Regional Freight Information Resources For Market Opportunities in the Great Lakes Maritime Transportation System: Phase II

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Executive Summary

The Great Lakes Maritime Information Delivery System (GLMIDS) is designed to facilitate the acquisition, storage, management, analysis and exchange of data between analysts and decision-makers within maritime commerce. (See http://maritime.utoledo.edu). This project is one aspect of a long-term effort to develop and manage a comprehensive data repository and information clearinghouse for maritime stakeholders within the Great Lakes. The intent of this particular project is to expand the information gathering efforts to include Automatic Identification System (AIS) vessel tracking and to incorporate these data into the comprehensive maritime database. The main objective for the system is to promote sustainable maritime transportation in the region by serving as an information resource for public policy decision-making and for drawing the link between maritime freight movements, economic viability, and environmental quality throughout the Great Lakes and St. Lawrence Seaway.

The system is designed to be a diversified web-based information delivery site that houses a detailed data repository consisting of 1) vessel movements and commodity flows, 2) port and dock functions, 3) regional economic activity, and 4) regional population/socioeconomic patterns. One important element of this phase of the project is the development of methods and techniques needed to acquire data through AIS in the Great Lakes. The project team has worked with third party data providers to obtain vessel movements and port calls down to the specific dock location. These data are aggregated into the system's data repository as a means to measure the volume of traffic and cargo flows through the system. In time, the project team can use these data to track trends in ship traffic, identify locations for intermodal connections to landside transportation networks, and to provide an important foundation for developing a Great Lakes Maritime Exchange (GLMX) for the system.

This project will also enable the expansion of the information delivery system to provide data pertaining to the economic impact of great lakes shipping on the regional economy, linking the Great Lakes Marine Transportation System (GL MTS) to the wider regional intermodal freight system. Users can thus retrieve data concerning such factors as tonnages, value of cargo, scheduled service, ship technologies, dock and port facilities and intermodal connections. The overall work on this project supports the maritime industry by supplying users with access to a multitude of current, accurate data and market accessibility tools that are essential for identifying which market segments can be effectively served by the GL MTS.

Introduction

The project described here is an extension of an ongoing effort to develop a comprehensive data repository and information clearinghouse for the maritime industry in the Great Lakes. The GLMIDS system is envisioned to serve as a central focus for diverse interests within the industry and is designed to support the promotion of sustainable maritime transportation in the region. To date, the project has focused on the acquisition, management and exchange of data from a diverse set of existing sources through firms, government agencies, and related organizations. The project team has developed a central web location for the dissemination of information derived from these data for public policy decisions and for drawing the linkage between maritime freight movements and economic viability throughout the Great Lakes and St. Lawrence Seaway.

In this phase of the project, however, the project team has turned its attention to the direct acquisition of vessel movements in the lakes. The process of automated data acquisition through the Automated Identification System (AIS) began during this phase of the project. The data gathered through this effort will be linked to other data within our repository to provide a more comprehensive picture of vessel traffic, commodity flows, and intermodal connectivity within GL MTS. The project team is currently working with Great Lakes and Seaway Shipping Online, Inc. (GLSS), a designated 501(c)(3) nonprofit organization incorporated in 2006. This organization has placed several AIS receivers at key points throughout the Great Lakes region and is currently planning to install additional sites. Data from this source will be used for aggregated reporting or in detailed analysis of commodity flows, port calls, and intermodal connections at ports. This data is securely protected and individual vessel movements will not be reported.

Eventually, the project team envisions this additional data will serve as an invaluable resource for evaluating intermodal transportation opportunities in the Great Lakes Region. It will be used to model vessel flows and intermodal transshipments of commodities within the region as a means to relieve congestion on the highway system and ultimately to promote efficiency, reduce transportation costs, and minimize environmental impacts. In addition, the system is envisioned to seek market opportunities for the GL MTS. Such efforts are not possible, however, without accurate and current data concerning the status of the transportation infrastructure, vessel and commodity flows, patterns of economic activity and the location and size of markets for commodities and goods shipped through the system.

Background

This project is intended to support the efficient and economic movement of commodities and goods through a much-underutilized transportation system. It is argued here that diverting freight traffic to the GL MTS will increase the capacity of the entire freight infrastructure, reduce congestion on the highway and rail systems, reduce system wide fuel consumption and vehicle emissions, and also increase safety throughout the system. Furthermore, promoting the GL MTS through detailed market research can hold down freight rates for shippers by providing a reliable alternative to rail and highway.

The research contribution here is clear: to provide the necessary support for not only market opportunities for great lakes carriers and shippers within the region, but also to draw the necessary link to the wider regional economy through taking advantage of this underutilized transportation resource in terms of:

- Employment,
- Economic impact of Great Lakes shipping,
- Safety issues associated with diverting freight traffic to GL MTS,
- Environmental impacts/benefits compared to other modes,
- Shipper savings associated with GL MTS,
- Congestion effects of other modes in comparison to GL MTS,
- Competition effects of Maritime Transportation and rate increases in other modes,
- Shift in intermodal connections and transshipment costs (e.g., "full cost" studies – pavement damage, fuel savings, crashes, *etc.*,
- The value of shipping to states, cities regions, *etc*.

The system is currently well positioned for assembling, storing and managing maritime data for the Great Lakes system. Users can take advantage of the GIS location-based query and selection capabilities as well as mapping functions to illustrate these relationships. Additional inputs in the system can certainly support market research efforts to divert freight to the GL MTS. Much of the work outlined here documents how these efforts continue as in previous phases, but with additional data inputs from direct acquisition through AIS.

The project team has established relationships with a wide range of interests in the industry. These relationships began in June, 2006, when The Great Lakes Maritime Research Institute hosted the Great Lakes Maritime Data Workshop in Detroit. This meeting marked the beginning of an initiative to assemble an internet-based data resource for Great Lakes Carriers, Ports and regional economic development organizations. Efforts continued with a second and third workshop in November, 2006 and October, 2007 in Toledo with additional discussions on market opportunities for GL MTS. Relationships with partner organizations established early in the development of this project continue through the present time with:

- US Army Corps of Engineers
- American Great Lakes Ports Association
- Canadian Chamber of Maritime Commerce
- US Maritime Administration
- Toledo-Lucas County Port Authority
- University of Wisconsin-Superior (GLMRI)
- University of Minnesota Duluth (GLMRI)
- NOAA
- Lakes Carriers Association
- Transport Canada
- Great Lakes Commission
- St. Lawrence Seaway
- Port of Duluth
- Detroit Port Authority
- University of Toledo

Data collection priorities were established in consultation with our partners in the industry. It was recognized early in the discussion that data acquisition efforts must be prioritized given constraints in time, staffing and budget. The project methodology was broken down into the following distinct tasks:

- Incorporate AIS data acquisition into the information delivery system as a means to obtain the following data on a continuing basis and in a more timely fashion:
    - Cargo flows—vessel types, vessel size, types of commodities, origins, destinations
    - Baseline data for Vessel movements including size, horsepower, emissions, fuel consumption, and ballast inventories, etc.

- Continue to assemble data in the centralized repository to include the following:
    - Port Facilities including docks, terminals, etc. and relevant attributes dealing with capacity, tonnages, *etc*.,
    - Linking Great Lakes maritime freight movements between origins, routes, ports and destinations as a means to link maritime freight flows to the regional economy,
    - Acquisition of additional economic data dealing with employment by sector, establishments, *etc*.,
    - Locks including relevant attributes dealing with size, capacity, tolls, *etc*. and
    - Navigation facilities.

- Documentation of data standards derived from data sources in the region (including consultation with data source agencies, Maritime Exchanges, Ports and other related organizations) and reporting data in units consistent with the maritime industry and related transportation modes;

- Maintain a dialog with regional stakeholders with respect to their information needs in order to prepare maps, graphics, tables and text in a user friendly format;

- The development of an internet-based data reporting site for data resources and organizations within the region including links to related sites;

- Documentation of the data resources on the site;

- Document the additional data dealing with ship technologies, intermodal connections and costs could be appended to the database as these data collection efforts are underway.

This fully functional, customized online Geographic Information System (GIS) called ***Midwest FreightView*** (MWFV) was developed originally as part of the *Mississippi Valley Freight Coalition.* The original project was conducted as a cooperative venture between ten Midwestern state departments of transportation and the National Center for Freight Infrastructure Research and

Education at the University of Wisconsin, The University of Illinois-Chicago, and The University of Toledo. The main objective of this resource continues in effort to maintain a long-term database and data distribution system built on a strong relationship with the political jurisdictions and stakeholders listed above. This data resource will thus serve as a central focus for these various interests to come together to focus on optimizing freight movements within the region. With the addition of other interests such as firms, shippers, carriers, regional planning agencies, port authorities and economic development organizations, this resource can have a direct positive impact on the regional economy.

GLMIDS is an outgrowth of the initial MWFV project. As such, the system is well positioned to carry out the ongoing task of assembling, storing and managing maritime data for the Great Lakes system. MWFV is incorporated in the GLMIDS website and is available at http://maritime.utoledo.edu. The site is able to accommodate a wide range of users that extends between casual browsers and "basic mappers" to more experienced GIS and database analysts. Though still in the development stage, some basic information resources in the form of prepared maps, graphics, tables and text are published and available on the Atlas page at the site. Additional tools for analysis and display options, database software, text editors and spreadsheets are available in the dataViewer. The user interface for this data reporting system was designed to be as logical and intuitive as possible. It is built on a *Citrix Metraframe* installation with a customized *ArcView GIS* application. (See the Appendix for snapshots of the dataViewer.) All operations are carried out on the Toledo Server—the users' computers simply act as a terminal. A contact link to the Toledo team is provided to obtain a username and password, which are required to work in and view the dataViewer.

The system will eventually support a complete set of advanced analysis capabilities such as vehicle routing and travel time computations to evaluate the effectiveness of the network to support freight movements. As a result of this vision, the system has begun to evolve into an effective tool for economic development planning as a means to measure accessibility to markets, identify bottlenecks in the network that hinder freight flows, and for identifying feasible locations for warehousing, manufacturing, retail and intermodal connection facilities.

Automatic Data Collection

The main focus during this phase was developing the data exchange interface and file transfer protocols between GLSS and The University of Toledo Center for Geographic Information Science and Applied Geographics (GISAG). Moving forward, the project team will continue to follow the approaches underway to consult with shippers and carriers, maritime labor organizations, port authorities, federal and state agencies, regional economic development organizations and other interests to identify market segments that can be served competitively by the GL MTS. This project will utilize these efforts in AIS vessel tracking as a means to expand upon the existing work in linking the GL MTS into the detailed regional freight data reporting system (*Midwest FreightView*).

To date, significant efforts have been devoted to acquiring, managing and storing detailed economic data to document patterns of activity among all of the economic sectors linked to

freight movements. Acquiring and using AIS data will allow us to more effectively document patterns of freight flows within the system in a more timely fashion. This expanded data acquisition system will enable analysts to more effectively measure the economic impacts of great lakes shipping on the regional economy by understanding the directions of the flow of freight within the region. The system will also provide valuable data dealing with estimated origins and destinations of freight movements within the region as a means to support the modeling of freight flows among modes--including water--within the region.

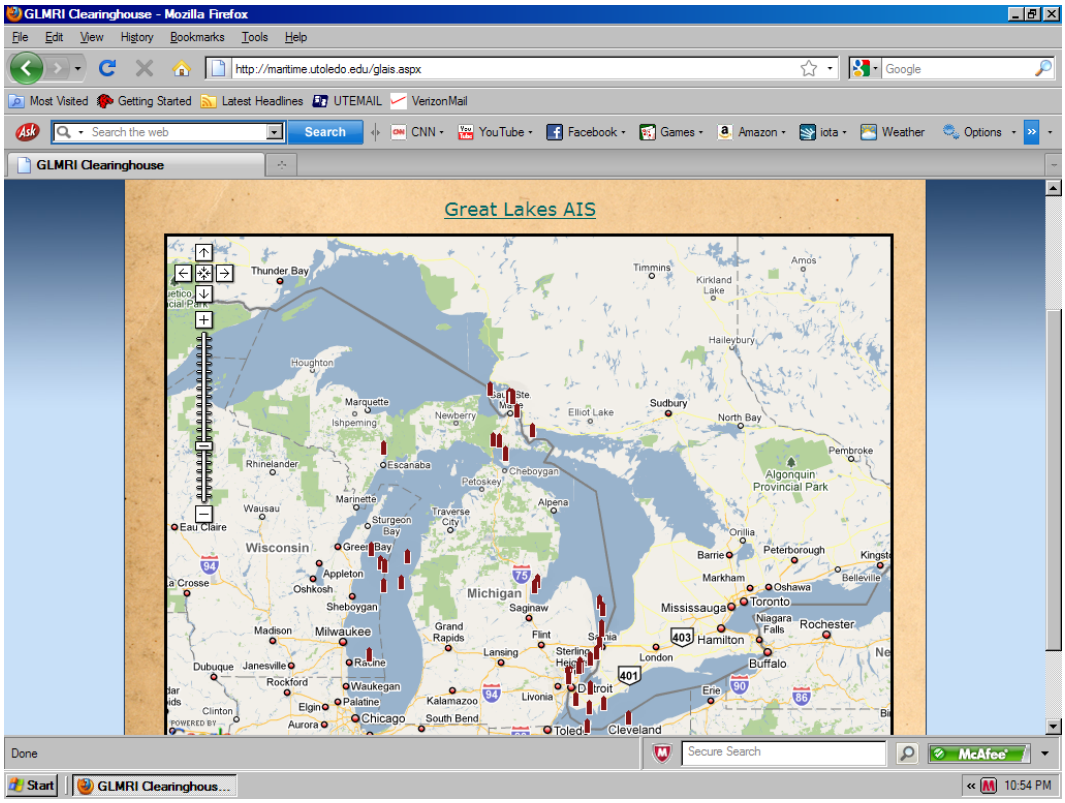

Figure 1. Platform for automated AIS data collection

Identification of market segments to be served by AIS data collection can be effectively dovetailed into the current system through specific efforts directed at acquiring specific data that deal with markets potentially served. These include:

- Tonnages
- Value of Cargo
- Scheduled Service
- Ship Technologies
- Dock and Port Facilities
- Intermodal Connections and Transshipment Costs

Once identified and collected, these data can provide opportunities to identify key individuals within each segment to contact and to develop the appropriate market plan for each segment (Vonderembse, 2007).

Conclusion

The combined vision of The University of Toledo University Transportation Center, the Great Lakes Maritime Research Institute, the Center for Freight Infrastructure Research and Education, the project team and our partners in industry have led to this version of the Great Lakes Maritime Information Delivery System presented here. To date, the project has produced a multi-dimensional data gateway system that will support the following functions:

- A detailed data repository for vessel movements, port functions, commodity flows, economic activities and environmental impacts, etc.
- A GIS data viewer for advanced users to view and analyze a variety of data
- An information delivery site for maps, tables, graphics, text and other features in the form of the ***Atlas of Great Lakes Maritime Commerce***
- A data exchange to support user inquiries and furnish information on demand.
- Assembly of data and report information among different Geographic areas of impacts and jurisdictions (*e.g*., States and Provinces, Congressional districts, Cities, Counties, Ports, *etc*.)
- Establishment of a communication link within the system (*e.g*., email access) for regional stakeholders to request specific information to be posted on the site. This function was agreed upon as essential if the information delivery was to be successful
- Establishment of a system for data exchange to analysts in maritime agencies and organizations; also develop a site in the system for analysts within the region to publish the results of their analysis—particularly with regard to public policy issues of interest to the Great Lakes Maritime Industry
- Development of a library function in the form of a data clearinghouse that reviews and summarizes data from diverse sources--both public and commercial--and provide links for users to branch to from the site.

The result of which is to provide stakeholders of Great Lakes maritime commerce with a comprehensive centralized resource for data and information. This aspect of the system focused on acquiring AIS data through the development of automated data collection techniques. This data collection resource will be used to model vessel flows and intermodal transshipments of commodities within the region as a means to relieve congestion on the highway system and ultimately to promote efficiency, reduce transportation costs, and minimize environmental impacts. Use of the data available in this system will enable users to more effectively identify those market opportunities for the GL MTS. Such as, short sea shipping within the lakes themselves as well as, diverting international trade from gulf and east coast ports into the GL MTS through the seaway as a means to relieve highway and rail congestion on land. The additional data from tracking vessel movements will certainly enhance the system's ability to deliver current, accurate data for analysis purposes.

Furthermore, this maritime information resource will thus enable shippers, carriers, public agencies and policymakers to conveniently examine a comprehensive view of the transportation infrastructure within the region with features of maritime transportation assets. More advanced users will be able to prepare maps that can incorporate a wide range of variables documented within the database. Less experienced users of the system will be able to use their web browsers to obtain detailed information in the form of graphics, tables, text and maps that incorporate any desired component of the transportation system: highways, railroads, intermodal facilities, ports, airports and the GL MTS. These components of the database will thus enable users to display freight movements and traffic volumes and relate these movements to economic activity in the region. Users can also download printed maps of their map compositions from the site.

Finally, continuous improvement of the information delivery system will remain a major objective as this resource evolves in the coming years. The project team will strive to maintain an open dialog with the members of the industry to assure success in this endeavor. Our dialog has also expanded to a wider audience through the dissemination of results shown in the references section of this report. Members of the project team will also be presenting on this system in a poster session at the Transportation Research Board (TRB) annual meeting in Washington, D.C. in January 2010.

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Dissemination of Results: GLMIDS

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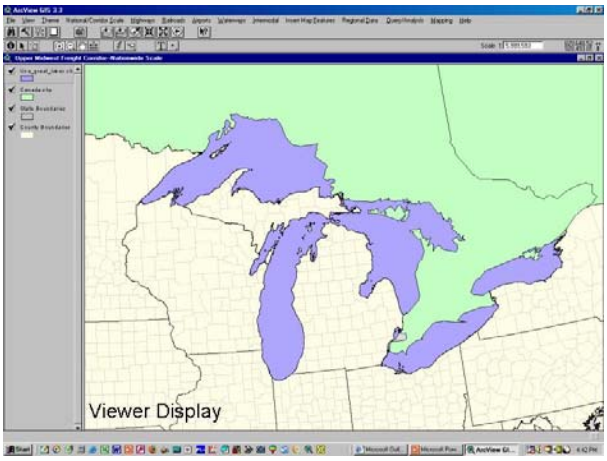
Lindquist, P.S., 2006. "Progress Report: The Great Lakes Maritime Information Delivery System", Joint Conference on the Great Lakes: From Data to Markets to Shipping Opportunities, GLMRI, UT ITI, ICHCA International, Toledo, Ohio, November 7, 2006.

Schafer, S.E. 2008. Creating a Think Tank, *Seaway Review* 36(3): 54-55.

APPENDIX

Sample of Map Output from *Midwest FreightView*
Great Lakes Maritime Database
And Detailed Data Listing



Example 1: Basic Mapping Functions

Figure A.1
Initial display for the user Interface in ***Midwest FreightView***

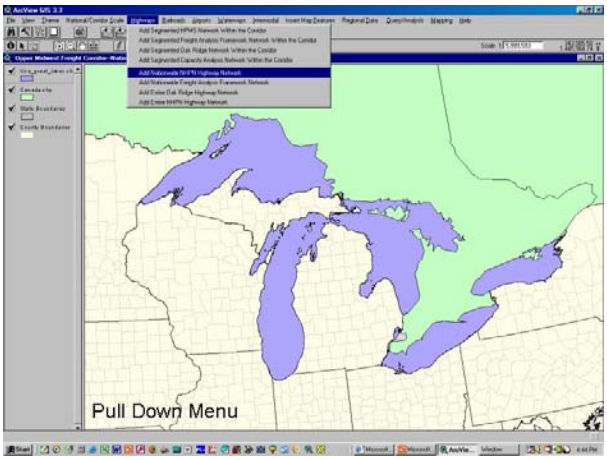


Figure A.2
User activates pull down menu to open the highway network in the Great Lakes Region.

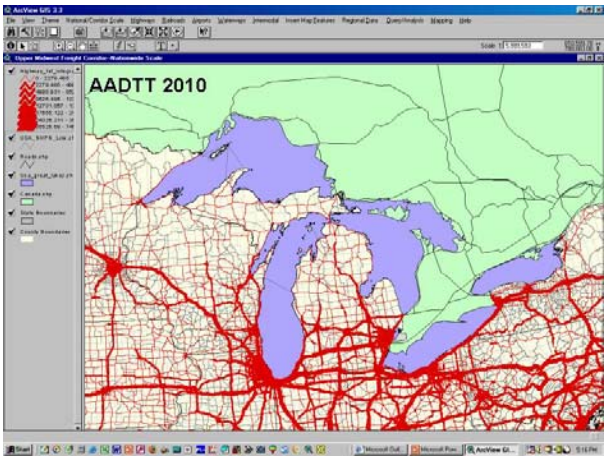


Figure A.3
MWFV provides users with the ability to highlight specific features in the display. In this case, interstate highways are highlighted according to projected 2010 Average Annual Daily Truck Traffic
(Source: FAF).

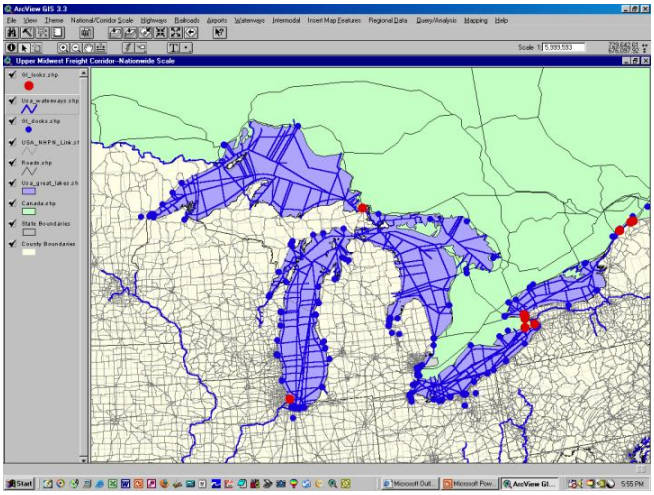


Figure A.4
MWFV displays integrated waterway network connecting docks/terminals, navigational locks, and waterway routes in the Great Lakes

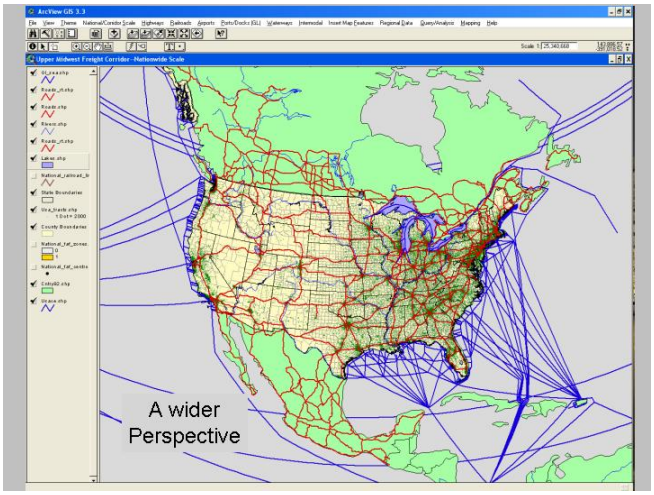
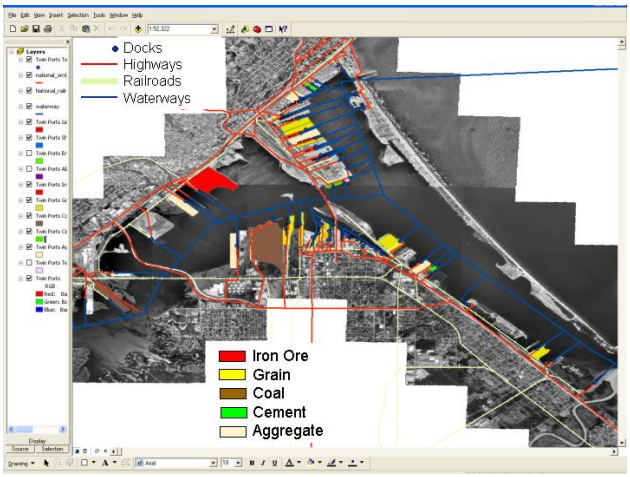


Figure A.5
A wider view of continental-scale waterway and highway networks connected to the Great Lakes Ports.

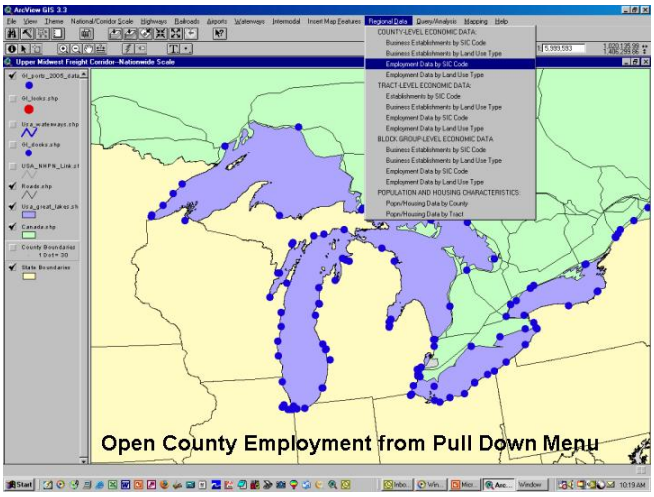


Example 2: Integrating the Waterway Network to the Landside Rail and Highway Networks at Terminals

Figure A.6

Aerial Photograph and GIS Data Layers: Port of Duluth / Superior

Superimposed Highway, Rail, Waterway and Dock Connections in Intermodal Network; Docks displayed by commodity



Example 3: Linking the Great Lakes Maritime Transportation System to the Regional Economy.

Figure A.7
User activates pull down menu to open the regional employment database. In this case, the user is opening employment data by census tract.

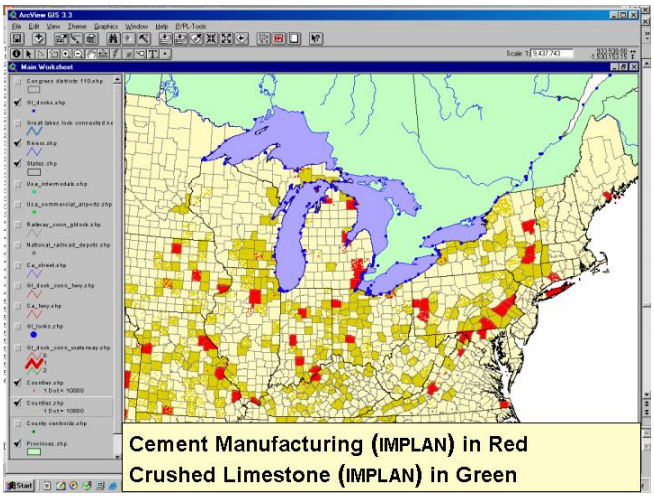


Figure A.8
MWFV displays a dot distribution map of cement manufacturing employment and Crushed Limestone Production alongside Great Lakes dock locations.

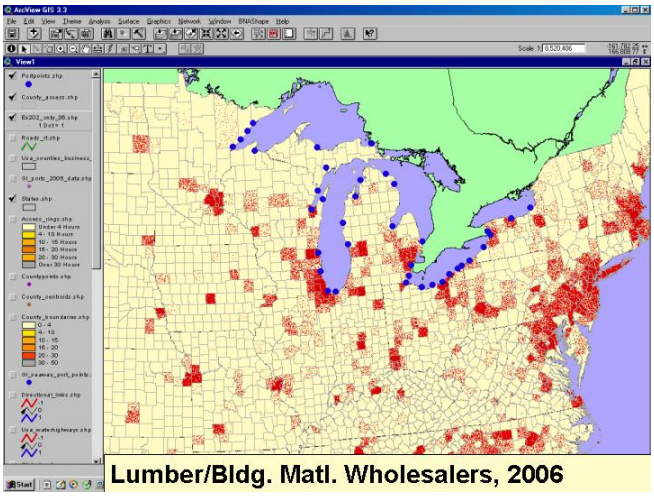


Figure A.9
MWFV displays a dot distribution map of Lumber and Building Material Wholesaler employment alongside Great Lakes dock locations—a potential market for imported building products.

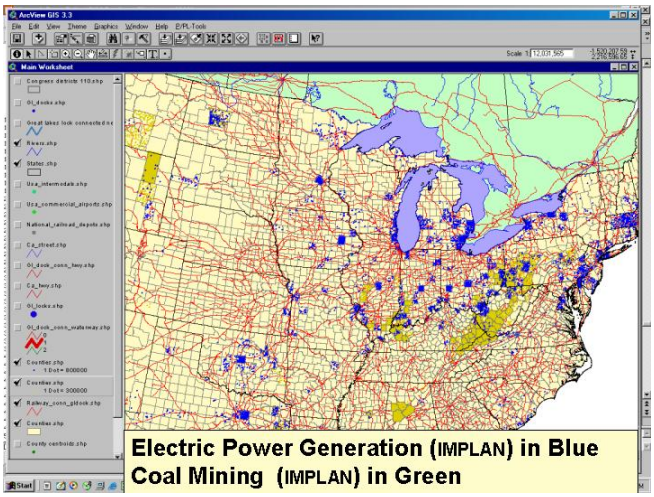


Figure A.10
MWFV displays the distribution of coal mining employment and fossil fuel electric power generation within the Midwest superimposed on the rail network.

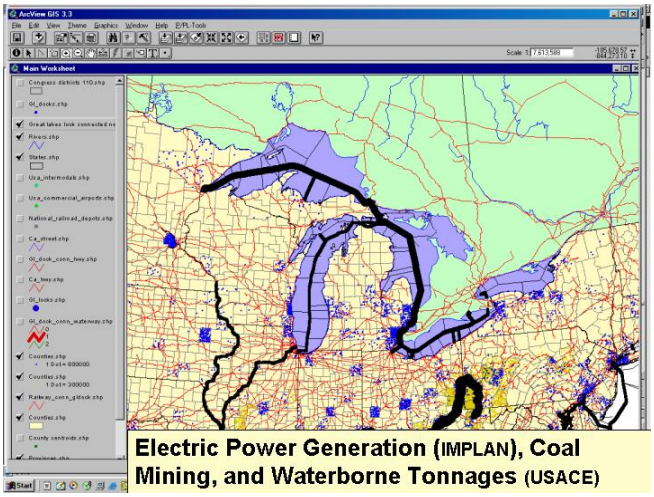


Figure A.11
MWFV now displays the distribution of coal mining employment and fossil fuel electric power generation within the Midwest and the flow of coal over the waterway system.

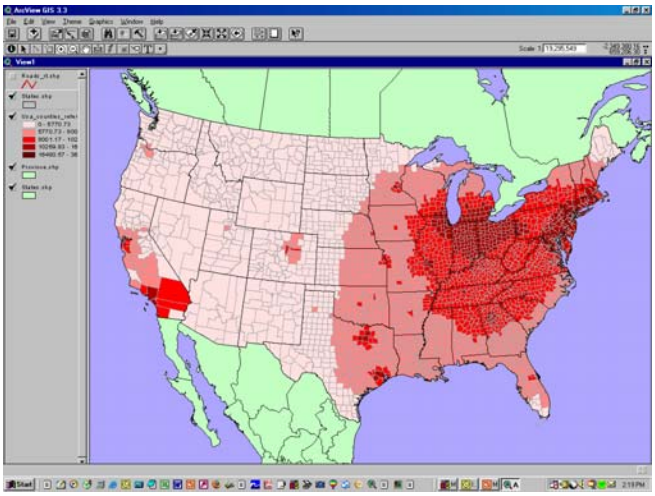


Figure A.12
MWFV now displays the results from newly-developed data analysis software. The map at the left displays the density of wholesale trade activity in the US by county. This density map shows the proximity of wholesale distributors relative to each county weighted by employment. Those regions in the darkest colors have the greatest accessibility to wholesale trade in the U.S.

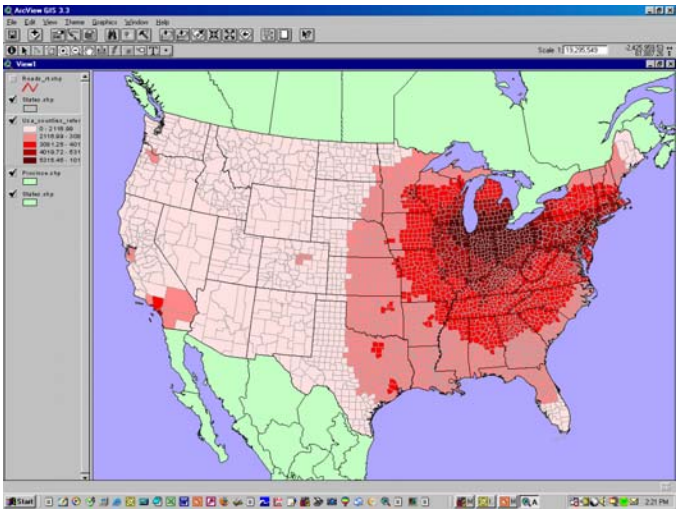


Figure A.13
MWFV now uses the same software to display the density of heavy equipment manufacturing by county. This density map shows the proximity of heavy equipment manufacturers relative to each county weighted by employment. Those regions in the darkest colors have the greatest accessibility to this sector in the U.S.

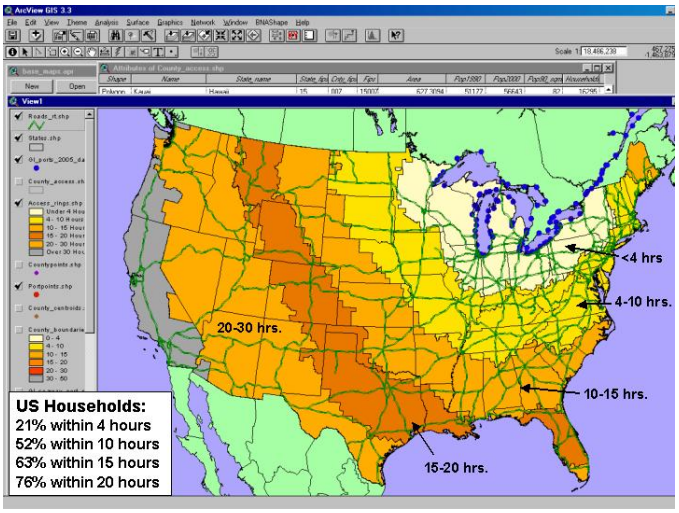


Figure A.14
Accessibility from Great Lakes Ports to National Market

Another example of output from recently developed data analysis software in MWFV. Travel Time to US households from their nearest Great Lakes Ports by Highway.

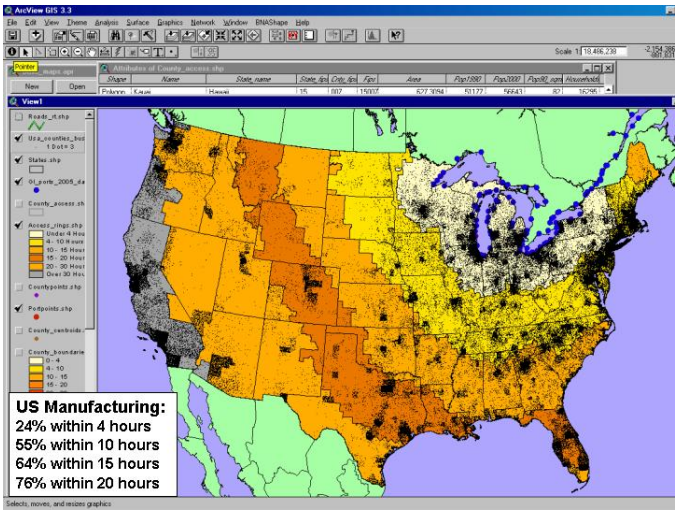


Figure A.15
Accessibility from Great Lakes Ports to National Manufacturing

Another example of output from recently developed data analysis software in MWFV. Travel Time to manufacturers from their nearest Great Lakes Ports by Highway.

Specific data assembled into the centralized data repository currently include the following:

1. Intrastate Employment patterns for each commodity type by SIC, NAICS, (Demographics Plus, Inc. *Business Counts Database*);
2. Population and Socioeconomic data representing Market Demand within the region;
3. Port Locations—U.S. (BTS National Transportation Atlas);
4. Dock Locations (Army Corps of Engineers) and attributes;
5. Waterway Network—Great Lakes and Inland Waterways (Army Corps of Engineers);
6. Baseline 2002 commodity flows through the Saint Lawrence Seaway and Great Lakes System obtained from the FHWA Freight Analysis Framework estimated from 2002 Commodity Flow Survey Data.
7. Population and Socioeconomic data representing Market Demand within the region (U.S. Census)
8. Port Locations—U.S. (BTS National Transportation Atlas);
9. Dock Locations (Army Corps of Engineers) and attributes:
10. Waterway Network—Great Lakes and Inland Waterways (Army Corps of Engineers)
11. Baseline 2002 commodity flows through the Saint Lawrence Seaway and Great Lakes System obtained from the FHWA Freight Analysis Framework estimated from 2002 Commodity Flow Survey Data. This data set provided the research team with a skeleton framework upon which to add subsequent flow data.
12. Employment by NAICS Classification among Counties and MSAs in Study Region (Source: BLS ES/202);
13. Lock Locations and lock performance statistics—U.S. side;
14. Weather Station Data (NOAA, to approx. 60 Miles Inland);
15. Updated US Highway Network that combines the HPMS and ORNL Network attributes and includes speeds and estimated travel times on links;
16. Integrated Network—Great Lakes Waterway, Highway, Rail linked to Commercial Docks, Locks (Army Corps of Engineers);
17. MARAD Annual Vessel Movements (1994-2004);
18. Import/Export Flows (Great Lakes East Coast and Gulf Ports);
19. FAF Zones and Centroids;
20. FAF2 OD Flows (National and Regional Scale);
21. Satellite Imagery / Aerial Photography of Dock Facilities;
22. Vessel Inventory—Great Lakes Fleet;
23. Updated Canadian Rail and Highway Networks.