Management Systems for Inland Waterway Traffic Control

FINAL REPORT

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SUMMARY

Genesis, Evolution and Structure of the Report

In February 2003, the Center for Transportation Studies at the University of Missouri-St. Louis released a white paper produced for the Institute for Agriculture and Trade Policy (IATP) entitled: "Upper Mississippi River and Illinois Waterways: How to Reduce Waiting Times of Vessels While Using the Current Infrastructure." The white paper recommended investigating an appointment system and revisiting some other low cost measures previously identified but rejected by the U.S. Army Corps of Engineers as a means of reducing the congestion that occurs periodically at locks in the Upper Mississippi River and Illinois Waterway.

Based on that recommendation, the Center for Transportation Studies initiated a project in March 2004 designed to (1) improve the management of and reduce the operational costs of inland water transportation assets and (2) identify and evaluate specific traffic management measures for implementation on the Upper Mississippi River and Illinois Waterways segment of the inland water transportation system. This project was to be funded by the Midwest Transportation Consortium and the IATP, with lock operations data to be provided by the Institute for Water Resources (IWR) of the U.S. Army Corps of Engineers, and was originally scheduled to be completed in March 2005. Soon after initiating work on the project, the IATP withdrew as a potential project partner.

In June 2004, the IWR agreed to fund a companion project at the Center for Transportation Studies that would investigate the potential use of vessel tracking systems primarily as an aid in implementing lockage and traffic management policies. Funding this companion project also made the Corps a full partner in the original study. The "vessel tracking" companion project included: (1) an investigation of automatic vessel tracking applications and related geographic information systems for inland waterway transport on the Upper Mississippi River system, (2) the documentation of appropriate technologies necessary to implement a vessel tracking system, and (3) the development of a prototype vessel tracking geographic information system.

Consequently, this report is structured in two distinct but related volumes. Volume 1, "Identification and Evaluation of Alternatives for Managing Lock Traffic on the Upper Mississippi River", focuses on identifying and evaluating traffic management alternatives for possible implementation and Volume 2, "Vessel Tracking for Managing Traffic on the Upper Mississippi River", focuses on the feasibility of using vessel tracking systems to provide real time or near-real time data on tow positions in support of new lockage or traffic management policies. Each Volume is summarized separately below.

Volume 1

This volume examines and evaluates alternative traffic management policies designed to improve the efficiency of lockage operations in an intermittently congested segment of the Upper Mississippi River (UMR) navigation system. The traffic management

alternatives examined and evaluated range from lock appointment systems, to re-sequencing tows for processing at a lock or a series of locks, to the complete scheduling of vessel movements on the waterway.

A detailed statistical analysis of U.S. Army Corps of Engineers 2000-2003 OMNI data compiled for the UMR navigation system is presented which indicates that the UMR system segment bounded by Lock 20 upstream and Lock 25 downstream experiences some periodic traffic congestion, is subject to intra-seasonal changes in demands for service, and operates as a interconnected system in that Locks 20-25 share a large amount of common and interrelated commercial tow traffic. The statistical analysis considers the role of many diverse factors in the operation of the UMR such as: the different types of vessels using the system; the different types of lockages required by different vessels; the night or day movements of vessels in the pools connecting the locks, the night or day lockages of vessels; and differing river flow characteristics that affect tow movements, to determine their impact on lockage times and transit times between locks. Equations produced by the statistical analysis are then employed in a new simulation model used to evaluate the results of implementing scheduling and sequencing rules designed to manage queues and vessel traffic more efficiently at Locks 20-25.

The discrete event simulation model is presented, validated against known UMR traffic flows, and used for investigating the effects of these traffic management alternatives. The simulation model extends earlier inland navigation simulation models of systems of locks by explicitly incorporating seasonal and interdependent traffic demands for specific origin and destination trips into the model. The simulation model is calibrated with historic data and shown to accurately represent the overall operation of the system including the periodic seasonality of the demand for lock use evident in the U.S. Army Corps of Engineers OMNI data.

Volume 2

This volume examines the feasibility of vessel tracking systems for better managing lockages on the UMR navigation system. Vessel tracking systems are widely available and can be used to improve waterway operations and to enhance safety, security and environmental protection in many settings. This volume describes current vessel tracking applications and technologies and presents a prototype vessel tracking geographic information system for the UMR. A description of automatic vessel tracking and related applications that have been developed for a variety of purposes worldwide and may be relevant to the UMR is presented first. This includes satellite-based vessel tracking systems, automatic identification systems (AIS), vessel traffic services, and vessel traffic management systems. The volume then discusses ongoing efforts to develop comprehensive inland waterway traffic management systems that exploit technological developments to provide stakeholders with information to support better waterway decision-making.

Next, the volume describes technologies necessary to implement a vessel tracking system on the UMR, including methods for acquiring dynamic data for vessels, and for communicating this data to a geographic information system (GIS) for visual display.

Important issues in position reporting, communications, and data integration, as well as key organizational issues involving responsibility and authority associated with vessel tracking on the UMR are highlighted.

Finally, a prototype vessel tracking GIS is presented that provides static displays and an example of dynamic vessel tracking to demonstrate the functionality possible from vessel tracking on the UMR. The prototype is built using the ArcMap 9.0 GIS with the Tracking Analyst extension for managing the dynamic display.

Conclusions and Recommendations

Our analyses reveal that, as a consequence of the low commercial traffic levels currently evident in the UMR navigation system, implementing an alternative traffic management policy does not appear to yield sufficient benefits relative to its costs to warrant the market disruptions its implementation would create. However, the implementation of a vessel tracking system could be designed to provide the additional benefits of enhancing homeland security, improving navigation safety, protecting environmentally sensitive river habitats. It may also provide a basis for implementing future traffic management policies should traffic levels significantly increase or the operational characteristics of the UMR navigation system significantly degrade.

Recommendation 1: New traffic management policies such as appointment and scheduling systems should not be implemented on the UMR at this time because of the small economic benefits they would create relative to their costs at existing traffic levels and the potential disruptions they would create in existing water transportation markets.

Recommendation 2: New traffic management policies such as appointment and scheduling systems should be evaluated under conditions of both significantly increased traffic levels and significantly degraded operating characteristics of the locks comprising the UMR navigation system in order to ascertain the effectiveness of alternative management policies in those circumstances.

Recommendation 3: Any vessel tracking system for lockage or traffic management on the UMR should be designed in concert with the selection of a potential lockage or traffic management alternative.

Recommendation 4: The responsibility and legal authority for lockage and traffic management on the UMR should be clarified before implementing larger scale lockage and traffic management systems.

Recommendation 5: Opportunities to partner with other agencies and private organizations in developing vessel tracking on the UMR should be explored. One area for special attention is to strengthen linkages with the Coast Guard regarding the implementation of AIS.

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Appendix A can be downloaded from http://www.cts-umsl.org/waterways.