Ohio River Navigation Investment Model (ORNIM): An Analysis Tool for the U.S. Army Corps of Engineers

Center for Transportation Analysis (CTA) Research Areas

Aviation Safety
Air Traffic Management Analysis
Data, Statistical Analysis
Geo-Spatial Information Tools
Defense Transportation
Energy Policy Analysis
Environmental Policy Analysis
Highway Safety
Intelligent Transportation Systems
Logistics Management
Supply Chain Management
Modeling and Simulation
Transportation Operations
Planning and Systems Analysis
Transportation Security

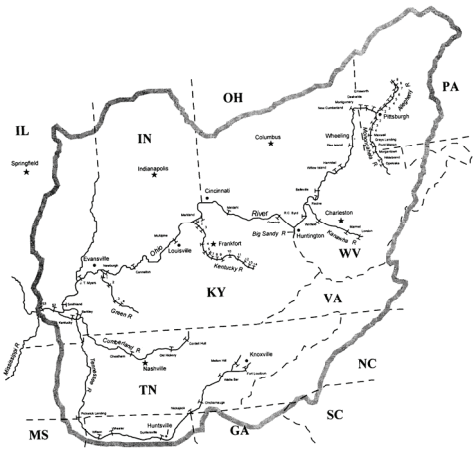
Patricia S. Hu, Director
Center for Transportation Analysis
Oak Ridge National Laboratory
2360 Cherahala Boulevard
Knoxville, TN 37932
865.946.1349
(Fax) 865.946.1314

Website: cta.ornl.gov

Oak Ridge National Laboratory is managed by UT-Battelle, LLC, for the U.S. Department of Energy under Contract number DE-AC05-00OR22725

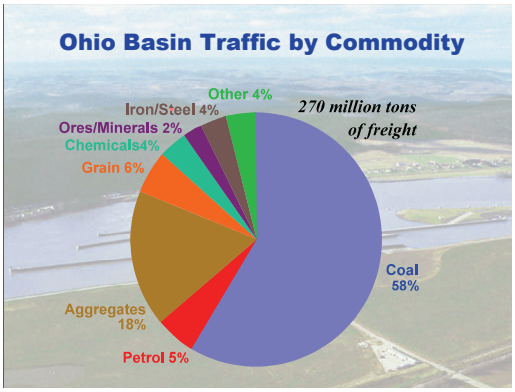
UT-BATTELLE

In support of the U.S. Army Corps of Engineers (USACE), the ORNL Center for Transportation Analysis (CTA) developed a set of analysis tools which are being used to plan investments in the Ohio River system over a 70 year time horizon. Each year, more than 270 million tons of cargo move across the 2800 miles of the Ohio River System. The river is a very attractive alternative to rail and highway transportation of heavy bulk cargo such as coal, grains, and building materials as long as the travel times are within reasonable ranges. As the travel times increase due to congestion at the locks, however, the additional cost begins to cut into the savings. The goal of the analysis is to determine the long range investment path (increasing reliably, expanding locks, etc.) which will maximize the net benefit to the country.



River Network

CTA developed a suite of analysis programs which model the movement of barges on the river, analyze lock reliability and delays, and select optimal replacement, repair or modernization efforts over the planning horizon. The models allow USACE staff analysts to compare different scenarios, projections and options for improvements on the waterway.



ORNIM Development

The Ohio River Navigation Investment Model (ORNIM) can be described as a spatially-detailed partial-equilibrium model. While it is not designed to estimate the total benefits of a river system, it is appropriate to estimate the benefits of incremental improvements. Freight transportation supply and demand is part of a simultaneous decision process by multiple economic agents, with spatial and time dimensions. ORNIM focuses on modal choice, or more specifically modal diversion from water shipment, while trip generation and distribution is handled exogenously through inputs (i.e. waterway traffic demand forecast scenarios). Waterway route assignment can be handled in the model by allowing the system to select the optimal path or by specifying the use of historical shipping paths.

ORNIM data is housed in a Microsoft Access database, which is combined with a Visual Basic interface that assists the user in specifying analysis assumptions, viewing and editing inputs, executing the C++ models and analyzing model results. The structure allows for easy importing and exporting of data to other applications (e.g. spreadsheets) and the use of external linear-programming packages. The building block approach of the model's modular design has already proven to support major conceptual redesigns during development with moderate to minimal code modifications. This should also be beneficial during the planned future expansion of the model to incorporate the Navigation Predictive Analysis Technique (NAVPAT) environmental model as an ORNIM module. The major advantage of ORNIM over previous techniques is its ability to analyze thousands of investment permutations at multiple projects and its ability to automatically select optimal project investment plans.

ORNIM consists of three basic modules: the Waterway Supply and Demand Model (WSDM) Module, the Lock Risk Module (LRM) and the Optimization Module. The WSDM Module determines the shipper-based equilibrium for a given set of demands and lock conditions. LRM uses a Monte Carlo process to estimate probabilities of closures due to lock component failures. The Optimization Module automates the selection of investments, previously a laborious manual process. The innovation of ORNIM is not only a more modern and efficient version of standard functionality, but also the leverage of these new capabilities into a new process for developing and assessing system investment plans.

Experience with the Model

The ORNIM system has been developed by CTA in cooperation with the Lakes and Rivers Division of the USACE. It has recently been used to develop the System Investment Plan for the Ohio River Mainstem Study, a major analysis effort involving five major future scenarios over a 70 year time horizon. Hundreds of alternative actions ranging from component replacements to major construction were analyzed for each scenario in isolation and in combination. These actions were then combined to form investment plans for the system.

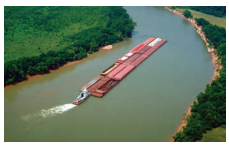
The ORNIM System


Repair Plans and Costs


Reliability Estimates


Random Closure Probabilities

Lock Risk Module


Cargo Forecasts

Optimal Investment Module

Waterway Supply and Demand Module


Towboat/Barge Operations

Optimal Investment in Projects and Maintenance


Construction Plans


Lock Operations


River Network

For more information regarding this research contact Michael Hilliard, Center for Transportation Analysis, Oak Ridge National Laboratory, phone (865) 946-1305 or email hilliardmr@ornl.gov.