Pavement Asset Management
Decision Support Tools:
Ohio Department of Transportation Case Study

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Introduction

- Aging pavement network and tight budget at most highway agencies
- Demonstrated optimal use of M&R dollars has become necessary amid calls for transparency and accountability
- Ohio DOT has developed decision support tools for pavement asset management through research projects
- Expanding from pavement to bridges and other assets
- Pilot for web access of information and tools
Condition of Different Systems

PCR Mileage Report

System = All Systems / Priority = All / District = All Districts / County = All Counties / Route = All Routes / PavementType = All Types / Year = 2011 - 2011

The diagram shows the condition of different systems based on priority, with categories for Excellent, Good, Fair, Poor, and Very Poor. The data spans the years 2011-2011.
Average Treatment Performance

System = All Systems / Priority = P / District = All Districts / County = All Counties / PavementType = All Types / Year = 1997 - 2011
Pavement Condition History

LUC 075R PCR (Manual Log) vs Year (2-2.05)

- PCR UP
- PCR DOWN
- Projects UP
- Projects DOWN
Network Level Optimization

- Supports high level asset management decisions
- Estimate the minimum budget required to achieve a desired condition level
- Maximize the benefits for a given amount of budget
- Determine treatment policy and budget allocation
Network Level Optimization

1. Minimize Total Cost
2. Maximize Network Condition

- Historical Pavement Condition
- Project History
- Treatment Classification
- Markov Prediction Model
- Current Pavement Condition
- Treatment Unit Cost
- Available Budget
- Optimal Treatment Policy & Budget Allocation
- Network Condition Prediction
- Condition Target
- Allowable Treatments
- Condition Classification
- Required Minimum Budget
Markov Prediction Model

Markov Transition Probability Matrix:

\[
P = \begin{bmatrix}
p_{11} & p_{12} & p_{13} & p_{14} & p_{15} \\
p_{21} & p_{22} & p_{23} & p_{24} & p_{25} \\
p_{31} & p_{32} & p_{33} & p_{34} & p_{35} \\
p_{41} & p_{42} & p_{43} & p_{44} & p_{45} \\
p_{51} & p_{52} & p_{53} & p_{54} & p_{55}
\end{bmatrix}
\]

\[P_{11} = 0.7 \quad P_{12} = 0.2 \quad P_{13} = 0.1 \quad P_{14} = 0 \quad P_{15} = 0\]
Markov Prediction Model

- System priority: General and Priority
- Pavement type: Concrete, Flexible and Composite
- Repair treatment: Preventive Maintenance, Thin Overlay, Minor Rehab and Major Rehab

\[2 \times 3 \times 4 = 24\] pavement groups are formed

### Treatment Matrix

<table>
<thead>
<tr>
<th></th>
<th>Excellent</th>
<th>Good</th>
<th>Fair</th>
<th>Poor</th>
<th>Very Poor</th>
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<td>Very Poor</td>
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### Do Nothing Matrix

<table>
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<tr>
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<td>0.73</td>
<td>0.27</td>
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<td>0</td>
<td>0.69</td>
<td>0.31</td>
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<td>Poor</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.58</td>
<td>0.42</td>
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<tr>
<td>Very Poor</td>
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<td>0</td>
<td>0</td>
<td>1</td>
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</table>
Performance vs. Treatment Cost

Pavement Condition Deterioration Trend

- Minor Rehabilitation
- Major Rehabilitation
- Deficiency Threshold

PCR vs. Pavement Age

0 5 10 15 20
## Determination of Treatment Policy

### Current Network Condition

### Predicted Performance

### Condition Target

### Treatment Options & Cost

### Optimization

<table>
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<th>Condition</th>
<th>Recommended Treatment</th>
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<td>Fair</td>
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<tr>
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### Optimal Treatment Policy

$ \text{Required Network Budget}$
Minimum Budget Required to Achieve a Condition Level

<table>
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<th>Deficiency Level</th>
<th>Year</th>
<th>Condition Target</th>
<th>$ Budget ?</th>
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<td>3.0%</td>
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<tr>
<td>2.0%</td>
<td></td>
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<tr>
<td>1.0%</td>
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<tr>
<td>0.0%</td>
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Recommended Treatment Budget and Allocation

Year


Budget ($ Million)

2011: PM, Thin Overlay, Minor Rehab, Major Rehab
2012: PM, Thin Overlay, Minor Rehab, Major Rehab
2013: PM, Thin Overlay, Minor Rehab, Major Rehab
2014: PM, Thin Overlay, Minor Rehab, Major Rehab
2015: PM, Thin Overlay, Minor Rehab, Major Rehab
2016: PM, Thin Overlay, Minor Rehab, Major Rehab
2017: PM, Thin Overlay, Minor Rehab, Major Rehab
2018: PM, Thin Overlay, Minor Rehab, Major Rehab
2019: PM, Thin Overlay, Minor Rehab, Major Rehab
2020: PM, Thin Overlay, Minor Rehab, Major Rehab
2021: PM, Thin Overlay, Minor Rehab, Major Rehab
2022: PM, Thin Overlay, Minor Rehab, Major Rehab
2023: PM, Thin Overlay, Minor Rehab, Major Rehab
2024: PM, Thin Overlay, Minor Rehab, Major Rehab
2025: PM, Thin Overlay, Minor Rehab, Major Rehab
2026: PM, Thin Overlay, Minor Rehab, Major Rehab
2027: PM, Thin Overlay, Minor Rehab, Major Rehab
2028: PM, Thin Overlay, Minor Rehab, Major Rehab
2029: PM, Thin Overlay, Minor Rehab, Major Rehab
2030: PM, Thin Overlay, Minor Rehab, Major Rehab
Budget Allocation among Treatments to Achieve the Best Condition Level

Budget $140 Million

Allocation ?

Condition ?
Network optimization can be used as a decision making tool to answer “what-if” questions regarding:

- Impact of different condition targets
- Impact of different funding levels
- Impact of different budget allocation
- Impact of different repair treatment policy
Deficiency Level Versus Average Annualized Expenditure

Average Annualized Expenditure Per Lane Mile ($1,000)

Deficiency Level

Priority System

General System
Future Directions: Transportation Assets Management

- Pavement
- Pedestrian Facilities
- River Ports
- Parks
- Bike Facilities
- Transit Lines
- Rail Lines
- Bridges
- Ohio’s Assets
Pavement Management Development

Markov Forecast ➔ Road Inventory

Decision Trees ➔ Pavement Condition

District Work plans ➔ Capital Projects

Maintenance Projects ➔
1. DoIT will transfer Pavement Databases needed for analysis into Sybase. DoIT Support
2. DoIT will provide GQL access to those basic databases on the PMS model.
3. Pavement Engineering will provide DoIT with the pavement management logic needed for programming analysis tools.
4. Pavement Engineering and DoIT will develop an update plan for all pavement databases.
State Average PCR for each System Over Time

Year

Average PCR
88 87 86 85 84 83 82 81 80 79 78 77 76 75 74 73

State Avg
Priority Avg
Urban Avg
General Avg
## Average Conditions at Rehabilitation

General System Flexible Pavements Activity 50 and Activity 60 from 1985 to 2010

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<th>1</th>
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<th>3</th>
<th>4</th>
<th>5</th>
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</table>
ODOT: District 3
Pavement Condition Condition Ratings, 2011

Legend
PCR Values
0 - 65
66 - 69
70 - 79
80 - 89
90 - 100
City Area
County

Note: This map shows the lower PCR value of a road segment with both up and down segments. Not all lengths of road have an up and a down segment.

Data Source: ODOT PCR PMS Table
Office of Technical Services, February 2012
Remaining Life

System = All Systems / Priority = All / District = 3 / County = All Counties / Route = All Routes / Pavement Type = All Types / Rem Life From = 2010

PCR Threshold - Priority = 65 / Urban = 60 / General = 60
Replacement Cost Summary

Pavement
$241,122,800

Bridge
$158,087,295

Culvert
$13,097,400

Barriers

Signs

Lighting
$6,904,492

$419,211,988
Pavement Summary

**ODOT - Priority System**
- 2008: 98%
- 2009: 97.3%
- 2010: 97.9%
- Goal: 95%

**ODOT - General**
- 2008: 98%
- 2009: 98%
- 2010: 97.3%
- Goal: 90%

**ODOT - Urban**
- 2008: 98%
- 2009: 98%
- 2010: 97.5%
- Goal: 90%
Where are we going?

- Currently Implementing a Commercial Pavement Management System (Deighton System)
- Currently developing an integrated asset management system prototype through the University of Toledo
- Currently Implementing Web-GIS application for displaying, distributing, and analyzing pavement and other assets
- Currently developing the framework for asset management database (consolidated database, COD)

- Performance Based Management
- Return on Investment Management
- Integrated System Support Tools
- World Class Transportation System
Thank You!