30-Erker

Streamlining the MPO Forecast Communication Process Using Advanced GIS Tools

By:
Vladimir Livshits, Maricopa Association of Governments
Matt Erker, Jacobs Carter Burgess
Brian Hoeschen, Jacobs Carter Burgess

PROBLEM DEFINITION AND INPUT INFORMATION

The Maricopa Association of Governments (MAG) is the Council of Governments serving the Greater Phoenix Metropolitan area. MAG is also the designated Metropolitan Planning Organization (MPO) for regional planning in the Maricopa County region. One of MAG's core planning activities involves regular reviews and updates of the Regional Transportation Plan (RTP), Transportation Improvement Program (TIP) and various life cycle programs for different types of transportation-related facilities (e.g. roads, bus routes, transit, etc.). These reviews and updates require extensive interaction, communication and data collection from the numerous jurisdictions and agencies (MAG Member Agencies). The primary information communicated between MAG and the Member Agencies is the Member Agencies planned transportation improvement projects. Before these transportation improvement projects can be included in the TIP, RTP or life cycle programs, they must be compiled by MAG and analyzed using complex numerical travel demand and air quality models. These numerical models require each potential project to be encoded into a modeling network that is specific to the year in which the project will be built.

The process of reviewing and updating transportation programs includes numerous challenges that create opportunities for improvement. The first area of potential improvement is the acquisition and management of project information from different jurisdictions. The project information provided by the Member Agencies often does not provide details sufficient to support accurate representation within the numerical models. In addition, the data might include errors that impact the results. The second area of potential improvement is related to how the future project data is integrated into the numerical models and ensuring any changes made by the Member Agencies are reflected in the model. The third area of potential improvement relates to possible business process improvements which could be realized by providing a common platform for transferring and communicating the extensive data sets.

SOLUTION

The first step in developing the solution was to perform the business process mapping (BPM). The primary objective of the BPM is to develop an understanding of the current business process and evaluate how it can be improved using new facilitative tools and new processes. The BPM is performed by interviewing key staff from various departments and documenting their primary business activities, including data used as input for their process, data produced from their process and all of the steps in between input and output. In addition to detailed written documentation of the business processes, the products from the BPM include flowcharts illustrating each step within the overall business process.

One of the key conclusions in the business process analysis and mapping was the predominance of data, especially data related to planned transportation improvement projects, and the difficulty of communicating that data from the Member Agencies, to MAG and all of the departments within MAG. The data communication was made even more difficult because the data exhibit the following qualities:

- Complexity – The transportation improvement data contains numerous complexities that make it difficult to manage. First, the data are geographic in nature. Each project has a spatial location and impacts specific physical locations and structures. The geographic location and the nature of the impacts are critical to correctly modeling the effect of the project on the overall system. Second, the data are multi-dimensional and relational. For example, one project can be included in numerous TIP and RTP plans and it is important to identify and track how this project has changed over time. As another example, one project has multiple funding sources used to pay for the various project phases.

- Variability – The transportation improvement data change over time as the various Member Agencies revise their own capital improvement plans. In addition, the rate of change tends to increase as the deadline for submitting the RTP and TIP nears. MAG needed a platform for tracking these changes to projects and ensuring that the most recent project data were being used in their analyses.

- Sensitivity – The RTP and TIP are large documents that specify which capital improvement projects are funded in the following years. It is important to retain the project definitions entered by the Member Agencies and ensure they are not accidently changed through the process. The number of people involved in preparing the RTP and TIP documents requires a secure process to be used to manage the data.

The factors listed above led the project team to the conclusion that significant advantages could be realized by providing a common platform for collecting, managing and communicating project-related data. This platform should be GIS-based because the project definitions are inherently geographic in nature. This platform should be available to all people who are involved in the process including MAG staff, member agencies, and ADOT staff but should include security provisions for ensuring data integrity. This GIS-based framework provides a link between the definition of capital improvement projects to their evaluation in the TIP and RTP to their presentation to the public. This GIS-based platform must have the appropriate interfaces to support each business process step without extensive manual data manipulation. This GIS-based framework provides a consistent platform for communication between all steps in the business process.

Project Data Capture and Visualization

The first part of the solution was to build a computer-based tool that Member Agencies could use to enter information about capital improvement projects. The project team chose to develop a tool that communicates through the internet back to MAG's GIS servers and allows the member agencies to enter the geographic and tabular information about their projects. The project definitions from the Member Agencies are saved in the GIS database in a simple geographic representation instead of the complex representation that supports modeling and other analyses. During design, the project team decided to store this simplified project description in order to reduce the work required by the Member Agencies. A latter section of this paper describes the process for converting the simplified project description into the complex GIS-based description required for analysis. Although simplified, this project description includes all of the information necessary to accurately represent the project in the numerical model, including project phasing, funding and inclusion in the planning documents.

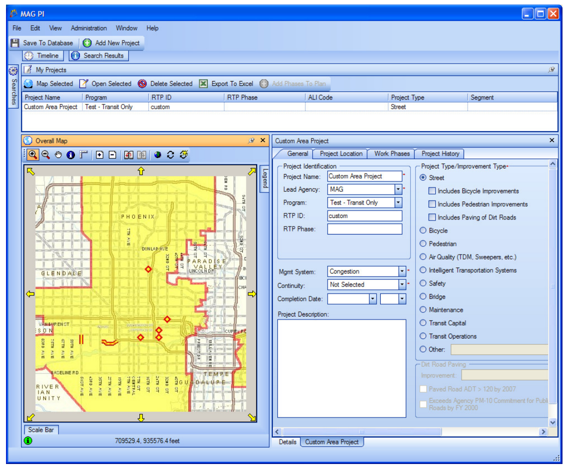

Figure 1 Project Data Entry Tool Screenshot

Linear Reference Based GIS

The project team designed the GIS database so that it accurately stores the project descriptions and other base layers but minimizes the required regular maintenance associated with the database. One of the key tenets of this design was the use of linear referencing. Linear referencing, similar to stationing used in roadway design, is a geographic location of an attribute based on a relative position along a linear path. In this

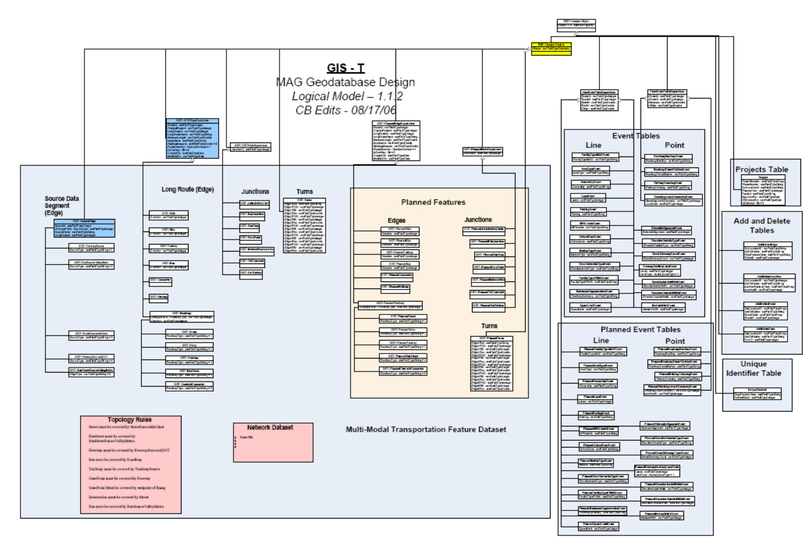

Figure 2 Geodatabase Design

definition the linear path is a *route* and contains measure values and the attribute is an *event* which can be a point event (one measure) or line event (begin and end measures). Events are stored in tables and have an inherent relationship to the route and the route's geometry; the route contains the geometry and an event cannot exist without the route. Attributes stored within a linear feature, such as a model link, require the line to be split or segmented to make a change to an attribute. If a line contains many attributes and those attributes change frequently, it would result in many small segments. Alternatively, if each attribute were stored as a linear event along the line, an attribute change would only result in a new event record independent of other attributes and underlying route geometry; a concept called *dynamic segmentation*. Using dynamic segmentation, multiple attributes can exist independent from each other or merged together to create the effect of smaller segmentation.

The project definitions from the Member Agencies are saved in the GIS database in a simple geographic representation instead of the complex representation that can support modeling and other analyses. MAG staff manually convert the simple project definitions into the complex representations using customized ArcGIS editing tools which facilitate tracking which projects require conversion and working with the linear reference system. Current state of the practice multi-year networks contain attributes within the network objects, such as links and nodes. A change to the network geometry or attribute requires adding and/or removing links and nodes. The multi-year attributes such as add year, update year, and delete year stored in each link allow the model network to change dynamically based on schedule changes for projects and when the project should be modeled. Adding a new roadway or extend a roadway in 2020 requires that all new links and nodes contain an add year attribute equal to 2020. Removing a roadway or portion of a roadway requires a delete year attribute equal to the year it is removed. Realigning a roadway would require a delete year attribute value to remove existing links and nodes plus new links and nodes with an add year attribute value to represent the new alignment. Once the projects are represented within the GIS database in the correct form, they can be compiled and used in other analyses.

TransCAD Interface

As described above, one of MAG's primary functions is to evaluate transportation improvement projects and how they will affect future travel patterns for various future time periods. The GIS-T manages all of the data related needed in the travel demand model. However, the travel demand model requires input data in a format based on links and nodes, that isn't directly exported from the GIS-T. The project team developed a four-step process for converting the GIS-T data into the link node format required for input into the travel demand model. This export process allows MAG to select a future model year and then automatically creates the model input files of the transportation network at that time period.

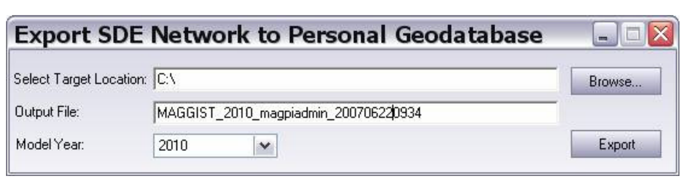

Figure 3 Export to TransCAD Tool Screenshot

CONCLUSIONS

The first phase of MAG's GIS-T implementation has proven the chosen approach to be a feasible and efficient way of managing transportation infrastructure data. The primary benefits of developing a linear reference based GIS network data management system include:

- Having a consistent, GIS-based data management system for transportation modeling and transportation planning (e.g., tracking projects in the TIP and RTP) provides cost savings and reduces errors,
- Automation of the main time consuming and labor intensive planning business processes, mainly by facilitating transfer of the projects in the transportation models,
- Improved visualization of transportation projects,
- Efficiency of the transportation improvements analysis, and
- Decreased effort for maintaining the transportation network, especially for ensuring consistency of different year networks.

The main project challenges are related to project scoping and phasing, coordinating with stakeholders and clearly defining the project technical tasks and solution. It was difficult to define the final product because much of the project involved combining innovative technologies into a coherent solution. Future phases are planned to include a number of tasks focused on improving and implementing the system beyond the scope of this pilot project.