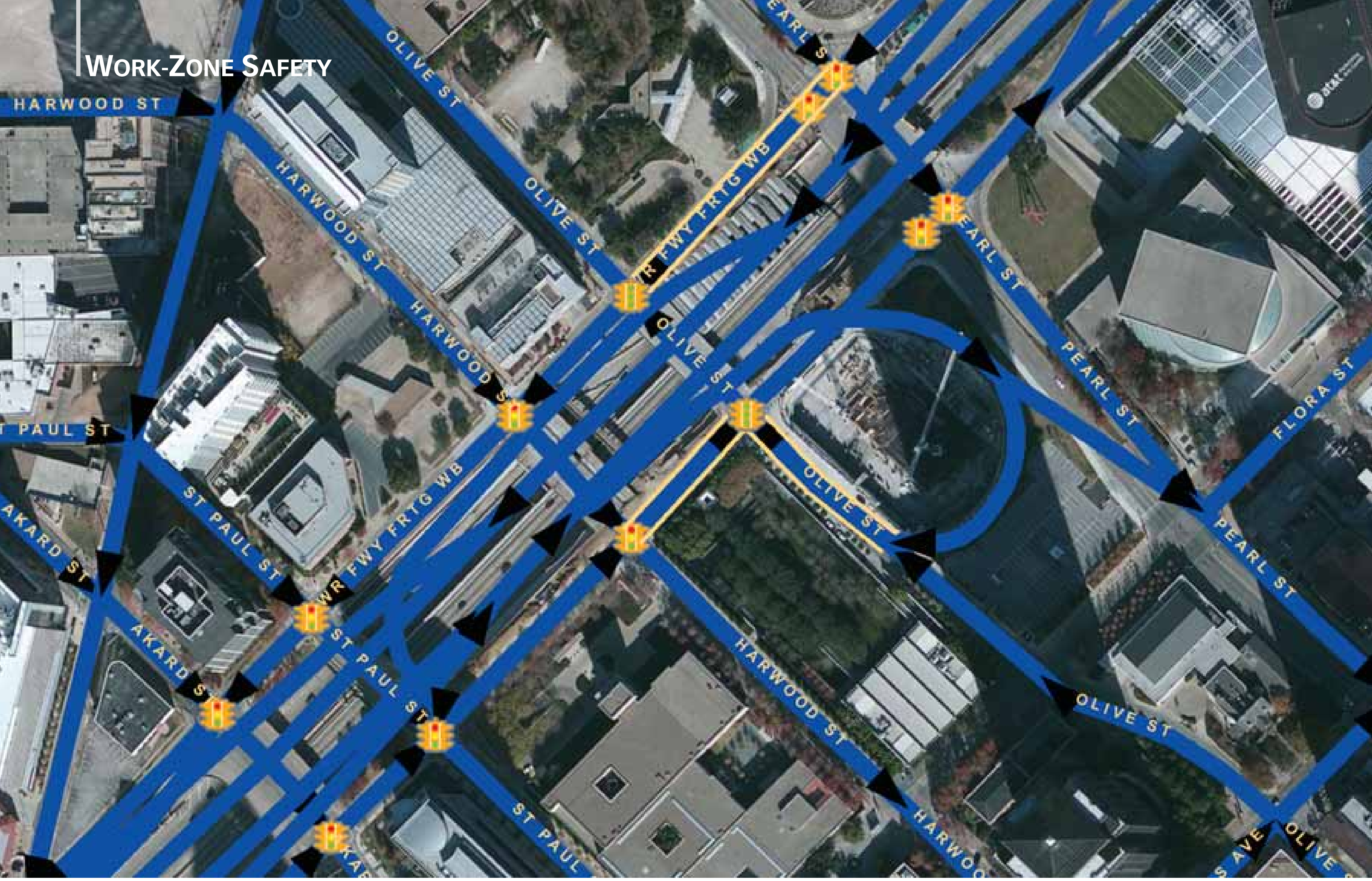

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A proper platform

GIS-based tool for work zones makes sense

According to the FHWA, there were 87,606 work-zone crashes in 2010 that led to 576 fatalities.

That number translates to one fatality in a work zone every 15 hours. Research into traffic safety has found that demand-management programs used to reduce volumes through construction sites have a high potential to decrease the number of crashes. Providing practitioners with higher-quality data and more powerful tools to analyze traffic impacts of work zones may make our streets safer.

The motivation behind a geographic information systems (GIS)-based traffic-control planning tool was the need to organize, visualize and manipulate data in a single package. The intention is that this tool provides construction personnel with a single interactive platform to quickly make informed decisions about proposed traffic-control plans (TCPs). The motivation behind developing a TCP is to provide a controlled construction zone that allows travelers efficient and safe movement through the affected corridor. A detailed TCP should consider the impacts to traffic volumes, which, if minimized through the work zone, may help limit the number of incidents. Safety of work-zone personnel as well as highway users is a primary consideration during traffic-control planning.

Building a temporary traffic-control plan requires information about the roadway of interest. These necessary data include

Fact Finder

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geometric characteristics such as lane widths, shoulder widths, length of the construction zone, as well as traffic information describing peak-hour volumes, speeds and numbers of lanes in each direction. The power of this GIS tool is the geodatabase structure that organizes information about the region around a work zone with an interface that enables the user to easily evaluate, revise and tune the TCP. In short, this GIS tool enables better decision-making by helping users easily maximize safety and minimize costs.

The most recent dataset available is most appropriate for this application, but forecasted volumes for future network conditions also could be used for traffic-control planning calculations relevant to long-term projects. Traffic-assignment models provide the greatest coverage of network-demand estimation and give the tool greater versatility compared with other methods of traffic simulation.

ArcGIS was used for the development of the database and calculation tools for this project. ModelBuilder is a development platform that combines predefined tool sets in ArcGIS, much like a high-level programming language. "ArcObjects" refers to the set of functions and tools that are predefined in ArcGIS. Since ArcObjects is the foundation of the ArcGIS software it will most likely continue to be a standard for the ArcGIS package, which will provide some freedom for future user development of the tool as well as stability through changes to the GIS software.

Another advantage of the ModelBuilder system is that it is easy to document and recreate if alterations to the tool sets are made. Considerations also were made for importing new transportation datasets and what it will take to make them compatible with the tool.

Traffic calculations desired for this project focused on capacity changes due to construction projects. Defining capacity for freeway segments is a rather straightforward calculation, but a larger effort is required for signalized intersections. The 2010 Highway Capacity Manual (HCM) signalized intersection procedure estimates capacity as the product of "maximum flow per hour of green time" and "the fraction of time the signal is green." Ideally, the signal cycle length and green time would be available to determine green time to cycle-length ratio.

Due to the size of the dataset and limitations in acquiring data, signal timings are not often available everywhere within an MPO network. Instead, the ratio of the critical lane volume to the sum of the critical lane volumes can be used to approximate "the fraction of time the signal is green." The volumes that are used for this approximation are the demand outputs from the MPO's transportation-planning model.

The primary inputs for the tool are two datasets: the MPO static traffic-assignment demand output from their in-house four-step planning model and the traffic-signal-location inventory that was geocoded by the Center for Transportation Research at the University of Texas at Austin. The MPO demand shapefile is made up of polylines representing the roadway network for the region. The traffic signals are represented as intersection points in the geodatabase file.

This traffic-control planning tool allows the user to locate and select an intersection of interest. The interface for the model is a dialogue box with default parameters that may be adjusted by the user. These parameters include cycle length, time of day, number of lanes and volume. The number of lanes and volume can be adjusted for each intersection leg. If the number of lanes or volume is not manually modified, then the location of the features will be used to automatically populate these values from the demand data set.

Lane volumes are calculated by dividing each total approach volume by the number of lanes. The lane volumes are used for the sum of critical lane volumes in order to calculate "the fraction of time the signal is green" that is a surrogate for the green times to cycle-length ratios. Using approximations for the prevailing-condition factors and the number of lanes, the saturation flow rate is calculated. Finally, the capacity is calculated for each leg of the intersection, and the corresponding volume-to-capacity ratios are determined.

> **"With enhancements made to this tool, multiple traffic-control scenarios may be analyzed.**

The start of the emerge

GIS software has emerged as a powerful tool for solving problems in civil engineering. The field of transportation is no exception to this adaptation of geographically referenced data. In fact, it is particularly important that planners consider the topology of a transportation system when performing any analysis, because connectivity and location of network elements influence traveler behavior.

A major issue in the integration of GIS in the transportation industry is standardization of the data and platforms that are used. A wide variety of institutions have begun accumulating network data in their own way, which makes it difficult for different institutions to work synergistically together. Future development of this GIS traffic-control tool will address some of these problems by encouraging a standard that enhances utility, prevents redundancy and, in turn, allows for greater interoperability.

Two in one

This GIS tool was created using a metropolitan planning organization (MPO) network because it contains the most up-to-date relevant network attributes. Typically, MPOs provide the best GIS data available, because MPOs create their data sets with the intention of using them for transportation modeling.

Users then have the opportunity to compare different TCPs using this static data. Additional functionality is being added to the tool where updated demands may be produced to reflect real-world responses to the proposed TCP.

Dynamic fashion

A more thorough investigation into a construction project's impacts could be accomplished through the use of a traffic-assignment tool with a more detailed level of traffic modeling. Dynamic traffic assignment (DTA) offers many new capabilities in the realm of traffic-network analysis. In particular, DTA can capture the effects of time-varying traffic flow, which are lost in traditional static traffic-assignment models.

The use of DTA to determine localized rerouting has the potential to provide data that was previously unavailable. Using different methods of incident management in current DTA software can help to predict changes created by TCP implementations of detours, temporary capacity changes and advance-warning systems.

One major issue with DTA is the number of compute cycles required to analyze a large network. To address this, techniques have been developed for use with static assignment to examine a portion of a larger network, or subnetwork. These concepts are being adapted for use with DTA to drastically reduce the computation time. This could ideally be applied to a regional network to create a subnetwork of interest given a certain construction location. Once the subnetwork has been developed, then a variety of scenarios could be efficiently tested to predict impacts of proposed traffic control.

Subnetwork analysis allows the user to maintain the integrity of the entire network while reducing the amount of time required to run scenarios. Statistical models have been used to determine the balance between large and small subnetworks.

Ultimately, the subnetwork recommendation feature being added to this sketch planning tool may allow the user to interactively predict changes in work-zone traffic demand as alternative traffic-control features are examined. This GIS tool will aid the user in choosing the size of subnetwork by suggesting an optimal size and the expected error associated with its use relative to the full network. The DTA subnetwork traffic volumes can then replace the data for the corresponding subarea in the GIS traffic-control planning tool. By updating this database with new volumes produced using DTA reflecting the effects of the work-zone traffic-control scenario, the realism of the evaluation process can be improved.

With the enhancements made to this tool, multiple traffic-control scenarios may be analyzed to determine the best way to limit traffic in work zones. This project demonstrates the power of GIS to help solve transportation problems through consolidating data and automating calculations. The overall goal is to improve traffic-engineering decisions to minimize user costs associated with roadway-construction projects and increase the safety of work zones. **R&B**

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