NIM: Navigation Investment Model

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NIM in Brief

• Set of analysis tools that are used to evaluate the benefits of investments in a river system

• Developed for the Huntington District of the US Army Corps of Engineers, beginning in 1995

• Comprises three major modules:
  – Waterway Supply and Demand Model (WSDM)
  – Lock Risk Model (LRM)
  – Optimization Module
ORNIM Modules

- WSDM
- Traffic Levels
- LRM
- Investment Plan
- Reliability Estimates
- Optimization
Waterway Supply and Demand Module

...determines equilibrium waterway traffic levels under a given system configuration and forecast scenario for each year in the analysis period, taking into account scheduled lock closures.
WSDM: Calibration

The NIM calibration process involves modifying movement and network parameters to force WSDM to develop shipping plans that mimic historic navigation shipping plans.

- Movement dedication factors
- Tow size limits
- Towboat utilization factors

Statistics are compared to targets at projects.
WSDM Equilibrium Process

Each movement has its own cost curve and demand function:
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Each movement has its own cost curve and demand function:

- Price: $p^*$
- Tonnage: $q^*$
- Demand function
- Cost function
- Consumer surplus
For short closures (1 day, 3 days, 10 days, etc.), movements are expected to accept the resulting delays. What about longer closures?

NIM provides a mechanism to indicate the response of each movement to a closure.

- Length of closure
  - e.g., different response to 15 – 59 vs 60 – 180 days
- Range of years
  - e.g., different response in years 2020 and 2037
- Externality costs by category
  - e.g., truck accidents, emissions, delay
Lock Risk Module

...estimates the probability of each potential closure in each year of a component’s life, given equilibrium traffic levels, hazard functions and event trees.
Lock Risk Module

Monte Carlo Simulation: A series of dice rolls.
For each component, step through its lifetime:
In year $y$, does it fail?
  If no, increment $y$
  If yes, what is its failure level?
    what is its fix level?
Apply repair consequences.
Lock Risk Module Results

Probability of Closure

Year

Probability

180-days Main
240-days Main
365-days Main
Optimization Module

…systematically compares investments, selects the optimal investment strategy and summarizes the results.
Optimization Alternatives

- Cover a range of improvements:
  - Component replacement
  - Rehabs
  - Extensions

- Can change
  - Components
  - Transit times
  - Maintenance schedules / costs
  - Costs
Optimization Objective

- Net Economic Benefits
- Include
  - Cost reduction benefits
  - Shift-of-mode benefits
  - Shift-in-origin or -destination benefits
  - New movement benefits
  - Induced movement benefits
ORNIM Modules

- WSDM
- Traffic Levels
- LRM
- Investment Plan
- Reliability Estimates
- Optimization
Metrics Reported

• Tonnage accommodated
• Tonnage diverted
• Transit times
• Average delay
• Externalities estimates
  – Road damage
  – Safety
• Tonnage by river segment
National Needs → Metrics and Objectives

**National Needs**
- Reduced Cost
- Increased Profits
- Economic Growth
- Jobs
- Security
- Resiliency
- Safety
- Environment
- Energy reduction

**Metrics**
- Traffic accommodated
- Traffic diverted
- Average Delays
- Capacity utilization
- Transit times

**Objective**
- Net benefits