INLAND NAVIGATION ECONOMICS WEBINAR SERIES

Mark Hammond
Inland Navigation Economics 101
LRD-PD-S
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Corps Inland Navigation Mission

Provide a safe, reliable, efficient, effective and environmentally sustainable waterborne transportation system for movement of commerce, national security needs, and recreation.

Federal interest in navigation derives from the Commerce Clause of the Constitution.
Corps Inland Navigation Role

• Plan, design, construct, operate and maintain infrastructure to support inland navigation.

• Locks & dams, channel dredging, river training works, bank protection, electronic charting (inland); cargo data collection and analysis, etc.

Public Law 95-502 describes the waterways and Corps role
• Nearly 12,000 miles 9 ft & over
• 192 lock sites / 238 chambers
• Moving about 600 million tons
• About 2/3 cost of rail and 1/10 cost of truck
LRD Nav Center to PCXIN

• 1982 ORD/LRD Regional Center for Inland Navigation Planning
  • System benefit estimation
  • Common data sets & models
  • 13 authorized/constructed; 3 lock rehabs author/construct

• 2003 USACE PCXIN
  • Support feasibility-level studies in other basins
  • PA class sponsorship
  • Model certification
  • Peer Review (RMO)

• Other areas of support
  • Dam Safety/Levee Safety
  • Asset Management
  • Special Operational Studies
PCXIN Technical Skills

- LRH-NC
  - 9 economists, 2 engineers, 1 operations analyst, 1 program analyst
  - 1 review manager, 1 statistician, 4 statistical assistants
- Other LRH offices – 2 PD, 2 PM, 2 OPs
- Other LRD economists – 2 LRB, 1 LRE, 1 LRC, 1 LRP, 1 LRL, 1 LRN
- Other Corps economists - IWR, MVS, MVP, MVN, MVR, NWP
- Regional Universities (Marshall, Tennessee, Toledo, Texas A&M, North Dakota State, Oregon)
- Oak Ridge National Labs & AE firms
Six Step Planning Process

1) Identify Problems & Opportunities - Scoping
2) Inventory & Forecast Critical Resources*
3) Formulate Alternative Plans – Nonstructural, Structural
4) Evaluate Alternative Plans – NED, EQ, RED, OSE
5) Compare Alternative Plans
6) Select Recommended Plan – NED, NER, Combined

* Involves readying the economic model(s) too!

Planning Guidance Notebook ER
1105-2-100 22 Apr 2000
SMART Feasibility Study Process

In-Progress Reviews (IPRs) as needed
### Right Level of Detail at Right Time

<table>
<thead>
<tr>
<th>Level of Detail Drivers</th>
<th>Problem &amp; Opportunity</th>
<th>Inventory &amp; Forecasting Without Project</th>
<th>Formulation</th>
<th>Evaluation/Screening</th>
<th>Comparison</th>
<th>Selection</th>
</tr>
</thead>
<tbody>
<tr>
<td>CRITERIA (metric &amp; Methodology)</td>
<td>Available Metric (Data)</td>
<td>- uncertainty level is often high</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Recommendation**

- Customized data, often quantitative
- Uncertainty may have been reduced

**Available Metric (Data)**

- Uncertainty level is often high
PCXIN & SMART Planning

- Data – current and consistent
  - Traffic Projections
  - Transportation Rates
  - Operating Costs
  - Commodity Value
- Models – certified/approved
  - System Model (NIM)
  - Capacity Model (WAM)
  - Port Model (GLSAND)
  - Lock Closure Model (SCC)
- Study Ready
- LRD Mandatory
Problems & Opportunities

• Reliability – Aging Infrastructure
• Asset Management – Infrastructure Strategy
• Ecosystem Restoration – Watershed Approach
• World Trade – Economic Growth
Inventory and Forecast

- Study Area
  - Resources
  - Industries
  - Commodity Traffic
  - Transportation Systems
- Shippers (Demand)
  - Traffic Demand*
  - Transportation Rates*
  - Willingness to Pay*
- Project Performance (Supply)
  - Reliability*
  - Capacity*

* major data inputs to the Navigation Investment Model (NIM)
Inventory and Forecast

Forecast Waterway Demand

WCSC Data
Base Year

Forecasts Based on Alternative Futures
Inventory and Forecast

Transportation Rates
Waterway & Overland

Base Rate Savings

<table>
<thead>
<tr>
<th></th>
<th>Current</th>
<th>Future</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waterway Cost:</td>
<td>$ 10</td>
<td>$ 16</td>
</tr>
<tr>
<td>Overland Cost:</td>
<td>$ 20</td>
<td>$ 20</td>
</tr>
<tr>
<td>Savings/Ton:</td>
<td>$ 10</td>
<td>$ 4</td>
</tr>
</tbody>
</table>

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BUILDING STRONG®
Inventory and Forecast

Willingness-to-Pay for Barge Transportation

Price Elasticity of Demand – Shipper Stated Preference Curve

\[ \varepsilon_{pq} = \frac{\%\Delta p}{\%\Delta q} \]
Inventory and Forecast

Modeling Lock Performance - Capacity

- Tonnage-Transit (Supply) Curve
- WAM uses LPMS data to simulate Supply

Family of Curves – set of curves for different closure durations
Inventory and Forecast

Component Engineering Reliability - RISK

- Hazard Function
- Event Tree

- Performance over time
- Non-Price Determinant of Supply

Hazard Function
Event Tree

Performance over time
Non-Price Determinant of Supply

MINOR #1
MINOR #2
MAJOR
CATASTROPHIC
Inventory and Forecast

- **Demand**
  - Forecast (Uncertainty)
  - Rates (Cost)
  - Elasticity (Shape, Slope)

- **Supply**
  - Capacity (Ton-Transit)
  - Reliability (Risk)
Formulate Alternatives

- Management Measures
- Structural/Non-Structural
- Formulate to maximize benefits to national economy and environment
  - Completeness
  - Effectiveness
  - Efficiency
  - Acceptability

[Diagram showing different maintenance strategies: Structural, Rehabs, Component Replacements, Reactive Maintenance]
Formulate Alternatives

Without-Project Condition

• Most likely condition expected to prevail in the absence of additional project authorizations
• Baseline for evaluating investments in the with-project condition
• Determine life cycle costs and benefits of operating existing infrastructure (i.e. no scheduled replacements), focusing on critical components (Reactive Maintenance)
• Includes non-structural measures
Formulate Alternatives

With-Project Condition

• Most likely condition expected to exist in the future with the implementation of a water resources development project

• Comparison to without-project conditions to identify effects of proposed plan

• The with and without-project comparisons provide framework for evaluating alternative plans
Formulate Alternatives

With Project Condition Environmental Features

- Ecosystem Restoration Projects
- Sustainability-based mitigation
  - Fish passage at dams
- Habitat mitigation for dam tail water impacts
  - Mussel bed degradation
- Beneficial use of disposal materials
  - Ohio River Islands National Wildlife Refuge
Evaluate Alternatives

NIM Suite of Modules

- Lock Risk Module
- Waterway Supply & Demand Module (WSDM)
- Optimization Module

- Engineering Reliability Estimates (& Consequences)
- Failure Repair Plans & Costs
- Investment Plans
- Expected Repair Costs
- Expected Transportation Costs
- Normal Op equilibrium lock tonnages
- Prob. Of Service Disruption
- Component Survivability
- Expected Repair Costs

- Willingness-to-pay for Barge Transportation
- River Network, Lock Performance Characteristics, & Towing Characteristics / Costs
- Forecast Waterway Traffic Demands
- List of Closures

Optimal Investment Projects & Maintenance

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Evaluate Alternatives

Four Accounts

- NED* – changes in economic value of the national output of goods and services
- EQ* – non-monetary effects on ecological, cultural, and aesthetic resources and effects of ecosystem restoration
- RED – changes in regional economic activity (income and employment)
- OSE – community impacts, health and safety, energy conservation, etc.

* required
# Compare Alternative Plans

Formulation Criteria Matrix ranked by average annual net benefits

<table>
<thead>
<tr>
<th>Plan</th>
<th>Criterion</th>
<th>Efficiency</th>
<th>Effectiveness</th>
<th>Completeness</th>
<th>Acceptability</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>New 600', Close Land After New Chamber Becomes Operational</td>
<td>Blue</td>
<td>Yellow</td>
<td>Green</td>
<td>Red</td>
</tr>
<tr>
<td>2.</td>
<td>New 600', Close Land After Wall Failure</td>
<td>Blue</td>
<td>Yellow</td>
<td>Green</td>
<td>Red</td>
</tr>
<tr>
<td>3.</td>
<td>New 600’ Keep Land Open as FAF</td>
<td>Green</td>
<td>Yellow</td>
<td>Green</td>
<td>Red</td>
</tr>
<tr>
<td>5.</td>
<td>New 800', Close Land After New Chamber Becomes Operational</td>
<td>Yellow</td>
<td>Yellow</td>
<td>Green</td>
<td>Red</td>
</tr>
<tr>
<td>7.</td>
<td>New 800’ Keep Land Open as FAF</td>
<td>Yellow</td>
<td>Yellow</td>
<td>Green</td>
<td>Red</td>
</tr>
<tr>
<td>9.</td>
<td>New 1200', Close Land After New Chamber Becomes Operational</td>
<td>Yellow</td>
<td>Yellow</td>
<td>Green</td>
<td>Red</td>
</tr>
<tr>
<td>11.</td>
<td>New 1200’ Keep Land Open as FAF</td>
<td>Yellow</td>
<td>Yellow</td>
<td>Green</td>
<td>Red</td>
</tr>
<tr>
<td>13.</td>
<td>New Twin 600’</td>
<td>Blue</td>
<td>Yellow</td>
<td>Green</td>
<td>Red</td>
</tr>
<tr>
<td>13a</td>
<td>New 600’ Deferred New 600’ Land Chamber</td>
<td>Blue</td>
<td>Yellow</td>
<td>Green</td>
<td>Red</td>
</tr>
<tr>
<td>15.</td>
<td>New 1200’ and New 600’</td>
<td>Red</td>
<td>Red</td>
<td>Green</td>
<td>Yellow</td>
</tr>
<tr>
<td>16.</td>
<td>Advanced Maintenance</td>
<td>Yellow</td>
<td>Yellow</td>
<td>Green</td>
<td>Red</td>
</tr>
<tr>
<td>17.</td>
<td>Without Project, Reactive Maintenance</td>
<td>Yellow</td>
<td>Yellow</td>
<td>Green</td>
<td>Red</td>
</tr>
</tbody>
</table>

Blue – superior, green-acceptable, yellow-questionable, red-unacceptable performance to meet study objectives

BUILDING STRONG®
Select Recommended Plan

- Preferable to no action
- NED Plan – maximizes net benefits
- NER Plan – (for ecosystem restoration projects)
- Combined NED/NER Plan – optimum
- LPP - complicated
Navigation Economics Products/Review

• **Appendix** – Project Navigation Study Economics
  - Attachment 1 – Navigation Investment Model (NIM)
  - Attachment 2 – Lock Capacity Analysis
  - Attachment 3 – Traffic Demand Forecasts
  - Attachment 4 – Transportation Rate Analysis
  - Attachment 5 – Social Costs of Diverted Traffic

• Review Plan (EC - 214)
  - ATR – required
  - IEPR – mandatory if…

• Model Status (EC - 412)
  - NIM - certified
  - WAM - certified
  - BCM – approved for use
  - GEM (LTI) – proprietary*
  - Traffic Diversion Model - proprietary*

* Approval not necessary; HQ requests thorough review of product