Transportation GIS Trends

ESRI • Fall 2009

GIS for Transportation

Enabling Web Access to Highway Data and Images

By Brian Bieber and Albert Sarvis

North Dakota has more miles of road per capita than any state in the nation. Despite the state's very large road network, it has a small population base to support it. To manage this issue, officials at the North Dakota Department of Transportation (NDDOT) are continually looking for tools to help them better manage assets and utilize current infrastructure. For NDDOT, access to timely and accurate data and distribution of information for daily operations are crucial elements for the organization.

Understanding the inherent benefits of sharing and integrating enterprise transportation information, NDDOT initiated research into industry trends and best practices for expanding and improving the use of its enterprise geospatial data to benefit workflows throughout various departments. Through its research, NDDOT determined

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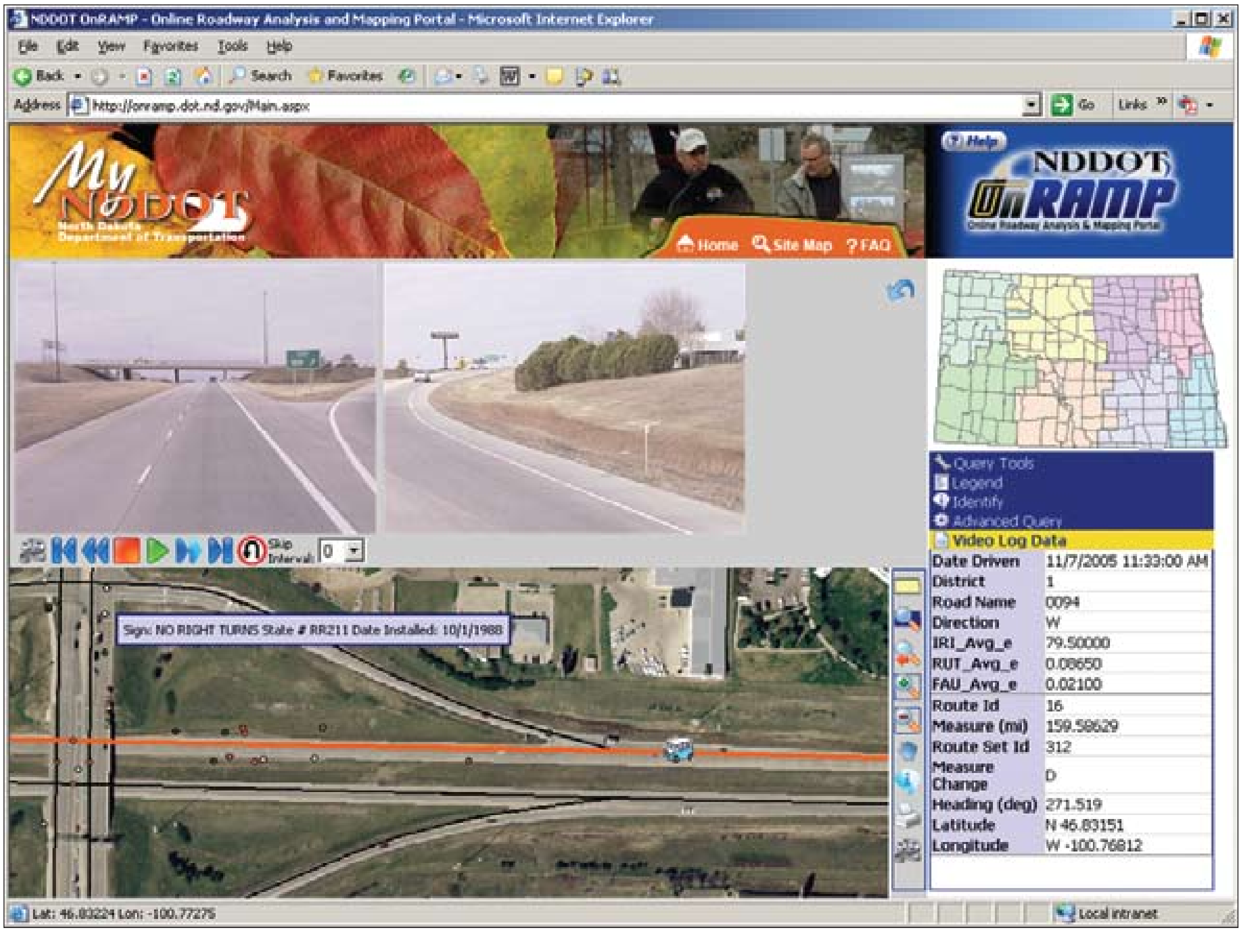
In This Issue



North Dakota DOT's Online Roadway Analysis and Mapping Portal (OnRAMP) is a GIS-enabled enterprise Web-based portal that gives DOT personnel visual images of the state's highway system, in addition to many other road management tools.

ESRI on the Road

ACI North America
October 11–14, 2009
Austin, Texas USA

AAPA Annual Conference
October 25–29, 2009
Galveston, Texas USA

ACI International World Congress
November 2–4, 2009
Kuala Lumpur, Malaysia

Transcomp
November 15–17, 2009
Anaheim, California USA

GIS in Transit Conference:
The Route to Success in Transit GIS
November 16–18, 2009
St. Petersburg, Florida USA

Gulf Traffic
December 6–8, 2009
Dubai, UAE

Talking Transportation

Terry Bills
ESRI Industry Manager
Transportation and Logistics

Your GIS Success Builds a Strong Community

Welcome to the first issue of *Transportation GIS Trends*. This publication delivers the latest developments and best practices in GIS technology as well as news and information relevant to the transportation community. Transportation professionals face challenges that are significant and growing and include a need to

- Provide comprehensive information systems that effectively guide decision making about using scarce public resources.
- Ensure the safety of our transportation systems.
- Monitor the effectiveness of our transportation policies and investments.

Transportation GIS Trends will describe how GIS technology can help address these challenges. The proof is in the successful solutions developed by you, our software users. We at ESRI never cease to be amazed by your enormous creativity as, worldwide, you design solutions to these challenges in new and important ways. As we share information on how GIS can help you make better decisions and more effectively manage public and private investments, we will draw examples from your novel and productive solutions in practice.

This newsletter seeks to incorporate the international community of transportation professionals. That is because the issues for security and making new infrastructure investments that transportation professionals face in our ports, airports, and rail and transit centers are the same whether they are in Los Angeles, Hong Kong, or Berlin. Each of you wants to make the most effective investment to relieve traffic congestion and promote effective and balanced development.

As a result of these mutual interests, we want to present in these pages the different ways various agencies and companies have gone about solving these issues through the use of GIS technology.

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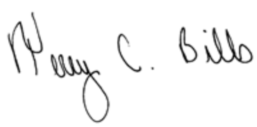
Terry Bills



Spatially Manage and Optimize Fleet Operations with ArcLogistics 9.3

Fleet Management Solution Helps Organizations Save Fuel, Reduce Emissions, and Cut Costs

ArcLogistics 9.3, ESRI's routing and scheduling solution for fleet management, improves on the ArcLogistics Route 3 solution with significant usability enhancements and new capabilities. Businesses and governments with fleets of any size can use ArcLogistics 9.3 to build the most efficient routes and schedules.

"With rising fuel costs and growing concern for the environment, ArcLogistics 9.3 is a viable solution for any organization that has a fleet," says Jack Dangermond, president, ESRI. "ArcLogistics provides businesses and governments with the necessary tools to maximize the performance of their vehicle operations while saving fuel, reducing costs, and minimizing their carbon footprints."

ArcLogistics 9.3 helps organizations create optimal routes and schedules in a multistop/multivehicle environment using variables that reflect users' operational workflows such as vehicle capacity and driver specialty. With ArcLogistics, dispatchers can create strict time windows and increase operating efficiencies by assigning orders to vehicles based on the optimal stop sequences using actual street network drive times instead of measuring distance and ordering stops "as the crow flies."

Existing ESRI software users benefit because ArcLogistics is built on ESRI's ArcGIS platform. Routing projects are now stored in a file geodatabase for virtually unlimited capacity. Users can export routing results as a network analysis layer for use in ArcGIS and ArcGIS Network Analyst, making ArcLogistics a data collection point for enterprise GIS efforts and analysis.

"ArcLogistics 9.3 maintains the quick and easy routing and scheduling functionality of ArcLogistics Route 3 while adding many new capabilities that make it a powerful GIS tool," says Karl Terrey, ArcLogistics product manager, ESRI.

Learn more about ArcLogistics 9.3 at www.esri.com/arclogistics.

Case Studies Wanted

Share the benefits of your GIS work with colleagues by submitting case studies for future issues of this newsletter. Topics include all transportation modes such as highway management, public transport, paratransit, postal address data management, port facility management, airport noise analysis, linear referencing methods, and railroad studies. Case study articles can be full page or half page, up to 800 words. We also like to include high-resolution screen shots or photography with the articles.

To submit a case study article, contact Marshall Cammack at mcammack@esri.com or Terry Bills at tbills@esri.com.

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ArcGIS and Traffic Analyst Improve Strategic Transportation Forecast Modeling

By Thomas Israelsen, Rapidis

Building and using advanced transportation forecasting models has become a lot easier with ArcGIS geoprocessing wizard tools and the ArcGIS extension Traffic Analyst. These benefits have been realized recently in the TRANS-TOOLS forecasting model.

The TRANS-TOOLS forecasting model is designed to predict the consequences of different European-level transport policies to support decision-making processes. The TRANS-TOOLS model is well suited to evaluate new investments in large-scale infrastructure projects (trans-European network projects), such as

- Bridges, tunnels, motorways, high-speed railways, and freight railways
- Fiscal instruments, like road pricing and fuel taxes
- Changes in airline networks including low-cost airlines

A consortium of European consultants and universities has recently completed and delivered its work on the project to build the TRANS-TOOLS model. This work was undertaken for the Directorate-General for Energy and Transport of the European Commission. The purpose of the project was to overcome the main deficiencies of the previously available models. The use of ArcGIS and Traffic Analyst as central components in the solution helped realize these goals in a reasonable time and for a reasonable budget.

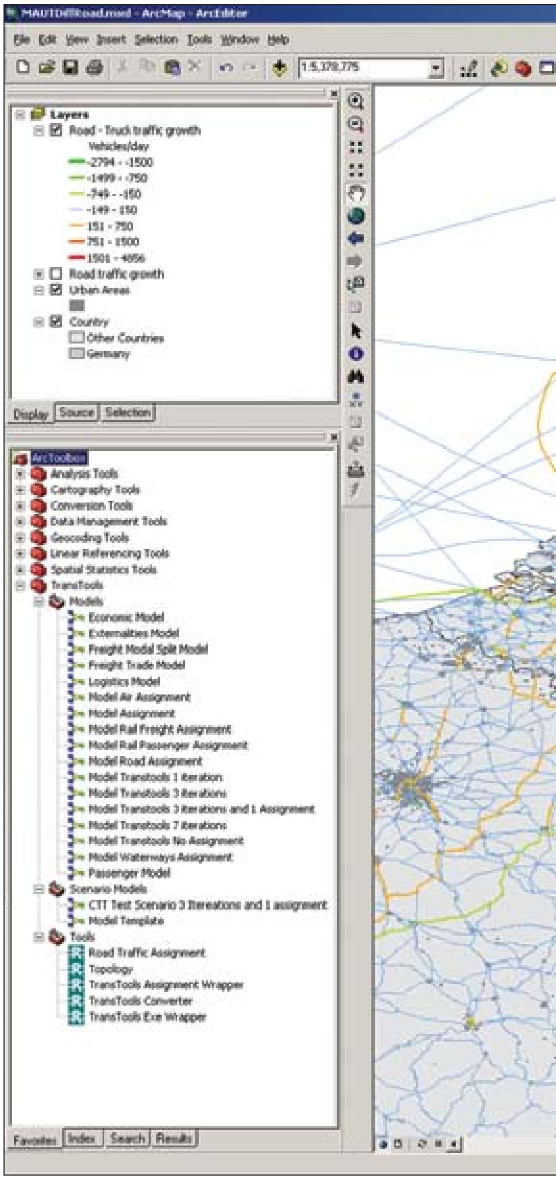
The main shortcomings in the existing models, which needed to be addressed in TRANS-TOOLS, were

- The previous models were mostly proprietary and built by consultants to only be used by those consultants. This meant that the models were quite expensive to use, and interoperability between different models was very difficult, since there was no standardization of data models or data formats and no uniform way of executing calculations.
- No single model supported the scope necessary for the types of forecasts needed.
- In some European countries, the models did not have sufficient levels of detail.
- The models did not take into account that many trips use a combination of modes. For example, air trips usually have significant road or rail transport to and from airports.
- The effect of congestion on the roads was not taken properly into account for road traffic.
- The effects of general economic development on transport demand were not properly taken into account.

Despite these imperfections, the previous models had many good qualities, and they represented a very significant investment. It made good sense to leverage those qualities in the new model. The task for the consortium became to improve some of the existing models, build new models, and integrate them all on a common platform that encompasses a logical and a physical data model. The consortium was also tasked with a way to execute all the different components in the correct order and create a common user interface in which users could edit scenario data, execute models, and create high-quality results and presentations.

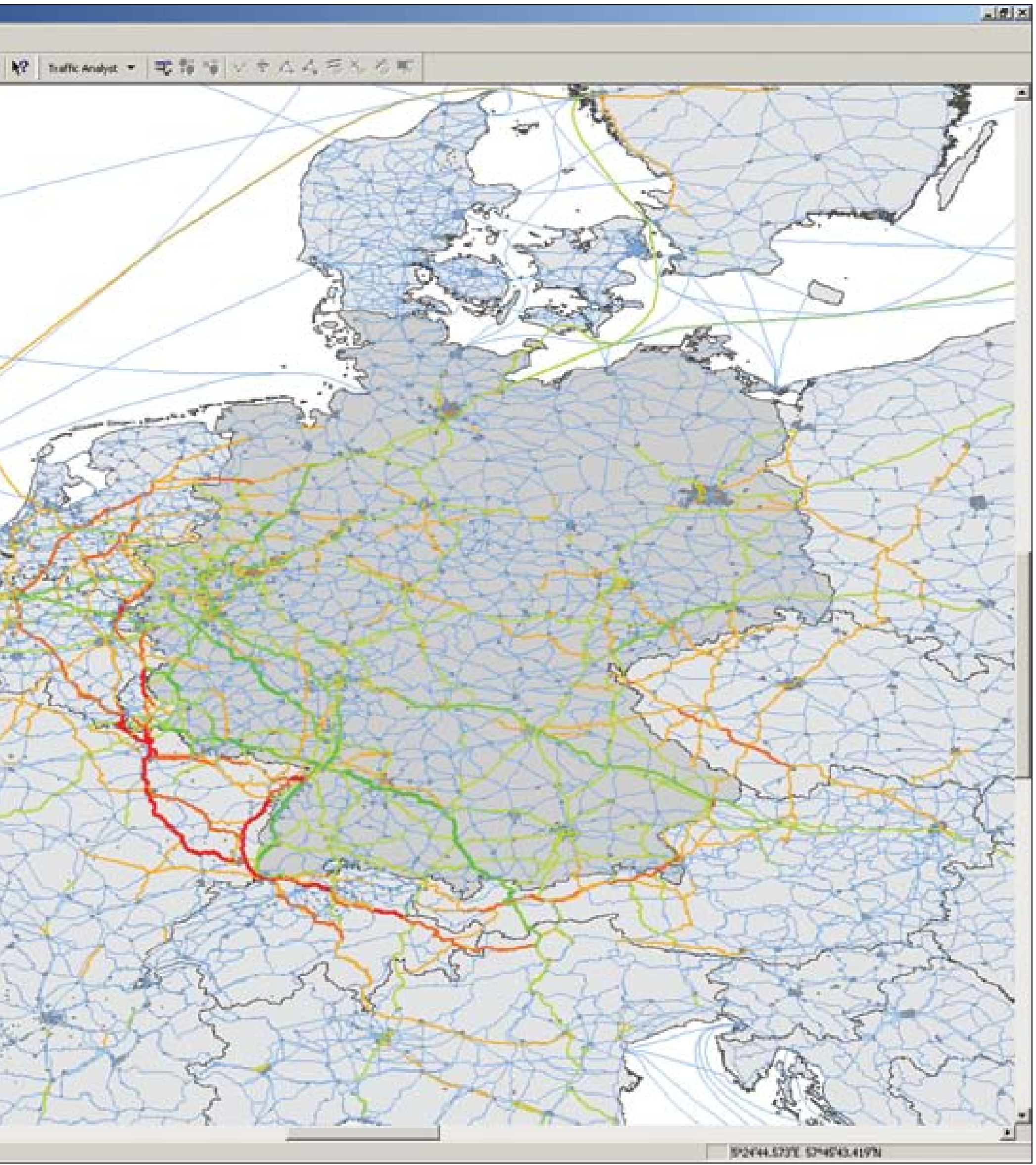
The consortium decided on ArcGIS and the Traffic Analyst extension for the platform because the solution is user-friendly and would enable the implementation of the new goals. Geoprocessing and ModelBuilder in ArcGIS allow a user to easily compose a model from a set of tasks without any programming necessary. Geoprocessing and ModelBuilder are flexible in the types of tasks they can control, which is ideal for TRANS-TOOLS, since it allowed the consortium to use three types of tasks: stand-alone command line programs, data management tools built into ArcGIS, and transport modeling tools from the ArcGIS Traffic Analyst extension.

The consortium was able to rework its existing models into command line programs so that they could be controlled by geoprocessing and



ModelBuilder. Concurrently, the consortium was able to quickly build new models from the generic transportation modeling tools available in Traffic Analyst. The preexisting models were improved and integrated with geoprocessing and ModelBuilder. One major set of models had to be created from scratch. They included the models for route choice and traffic assignment.

Once the individual models were ready (preexisting models that had been improved and fitted to geoprocessing/ModelBuilder, as well as new models built from scratch using Traffic Analyst), they were put together in the proper configuration using ModelBuilder. This arrangement had a very significant benefit. Depending on which type of scenario the overall TRANS-TOOLS model is used to examine, the various submodels need to relate slightly



TRANS-TOOLS models the flow of road and car/ferry traffic when a road toll is imposed on the German motorway system.

differently to each other. The task of creating such scenario model variations consists of pointing and clicking in the ModelBuilder application. No programming is necessary. This means that end users can perform reconfiguration even after the model has been delivered to the European Commission. This feature also enables the model to reliably handle a much wider set of scenarios.

The TRANS-TOOLS model consists of a number of major submodels:

Economic model: A general equilibrium model, this predicts real GDP growth for each zone in the model based on the changes in transport costs imposed by the different model scenarios.

Freight trade model: For a number of different commodity groups, the freight trade model predicts total trade flows between each combination of origin and destination zone.

Freight modal split model: For each combination of commodity type, origin zone, and destination zone, the model calculates the share of each of the four freight modes in the model: road, rail, sea, and inland waterways.

Freight logistics model: For each combination of transport mode, commodity type, origin zone, and destination zone, this model predicts the likely location and usage of distribution centers along a trip.

Passenger model: For each combination of passenger trip purpose, origin zone, and destination zone, the passenger model calculates the number of trips by each transport mode: road, rail, air, and bus.

Traffic assignment: All the information on freight and passenger trip volumes between origin and destination zones, which is produced by the freight logistics model and the passenger model, is used in a route choice model, so that these trips can be assigned to all the individual segments in the networks of the model. The results are loads for each individual street segment, rail segment, air leg, and inland waterway segment.

The overall transportation model mainly works by reaching a balance between supply and demand. This is done by switching between the traffic assignment model (which, in addition to network loads, also calculates average travel costs between zones), the passenger model, and the three freight models.

Environmental impact model: Once a balance has been reached in the transport model, the environmental impact model is executed. Based mainly on network loads, this model predicts impacts on the environment, such as pollution, energy consumption, and number of fatalities caused by traffic accidents.

TRANS-TOOLS is the combination of all these models. ArcGIS and the Traffic Analyst extension turned this combination into an operational framework, which can be used and extended by the client. Instead of always needing to hire expensive consultants, the European Commission now has the ability to create new scenarios and run the model to see its effects. In addition, the European Commission makes TRANS-TOOLS freely available to anyone interested in using it.

More Information

For more information, contact Thomas Israelsen, managing director, Rapidis, at ti@rapidis.com.

ESRI Press Publishes a Practical, Comprehensive Guide to Designing a Geodatabase for Transportation

Constructing a geodatabase to manage a highway, railway, mass transit, or navigable waterway system can be highly technical and painstaking. J. Allison Butler's book *Designing Geodatabases for Transportation,* new from ESRI Press, provides practical, step-by-step direction that will make the process easier.

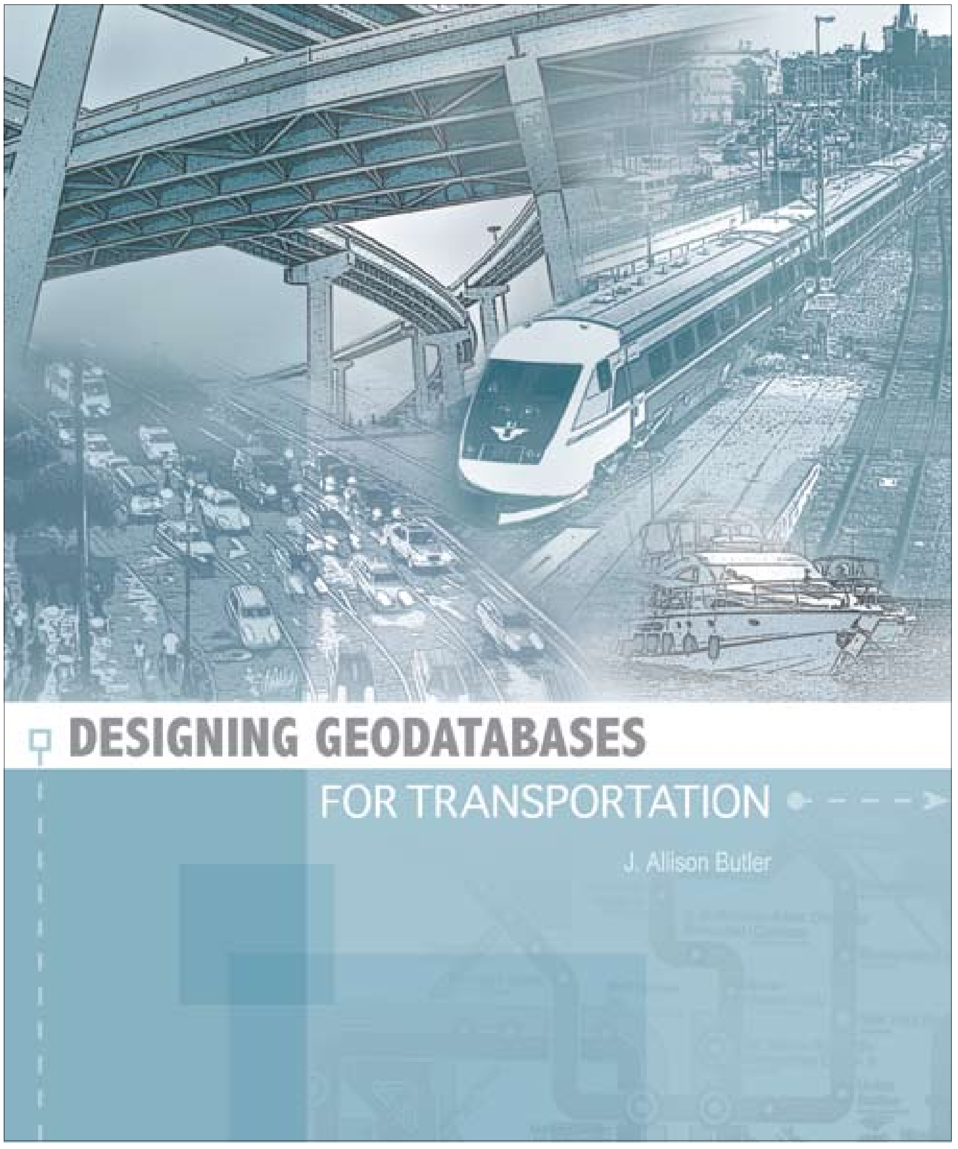
The book shows how to meet transportation data requirements within a unifying multimodal framework that promotes efficiency. Larger transportation agencies—consisting of highly independent sections, each with its own database structure and no cross-connections—have traditionally focused on highway construction and maintenance. But, with rising fuel costs, agencies are turning to enterprise GIS to better manage their transport systems and coordinate different modes of travel such as providing bus feeder routes to commuter rail stations.

"GIS has long included spatial databases for transportation, but this book is the first published about how to design one," says Butler, a spatial geodatabase design expert who has spent 30 years working for local, regional, and state transportation agencies.

Butler says larger transportation organizations have often designed homegrown solutions to meet information needs, but these often turn out to be poorly documented and hard to change. "*Designing Geodatabases for Transportation* shows how to solve the many problems existing today as a result of haphazard database design over many years," Butler says.

The database design in the book shows how agencies can coordinate internal and external connections without making drastic organizational changes. The ideas are presented in a "cafeteria" style that allows users to pick solutions that meet their needs.

Designing Geodatabases for Transportation describes how to design a GIS to manage data about transportation facilities and services, from railroads to traffic-monitoring systems. Early chapters cover basic geodatabase design concepts and include best practices sections on data business rules and geometric abstractions.



Designing Geodatabases for Transportation details enterprise GIS design for managing transportation systems.

Later chapters go into data editing, linear referencing, and classic transportation data models. Through targeted sidebars, the book presents ArcGIS fundamentals and geodatabase design guidance geared toward novices while also providing advanced information aimed at experienced GIS developers.

The book's last section delves into enterprise solutions and modal data models, with chapters dedicated to the Unified Network for Transportation (UNETRANS) data model, state department of transportation (DOT) highway inventory editing and publishing, navigable waterways, and railroads.

Butler has authored more than 75 papers and other published works and has been an innovator in such fields as spatial database design, construction management, policy planning, and economic development. He was a key participant in developing the GIS Certification Institute (GISCI) and currently serves as its president.

Designing Geodatabases for Transportation is available at online retailers worldwide, at www.esri.com/esripress, or by calling 1-800-447-9778. Outside the United States, visit www.esri.com/esripressorders for complete ordering options, or contact your local ESRI distributor.

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Enabling Web Access to Highway Data and Images

that a geographic information system (GIS) Web portal that integrates multiple datasets in an easy-to-use and readily accessible interface would be a cost-effective solution for increasing data sharing and usage.

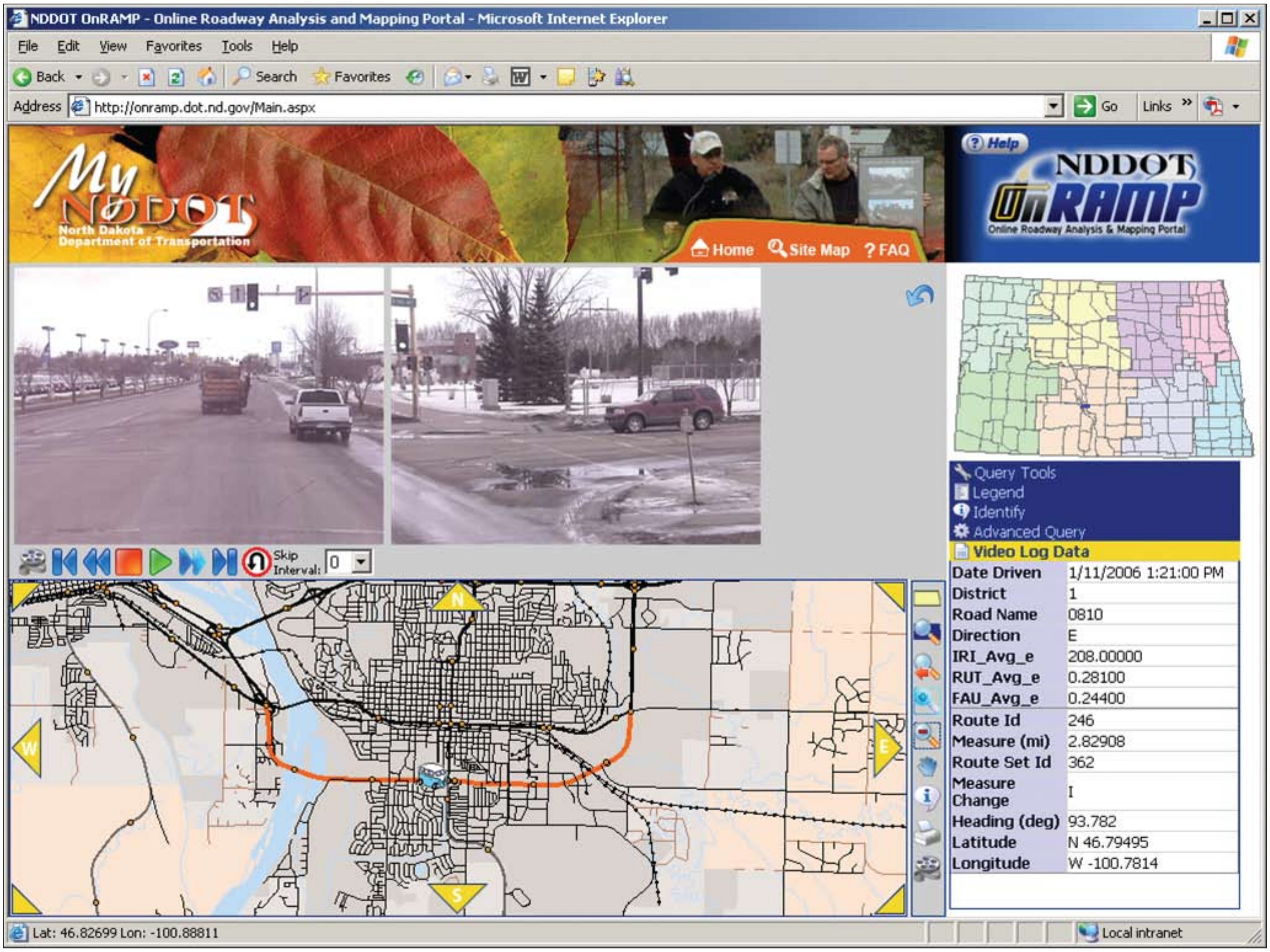
NDDOT's GIS Web portal was designed to access transportation-related data and information quickly and easily. The system was developed in such a way that it integrates with other spatially enabled applications, thereby increasing accessibility beyond simple GIS data layers. NDDOT's Image Log data, a digital library of road views taken from vehicles driving down the road, was used as the first application for this integration model and completed the foundation for the new GIS Web portal.

Based on its needs, NDDOT implemented the Online Roadway Analysis and Mapping Portal (OnRAMP). The system, developed with the aid of Pennsylvania-based GeoDecisions, was designed to ensure that its foundational technology would meet the future needs of a functionally rich portal. The ability to add new spatial datasets to the portal was a core NDDOT requirement and was accomplished by designing configuration tables into the portal. Therefore, key GIS display parameters, such as layer, symbology, labeling, scale suppression, and MapTip details, can be centrally managed and updated by an administrator. The portal can also be accessed through other NDDOT applications through a shared URL string containing spatial parameters. These spatial parameters allow seamless integration with other applications at NDDOT, making both problems and solutions more manageable.

OnRAMP was built with several access points to the Image Log data to fully expose the portal's integration capabilities. Known as Video Log, the new Image Log viewer can be accessed within a results window generated by a query or map selection. Additionally, the user can directly click a point on a road rather than typing in information.

For Image Log, NDDOT's Pavement Management Section collects two digital images along the road, approximately every 26 feet—one facing straight down the road and one facing toward the right shoulder. New road images are collected for the entire state every two years. Previously, users throughout NDDOT had been accessing Image Log data through a desktop application for asset location/validation, virtual inspections of approaches, viewing of curves and line-of-sight issues, and scouting of locations for variable message signs. Image Log access, however, required a high-speed connection to the NDDOT network. This requirement prohibited many district personnel from effectively utilizing the information. With the Web-based environment of OnRAMP, access to these images through the lower bandwidth connections in district offices is possible.

Prior to the implementation of OnRAMP, the millions of highway images that NDDOT collected each year were not georeferenced. These images are created with a proprietary file naming process and are often missing the GPS coordinate



OnRAMP features street-level video of North Dakota's roadways.

data that allows the images to be georeferenced to the location the photo was taken. To remedy this issue, a tool was developed that provides NDDOT with the option of using either GPS data or an interpolation routine, based on route name, mileposts, and image sequence, to locate each image on the roadway. This image placement tool allows an administrator to dynamically update images with accurate location and reference data. Accordingly, a vehicle icon denoting the current Video Log location can be tracked on the map as a user drives virtually down the road.

The implementation of Video Log has enhanced the functionality of NDDOT's existing Image Log desktop application. New features, such as an integrated Web-based map interface, the ability to view and save full-resolution images, and the capability to export a video file of a sequence of up to 50 forward-facing images, permit users to intuitively use the image data more effectively. Moreover, existing Image Log functionality, such as altering the image display interval (e.g., showing every third image pair), DVD-like player controls, jumping to images of the opposite direction along the same road, and adjusting side-by-side image alignment for a panorama view, has been preserved in the new Video Log application.

Since the need to improve data accessibility and availability was one of the primary goals of the project, innovative technical approaches were required to present the large volumes of information on a Web application platform. OnRAMP was developed using primary development languages stored in ArcGIS Server. The combination of Asynchronous JavaScript and XML (AJAX) provided an ideal platform for Visual Basic, .NET, and JavaScript. The GIS data is accessed using ArcGIS Server to display NDDOT's spatial data, enabling multiple communication relationships between the user and the server. Additionally, the application requires no plug-ins or other software on a user's standard Web browser, making it extremely user-friendly and minimizing costly upgrades. The application is also compatible with multiple browsers and has been designed to make maximum use of the browser screen space by presenting multiple tools in sliding frames.

Altogether, OnRAMP improves enterprise transportation information sharing and integration throughout NDDOT. The system enhances accessibility of the existing Image Log data via the Web to all NDDOT users. It also meets the challenge of disseminating attribute and image data over varying Internet bandwidths at district offices and provides a user-friendly Web portal interface.

More Information

For more information, contact Brian Bieber, programmer/analyst III, North Dakota Department of Transportation, Bismarck, North Dakota, at bbieber@nd.gov or Albert Sarvis, PMP project manager, GeoDecisions, Camp Hill, Pennsylvania, at asarvis@geodecisions.com.

Singapore Land Transport Authority Takes the High Road with GIS

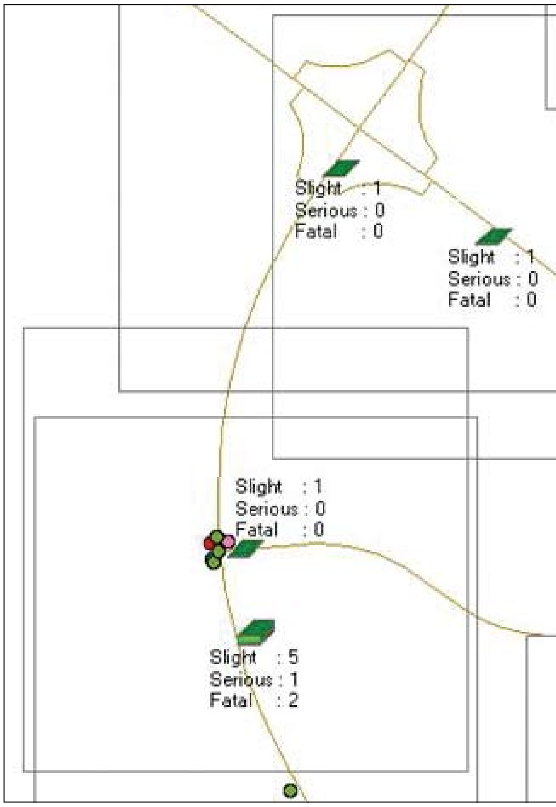
By Matt Freeman, ESRI Writer

Since the Southeast Asian island country of Singapore became an independent republic in 1965, it has seen rapid growth and commercial development. Over the decades, its thriving technology industry has lent itself to a burgeoning urban landscape and a road and rapid transit system constantly in need of expansion and improvement. In 1995, the government acknowledged the unique transportation needs of the 682-square-kilometer city-state and its 4.6 million people by merging four public-sector entities and establishing the Land Transport Authority (LTA). The union brought together the Registry of Vehicles, Mass Rapid Transit Corporation, the Roads and Transportation Division of the Public Works Department, and the Land Transport Division of the Ministry of Communications. United, LTA's goal was to fulfill the long-term transportation needs of Singapore while providing a seamless journey for all who drive as well as those who take public transportation.

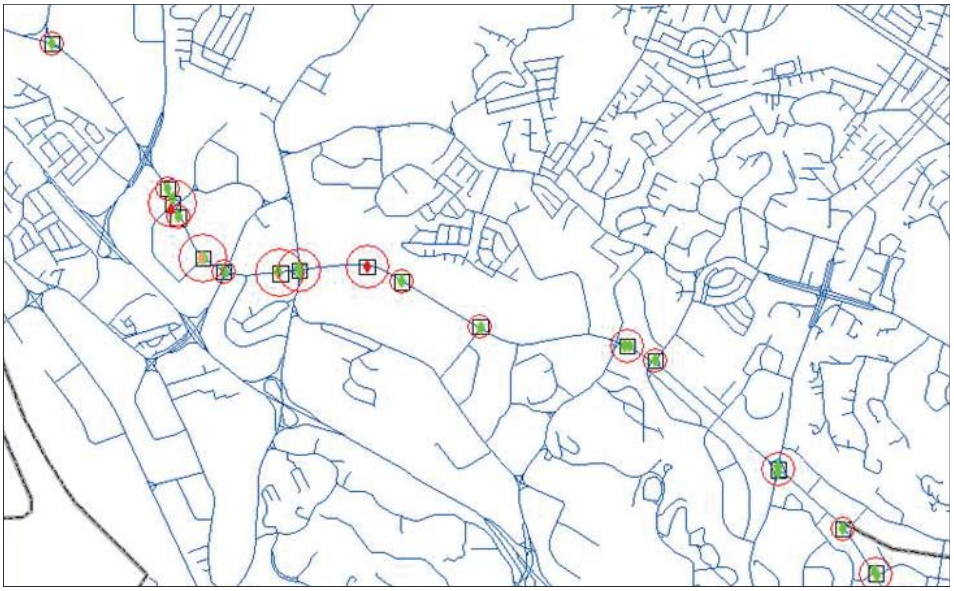
The union of the four organizations, however, introduced its own roadblock: disparate information technology systems that supported a multitude of interlocking business processes and operations that were spread among more than 60 geographically dispersed offices. "Each of the organizations that became LTA had been around for 30 or 40 years, so they all had very steep, embedded processes," explains Rosina Howe-Teo, chief innovation officer of the Innovation and InfoComm Technology Department of LTA. "When they became one organization, obviously the information flow and workflow became a problem. There was a lot of data captured and duplicated between the various departments; we were never really sure which data was the most accurate, and we didn't have one complete place to store it all."

As a solution, LTA went to work on developing a GIS-based network that would centralize its spatial data and support the planning, design, survey, construction, operation, and maintenance processes of its entire transportation infrastructure. LTA's decision to use GIS as one of its IT platforms was based on the features and functionality of ESRI's ArcGIS software. This new enterprise not only promised LTA the ability to manage its own resources and assets but also gave it the freedom to collaborate with other government, private, and public agencies with an interest in a free-flowing transport system.

Known as the Land Transport GIS Data Hub (LTGDH) since its inception, LTA's enterprise GIS is a geodatabase where all geospatial data related to land transport infrastructure is managed, maintained, and centrally governed. LTGDH holds the growing number of digital map layers such as road safeguarding, road inventory, and rapid transit system information. Besides the need for a central repository of GIS information as a single source of reference and retrieval, data governance was vital to establish clear accountability, ownership, access rights, and version control. These procedures ensure data quality, consistency, accuracy, and security and help facilitate data sharing among government entities.



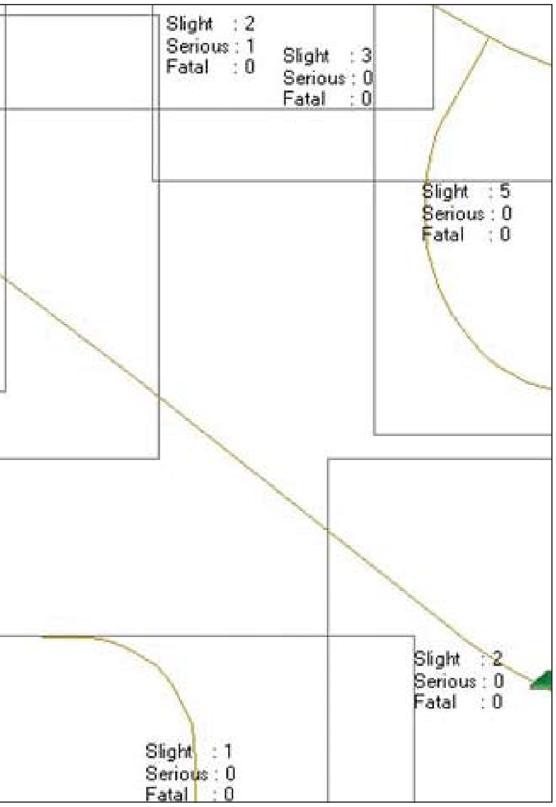
As a result of its GIS-based traffic safety analysis, accidents have been reduced at treated intersections by 66 percent and expressways by 90 percent.



The Land Transport GIS Data Hub allows LTA staff to visualize traffic accident and collision patterns and identify areas that may need improvement.

Surveying and Civil Engineering

As the main government agency for land transport development in Singapore, LTA has amassed a wealth of information pertaining to soil types surrounding the structural foundations of land transport infrastructure projects. LTA uses the GIS technology in LTGDH for capturing borehole information for soil analysis, planning of construction site excavation, foundation design, and tunnel alignment. To date, there is data from more than 8,000 borehole records captured by LTA, all of it stored in LTGDH.



"Since Singapore is a densely populated island, much of our rapid transport systems are built underground," says Howe-Teo. "Tunneling will sometimes go through very challenging soil conditions—hard and then soft soil—that can shift. With our GIS, we have mapped the instruments that are placed in the ground to measure any movement. At the same time, soil samples also help us locate the water table, which helps our engineers determine safe tunneling methods."

Maintaining a high level of safety in and around LTA work sites is a paramount matter. To ensure that staff, contractors, and nearby residents are protected at all times, LTA deploys GIS technology to track, map, and monitor the location of site instrumentation, ground movement, and groundwater tables.

As part of a total safety management process, major civil hazards are monitored and tracked across construction phases with the aid of GIS maps. Risk management facilitators at major project sites are required to identify and map potential safety hazards by using a structured risk assessment framework and determine their corresponding mitigation measures. The progress of the mitigation measures that are put in place is followed and monitored throughout the lifetime of construction.

Roadway Planning, Design, Construction, and Maintenance

In the regulatory domain, LTGDH allows LTA to regulate structural and civil projects that may affect road and rapid transit system infrastructures as part of its planning and development efforts. Through an online submission system, civil engineers and consultants submit their plans to LTA for endorsement. Online reviews of GIS maps by LTA subject matter experts support collaborative efforts to steer clear of works that may be detrimental to Singapore's transport infrastructure.

Surveyors, real estate developers, lawyers, architects, and engineers can also purchase maps of future road line and railway plans, produced by LTGDH to perform property transactions and draft development proposals. This service not only assists private industry but also reduces the number of plans that could affect the road and rail systems, which saves LTA time, resources, and money.

In road management, an interagency system uses GIS to coordinate road construction to minimize disruption to Singapore's commuters. Utility service agencies (such as telecommunications companies and electric and gas providers) that need to carry out works on public streets, such as laying power cables and gas pipes, are required to apply for permits from the corresponding land-managing government agencies. Through the Permit for Road Occupation Management portal, which resides inside the LTGDH, service agencies can submit their applications for roadwork permits.

LTA also uses GIS to plan the maintenance schedules for roads throughout Singapore. GIS maps help visualize road conditions captured by specialized vehicles. With predictive forecasts on road deterioration and structure life, road maintenance is prioritized for different treatment methods accordingly, while the budget outlay is optimized.

Traffic Management and Operations

With the rapidly increasing vehicle population and the rising expectations of the traveling public, Singapore must do more than provide a better road network and a more efficient public transport system. LTA is also expected to provide a safer and more orderly motorized society. For traffic management, LTA created a GIS-based, multiquery accident application that is integrated with tools for geographic analysis.

In the past, LTA has been limited to the use of statistics, charts, and tabular data to analyze traffic accident or collision patterns and identify hazardous locations in need of road safety improvement. With GIS, visualization of these collision incidence distributions or patterns makes a greater impact, since by nature, using maps is more intuitive than using statistics, tables, and charts in understanding spatial phenomena.

LTA conducts "black spot" analysis to identify accident-prone areas through geographic visualizations within its GIS. Experts are now able to study the traffic scheme in high-risk areas and implement site treatments. As a result, traffic accidents have been reduced at treated intersections by 66 percent and expressways by 90 percent. In 2007, the project won the prestigious Prince Michael International Safety Award for outstanding achievement in its collaborative efforts in promoting road safety through innovations in engineering and active public education.

Along with ensuring road safety, LTA is also proactively disseminating traffic-related information through its One.Motoring (www.onemotoring.com.sg) portal, a one-stop Web site that houses all motoring and road information and vehicle-related transactional e-services in Singapore. Based on an intelligent traffic and incident management platform, LTA broadcasts average traveling speed, accidents, and roadworks on major arterial roads and expressways via an interactive GIS map that is updated every three minutes. One.Motoring is a valuable online destination for the general public in Singapore. "Anyone in the public can go to One.Motoring and retrieve information and see the current traffic flow," states Howe-Teo. "They can plan a route in advance before they leave, and they can even access the Web site from a mobile device." With more than 15 million monthly page views, the online resource received a user satisfaction rating of 93 percent in 2008.

More Information

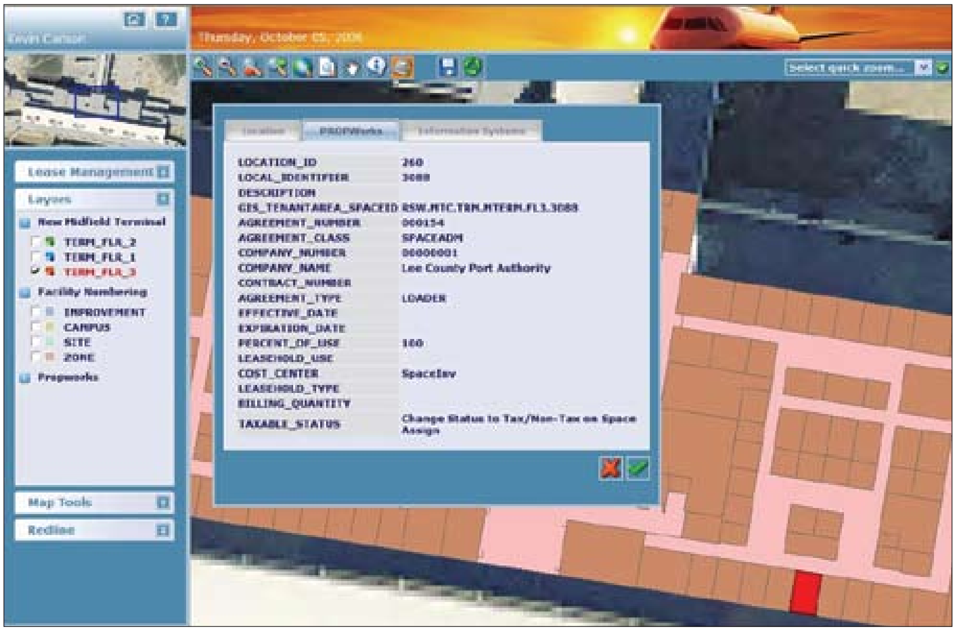
For more information, contact Richard Lee at rlee@esrisa.com.

GIS—A Practical Technology for Airport Systems Integration

By Kevin Carlson, Director of Airport Management Systems, DMJM Aviation, AECOM Technology Corporation

Airports rely on a set of very specific information systems critical to supporting their missions. Using GIS as a Web-based window into these systems improves airport management and operations. GIS technology documents the physical layout of the facility and provides insight into and analysis of the data stored in important airport management systems.

Airports are responsible for operating, maintaining, and improving large, multifaceted facilities and are comparable with municipalities in the scale, scope, and diversity of their assets. Like municipalities, airports control land use; plan and manage large-scale construction programs; play host to diverse tenants such as airlines, retailers, and service providers; and maintain the condition of indoor and outdoor facilities affected by structural age, weather, and frequent use.



An enterprise GIS is integrated with an airport property management system at Southwest Florida International Airport.

In addition, airports rely on very specific systems and requirements that form a critical component of the airport's primary job of providing a safe, secure, clean, and efficient facility for airlines and the public. As gatekeepers for the National Airspace System, airports must operate or support systems that track flight times and gate use, manage revenue from tenant billing and facility use charges, control security and access to the airfield, provide critical infrastructure to airlines for passenger and baggage processing, manage traffic and parking, control aircraft movement, and provide landing guidance. Airports are also subject to aviation-specific laws and regulations for tracking and logging the condition of the facility on a daily basis (FAR Part 139), managing and reporting incidents, applying for and receiving federal funding, managing construction to minimize impact on aircraft movement or safety, and more.

Location Establishes the Information Hub

Most airport systems, requirements, and regulations have a location component that makes the use of GIS technology ideal for analyzing, monitoring, and displaying their data. As a result, "airport GIS" is developing as a location-based information hub for all things sharing spatial coordinates.

For example, enterprise GIS provides a centralized way to make queries about a specific room in an airport concourse. You can identify who leases, occupies, and is responsible for cleaning it; when the lease expires; where construction drawings are stored; its IP address; the quickest route to the room; whether it is inside a secure area; which employees have access to it; and any recent work orders that affect the room.

Queries related to outdoor surfaces can be made about the shortest taxi times between two points, effects of construction crane placement on surrounding airspace and flight procedures, the best way to generate taxiway closure diagrams, coverage of on-airfield closed-circuit television (CCTV) cameras, subsurface utility locations, or the tower's line-of-sight view.

The goal is to keep using the systems that manage airport activities and use GIS as a window (through Web portal) into these systems to improve the way airports are managed and operated. The following examples highlight current airport uses of ESRI software to implement this goal.

Baltimore-Washington International Thurgood Marshall Airport

Baltimore-Washington International (BWI) Thurgood Marshall Airport's Engineering Document Retrieval System (EDRS) uses ESRI's ArcGIS Server software to manage approximately 30,000 documents, drawings, and specifications on a server and provide Web access to the data. Each document is associated with an airport grid system and other airport GIS features such as taxiways, runways, and buildings. Through the Web-based EDRS interface, a user can run a location- and attribute-based search to find, for example, the as-built drawings dated between June and November 2003 that pertain to a certain taxiway segment. Multiple searches using map features or text criteria produce a final checkout set that airport engineers can save, send by e-mail, or view online using the freely available Brava! Reader document viewer, made by Informative Graphics Corporation.

The benefit of organizing facility record information by location in combination with text attributes, such as date, contract, and document type, is the creation of an extremely useful repository that can be quickly searched to support emergency response and used in an everyday capacity to improve airport staff productivity. DMJM Aviation, Inc., developed the EDRS system in concert with Towson University's Center for GIS and Grafton Technologies, Inc.

Southwest Florida International Airport

Southwest Florida International Airport's (RSW) enterprise GIS system integrates PROPworks, an airport property management system made by Air-Support IT Services, Inc., with ESRI's ArcGIS to visualize and query lease information through a Web-enabled GIS interface. An authorized user can select a room using an interactive Web application and view all the lease information stored in the property management system. Conversely, a user can enter search criteria such as the tenant or lease agreement. The application will search the property management system, find the appropriate leaseholders, and highlight the corresponding space on the Web-based map interface. This application has not changed the way personnel maintain the property management system—they still use it to add or remove space identifiers to a lease when appropriate. Mr. Doug Swank, senior development manager for Lee County Port Authority, agrees that its "Web-based enterprise GIS, which utilizes ESRI and Oracle products, gives Lee County Port Authority staff the ability to visualize our airport facilities and link to data in other systems using an intuitive, map-based display." All available room identifiers are provided by the GIS system through a database table. GIS staff members maintain the mapping portion that tracks the physical layout of a building's rooms. DMJM Aviation did the work to integrate RSW's enterprise GIS system with the PROPworks property management system.

Denver International Airport

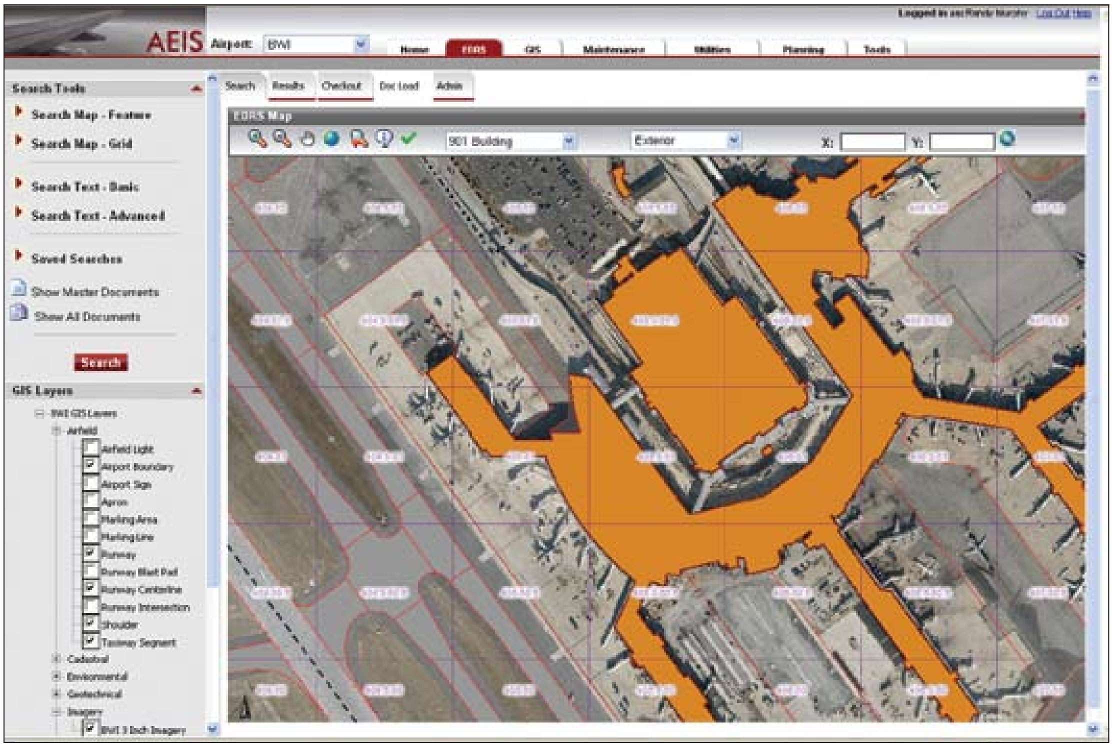
Denver International Airport's (DIA) geospatial airfield pavement evaluation and management system (GAPMS) provides a sustainable link between airfield pavement management and enterprise GIS. DMJM Aviation equipped eight Tablet PCs with customized ESRI ArcMap interfaces, GPS receivers, and GPS-enabled digital cameras. Crews use the devices when walking the runway, taxiway, and apron structure to capture information about the type, severity, and nature of pavement distresses. GIS scripts synchronize information into a common dataset for analysis, and ArcGIS Server enables Web viewing and collaboration. By relating information collected in the field to historical data for each pavement section, the airport can correlate pavement stress with aggregate types, weather conditions, construction contractors, and other important information about the pavement's history. With the prohibitive cost of replacing a runway and foreign object damage from deteriorating pavement posing a major safety issue for aircraft, access to airfield pavement information and subsequent analysis is invaluable.

GIS Integration Trend

Other airports are following the GIS systems integration path. Orlando (Florida) International Airport is building a spatial asset management system—using ArcGIS Server and with assistance from DMJM Aviation—to support new airline lease and use agreements and improve airport maintenance management. Another example is Philadelphia (Pennsylvania) International Airport, where DMJM Aviation recently implemented an ArcGIS Server Web portal for asset management and collaboration. Airport GIS applications continue to evolve toward becoming a single, location-based airport management dashboard that combines information about a facility's history and construction, current configuration and maintenance, and real-time aircraft operations and resources.

More Information

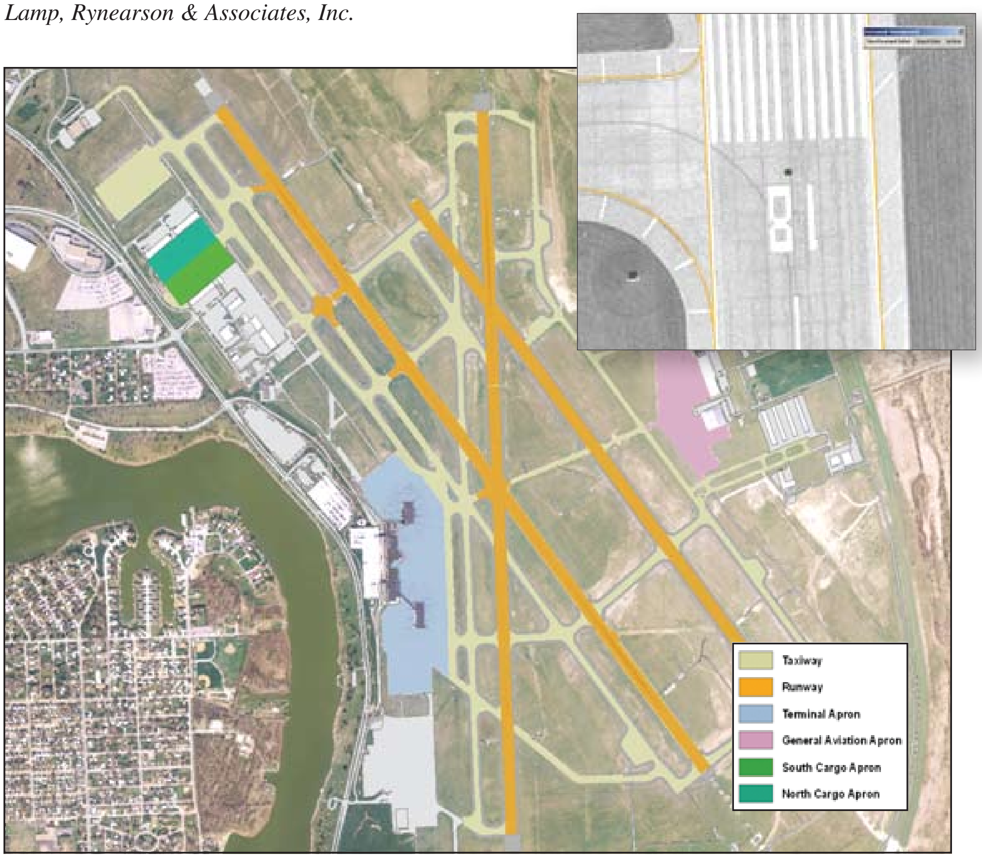
For more information, contact Kevin Carlson, director of airport management systems, DMJM Aviation Systems Engineering Division, at kevin.carlson@dmjmaviation.com.



BWI's Engineering Document Retrieval System offers map and airport grid-based document searches.

Airfield Improves Pavement Management Tracking with GIS

By Michael R. Preston, GIS Department Manager, Lamp, Rynearson & Associates, Inc.



A mobile GIS solution maps and documents runway surface defects at Omaha's Eppley Airfield.

Eppley Airfield in Omaha, Nebraska, is a medium-sized commercial airport that serves more than 4.2 million passengers a year. Its 26,155 linear feet of runways and its aprons and taxiways combine to total more than 11 million square feet of hard surfaces, which can only mean one thing—an asphalt and concrete pavement maintenance challenge.

Managers who run the airfield wanted an efficient, technology-driven solution for maintaining their pavement management system. They found that GIS technology provided them with a mobile and accurate way to keep track of airport surface defects and their repair status.

Because federal assistance supports airport improvements, the Omaha Airport Authority's (OAA) Operations Department is responsible for ensuring future federal funding eligibility by keeping runways in safe, working order. To receive maximum federal funding appropriations, the department must maintain detailed reports of self-inspections and repair actions for presentation during the Federal Aviation Administration's annual inspections.

Airport personnel previously used manual methods to find defects in the landing strip and track work orders for their repair. For years, inspections consisted of OAA personnel walking the runways looking for cracks or spalls. They marked the location of blemished areas on chart-sized paper diagrams that they carried around in tubular cases. Carrying these cases was a chore, and finding a suitable surface on which to spread the paper diagrams took valuable time. They used paint to mark deficient pavement. This proved to be inefficient, because repair crews would later have trouble finding the spot, or the paint marks would fade due to aircraft traffic. Consequently, repair crews had to rely on written descriptions of the location to guide them to the repair site. Also, keeping track of the work orders for these repairs was a paperwork nightmare.

Goals set for the new pavement management system were threefold:

- Provide safe and operable pavements at the least possible cost.
- Provide the owner with sufficient information to best determine when and where to spend funds.
- Comply with federal requirements and maximize available federal funds.

Airfield personnel were familiar with Lamp, Rynearson & Associates (LRA), Omaha civil engineering consultant and ESRI business partner, because it had provided engineering services to OAA since 1982. When asked to investigate a better way to keep track of airport surface defects and their repair status, survey and GIS specialists at LRA used their knowledge of the airfield's infrastructure and experience in GIS and transportation engineering to apply an innovative, technology-driven solution for the pavement maintenance management process.

LRA's method uses GPS and GIS technology to accurately map each surface defect. It also provides electronic forms for keeping track of maintenance history and links the data to the map locations. In the field, inspectors record each defect's location on the airport basemap, describe its characteristics, attach a date and time stamp, and forward the information for creation of a maintenance work order.

LRA customized ESRI's ArcGIS and ArcPad to create a user-friendly interface. Using an ArcPad software-equipped PDA or handheld computer and a Leica GPS receiver, personnel can track locations with reference to a map of pavement boundaries and other GIS layers. By standing or driving next to a pavement defect, the workers can log its position and fill out the electronic form on the handheld computer. This information is then reported to maintenance personnel responsible for repairs.

This dramatically different new system of pavement management made construction and repair safer, faster, and more cost effective. Airport security and safety have become increasingly important in the last few years. Airports can mirror this unique system of using GIS and GPS to improve airport pavement management processes and improve the overall efficiency of airport operations.

For more information, contact Michael R. Preston, department manager, Lamp, Rynearson & Associates, Inc. (e-mail: mike.preston@lra-inc.com).

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