the western edge of the county. Wilson is the county's only large population center.

The first GIS plot from Wilson County EMS shows all EMS responses from July 15, 2002, through Jan. 15, 2003. Each color represents a different unit. This gives you a general sense of where each unit responded, as well as the overall placement of the total response volume. It's obvious to even the casual observer that the bulk of responses occurred in the city of Wilson (center of map).

The second map is a zoomed image of Wilson, showing street level detail and response placement of the cluster of responses in the center of the first map.

The third map shows predicted driving times from the Wilson County EMS headquarters in various colors. The headquarters is in the small blue area at the center of the plot. MapPoint has been programmed with the speed limits for most sections of road and it makes a predictive analysis of how long it will take to drive a certain distance based on speed limit, stoplights and average traffic. The more powerful Network Analysis tool from ESRI can add into the equation time of day, day of the week and traffic flow (as in cars per minute through an intersection). However, this requires the requisite programming knowledge, as well as the proper data to feed into the system to make these predictions. Except for the most complicated scenarios, MapPoint appears to do adequate work, as long as you understand the process it uses to produce the predictions.

MapPoint took less than 15 seconds to produce these maps from the data stored in a SQL server. Having the crews enter clean addresses into the data system is always the biggest problem in any plotting situation. Inevitably, there will be some addresses that have to be manually cleaned up to get an accurate reading. Enforcing entry rules via validations in the data entry process really helps with this but doesn’t eliminate the problem entirely.

My colleague Jeff Lindsey recently wrote about GPS gear in EMS in the Hands On column. GPS is an ideal and complementary solution for the addressing problem. If we can capture the exact coordinates of a response location via GPS, then we have no address clean-up issues. With GPS coordinates, MapPoint could generate a map plot in half the time. If you only need to create a few maps a few times a year, it isn't an issue, but if you want to create maps for every hour of every day, the processing time does become an issue and GPS accuracy will pay for itself in the time savings vs. the time spent cleaning up addresses and the extra map generation time.

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