Pavement Preservation Integration with Pavement Management

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Pop Quiz #1

YOU HAVE TWO CARS. HOWEVER, YOU HAVE MONEY FOR ONLY ONE OIL CHANGE. WHICH CAR GETS THE OIL CHANGE?

CAR #1

CAR #2
Pop Quiz #2

You have bought your dream house.
Pop Quiz #2

How would you prevent it from becoming this?
National Context

- 4,000,000 + Miles of Pavement Structures
- $1,000,000,000,000 (1 Trillion) Network asset worth
- Each US citizen
  - “owns” 70 ft of highway
  - $17,000 personal investment
- 3” thick, 12’ wide AC Pavt paved from NY to LA / day
- Enormous Portion of our National Economy

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Dr. Matthew Witczak
National Context

  – Lifeline of Public Travel Mode (Work and Leisure)
• Difficult to Visualize System will Become Obsolete in Intermediate to Long Term
• As a Nation, We Have NO ALTERNATIVE but to maintain Current Network Infrastructure

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## National Context

- **Budget Needs**
  - 2010: $54.0 B
  - 2015: $61.5 B

- **Proj Rev. Exp. deficit**
  - 2010: $34.2 B
  - 2015: $40.5 B

- **Exp. deficit**
  - 2010: $19.3 B
  - 2015: $21.0 B

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Pavement Management

“...a management approach used by personnel to make cost-effective decisions about a road network.”

AASHTO Pavement Management Guide (2001)
Pavement Management System

“...a set of tools or methods that assist decision-makers in finding optimum strategies for providing, evaluating, and maintaining pavements in a serviceable condition over a period of time.”

Decision Criteria

- Highest Benefit for Lowest Lifecycle Cost
- Condition Constraints set by Agency
- Budget Constraints on Agency
- In reality, not one highway segment but many
  - 3800 centerline miles in Connecticut
- How do we do this?
Pavement Deterioration Curve

Pavement Condition

Very Good

Routine Maintenance

Preventive Maintenance

Rehabilitation

Reconstruction

Very Poor

New

Pavement Age

Old
Pavement Deterioration Curve

- Very Good
- Routine Maintenance
- Preventive Maintenance
- Rehabilitation
- Reconstruct

- New
- Pavement Age
- Old

Pavement Condition
Inventory Data

• Network data:
  – Physical location
  – Dimensions (number of lanes)
  – Traffic volumes and classification

• Pavement data:
  – Type (flexible, composite, rigid)
  – Construction history
  – Surface age
  – Material properties
  – Pavement Condition
Condition Data

• Structural condition
  – Cracking
  – Rutting
  – Roughness
  – Patching/Deterioration

• Structural capacity: modulus $\frac{\sigma}{\varepsilon}$
  – Falling Weight Deflectometer (FWD)
  – Seismic Pavement Analyzer
Condition Data

• AASHTO Road Test:
  – Serviceability criteria (% of 14-person panel rating the road “unacceptable”)
  – Proxy: Pavement Serviceability Index (PSI)
    • Roughness, Cracking, Rutting, Patching & Deterioration
      • $\text{PSI} = 5.03 - 1.9 \log(1+\text{SV}) - 1.38 \times \text{RD}^2 - 0.01 \times (\text{C}+\text{P})^{0.5}$
Functional vs. Structural Condition

- Serviceable pavements which have failed structurally (cracked but smooth)
- Structurally sound pavements with low serviceability (not cracked but rough)
- Treatments differ based on cause
  - Re-profile to make smooth
  - Major rehabilitation to make structurally sound
  - Costs vary
- Pavement engineers must address both
Inventory Data Collection

• Planning, Inventory, and Data
  – Traffic, pavement type, dimensions

• Geographic Information Systems
  – Climate, soils

• ConnDOT ARAN vehicles (Photolog)
ConnDOT Data Collection Vehicle

- GPS
- PVT DISTRESS
- PHOTOLOG
- R-O-W IMAGING
- ROUGHNESS
- RUTTING
- INERTIAL REFERENCING (GYRO)
Wisecrax Image

- Lane identification
- Red lines are detected cracks
- Summarized for every 10 meters of pavement length
- Stored on database
Pavement Performance Models

- **Condition vs. Time**
  - Environmental cracking index
    - TRANSVERSE CRACKS
  - Structural cracking index
    - WHEelpATH LONGITUDINAL CRACKS
  - Rutting index
    - MAXIMUM RUT
  - Roughness (ride) index
    - IRI

- **Panels**

- **Existing condition data**
Pavement Performance

• Pavement performance is modeled based on pavement families
  – “Flexible pavements with high traffic in a coastal zone and clayey soils in a poorly drained area”

• Condition versus time
Pavement Performance Models

ENVIRONMENTAL CRACKING for Family: {Flexible, Thin, Light Traffic, Inland, Good Soil}
Putting it all together

• Network optimization using a single condition index
  – Replicate the analysis for all segments in the network
  – Optimize over the long term (network goals)

• Treatments triggered by specific conditions
  – Nature of distress

• PMS software used to produce program and impacts
  – Deighton Associates’ dTIMS-CT, 2007-2008
Condition Index

• Pavement Condition Index
• Scale 1-9
• Historically collected via windshield survey
  – Roughness, Distortion, Cracking, Disintegration, Drainage
• “Synthetically” produced by PMS now
• Used for network optimization, but treatments are triggered by individual indicators (structural, functional)
Treatments Considered

- Reconstruction 😊
- Quasi-reconstruction 😊
- Structural Rehabilitation (significant milling, repair, and/or overlay) 😊
- Functional overlay / diamond grind 😊
- Thin and Ultra-thin resurfacing 😊
- Not crack sealing 😞
Cost/benefit analysis

• **Costs**
  - *Agency Costs*
    - Construction, maintenance
  - *User Costs*
    - Delays during construction
    - Vehicle operating costs

• **Benefits**
  - Difficult to quantify
  - Area under the curve that includes the treatment
Costs and Benefits

- Very Good
  - Routine Maintenance
- Pavement Condition
  - Preventive Maintenance
- Very Poor
  - Rehabilitation
  - Reconstruction

New | Pavement Age | Old
Outputs of PMS

- Required funding, impact on network with available funding
  - Multi-year program (3-5 years)
  - Multi-year impacts (10-20 years)

- Relative size of programs by treatment
Pavement Preservation

• A set of planned actions that are done on structurally sound pavements to extend their life.
  – The RIGHT treatment on the RIGHT road at the RIGHT time.
Pavement Preservation in PMS

• Are preservation treatments included in PMS?

• What impacts on pavement performance are modeled?

• To what level of detail can actions be programmed?

• Is my pavement condition data sufficiently timely for use in preservation treatments?
Pavement Preservation in PMS

• Are preservation treatments included in PMS?
  – YES, except for crack seal
What impacts on pavement performance are modeled?

- Rubberized chip seal:
  - Moves a pavement 10 years back up the “environmental” condition index
  - Resets “disintegration” distress.
  - Shifts the condition index up.
Pavement Preservation in PMS

What impacts on pavement performance are modeled?

- **Reclamation:**
  - Moves a pavement back 18 years in age
  - Resets all condition indices to 9 (excellent).
  - May change the pavement family
Pavement Preservation in PMS

• To what level of detail can actions be programmed?
  – Depends on how detailed *(given: accurate and precise)* the data are and whether it relates to the causes of distress.

• Can always go back to condition data
Using PMS data at a project level

- Treatment specific
- Look at driving distress
- Find threshold value
  - Would rather have more detail in data
- Filter out segments above threshold value
- Have a prioritization scheme
  - A. Oldest, B. Best condition
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<th>Distress</th>
<th>Traffic Cause Ext. Sev.</th>
<th>Crack seal</th>
<th>Crack fill</th>
<th>Rubberized Chip seal</th>
<th>Microsurfacing</th>
<th>Ultra-thin HMA</th>
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<th>Mill and Fill</th>
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Indicator of environmental cracking for thin HMA

- **Transverse cracks**
  - Threshold value: 3 meters / 10 meters of lane

- **Transverse cracks as fraction of total**
  - Indication of predominance of this distress

- **(Pavement age)**
  - If it’s too new then it could be reflection cracking
Next Steps

- Review Pavement Families – preserved vs. unpreserved curves
  - Allows for benefit of crack-sealing (preserved curves flatter)
- Finalize the Pavement Preservation Matrix using PMS data
- Refine relative costs (M&P of traffic, safety, etc.)
Pavement Preservation in PMS

• Is my pavement condition data sufficiently timely for use in preservation treatments?
  – At present, we have found the limits of our data (maybe with more time to look at the data?)
  – Pavement Preservation decisions from distress data require higher accuracy and precision because achieving cost-benefit ratio with project scope is very time-sensitive (but “bad is bad”)
Thank you for your attention!

Questions?