Maintenance Decision Support System
Pooled Fund Study TPF-5(054)

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MDSS Stakeholders Meeting #11
Charlotte, NC September 16, 2009
Motivation for MDSS

- Rising expectations of traveling public and commercial carriers
- Rising material & fuel costs
- Constrained agency funding and staffing
- Reliable, timely, reports of conditions hard to get
- Some weather conditions are difficult to forecast
- Pavement response to weather conditions and maintenance treatments is complex
- New deicing chemicals are available
- Retiring maintenance staff replaced by less experienced workers
MDSS is New…
but Not New

- Assess DOT Needs, Readiness
- Evaluate Functional Prototype
- Develop MDSS Software
- 6-State Limited Deployment
- Refine MDSS Software
- Validation Studies
- 8-State Field Trials
- 10-State Field Trials
- Expanded Deployment
- 12-State Field Trials
- B/C Analysis
- 14-State Field Trials
- Broad Deployment
- Refinement, Management Tools
- 2002
- 2003
- 2004
- 2005
- 2006
- 2007
- 2008
- 2009
- 2010

2003
2004
2005
2006
2007
2008
2009
2010
MDSS Growth 2002-2009

5 states (2002)

15 states (2009)

Contractor is Meridian Environmental Technology
MDSS Routes 2008-2009

<table>
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<tr>
<th>State</th>
<th>Routes</th>
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<td>CA</td>
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Project Objectives

**Integrate**
- Maintenance practices & policies
- Available maintenance resources
- Previously reported maintenance treatments
- Road conditions & predictions
- Weather conditions & forecasts

**To Yield**
- Continuously updated maintenance recommendations
- Mechanisms that enable “what if” decision support
- Information for business analysis
MDSS Operating Premise

If you know…
- road characteristics
- current conditions
- predicted weather
- physics & chemistry of snow, ice, chemicals
- available resources (material, equipment, schedule)

MDSS can recommend…
- treatment type
- application rate
- optimal timing

...and predict
- future road conditions with or without treatments
MDSS Mass & Energy Model

MDSS operation requires knowledge of plowing and chemical applications
Pooled Fund MDSS: Essential Elements of MDSS

- Report actual road conditions
- Report maintenance treatments
- Assess past & present weather conditions
- Assess present roadway state
- Predict storm-event weather
- Recognize resource constraints
- Identify feasible maintenance treatments
- Predict road surface behavior
- Communicate recommendations to supervisors and workers
Science-based integration of information from many independent systems:

- Weather observation systems  
  (*in situ* & remotely sensed)
- Weather forecast systems
- RWIS/ESS
- Maintenance vehicles
- Human-reported conditions and activities
Modeling Achievements

- Sophisticated new road condition and maintenance modeling capabilities:
  - Traffic impacts on road surface moisture on a vehicle-by-vehicle basis
  - Mass & energy balanced treatment of the road condition impacts of all deicers
  - Calculation of combined freeze points resulting from arbitrary deicer mixtures
  - Cross-sectional differentiation of roadway conditions / snow & ice depths
MDSS Road Condition Prediction

Pavement Temp: 32.5°F
Percent Ice: 44%
LIII/F/S Depths: 0.019 / 0.000 / 0.000 / 0.15"
No Materials Present

Pavement Temp: 32.0°F
Percent Ice: 45%
LIII/F/S Depths: 0.020 / 0.000 / 0.000 / 0.17"
No Materials Present
Multiple means of generating maintenance plans and expected outcomes:

- “Dynamic” approach based on maintaining Level of Service at least cost in consideration of available local resources, practices, and policies
- “Standard Practice” approach based on local, state, or Manual of Practice guidelines
- “What If?” approach permitting construction and assessment of user-defined maintenance plan

Side-by-side comparisons of expected outcomes permitted
Note different road conditions resulting from different maintenance plans.
GIS-based user interface for configurable, integrated visualization and analysis of:
- Road condition analyses & forecasts
- MDC/AVL data, including dashboard cameras
- RWIS/ESS data
- Weather observations & forecasts
- Blowing snow analyses & forecasts
- Camera imagery
- Maintenance recommendations
- Outcomes of user-definable maintenance plans
MDSS Graphical User Interface (GUI) Map View
MDSS GUI Route View
Field Achievements

- Real-time assimilation and interpretation of data received from maintenance vehicles
  - Reported road and weather conditions adjust MDSS assessment of current conditions, alter recommendations
  - Impacts of communicated maintenance activities are simulated and used to adjust predicted conditions and need for further maintenance activities

- Real-time feed of vehicle-specific, maintenance-centric information back into vehicles
  - Tailored recommendations, forecasts, radar imagery, and fleet location depictions
Mobile Data Collection
Sensors & Antennas
Mobile Data Collector
Touch Screen Computer

SDDOT Maintenance Decision Support System

DEMO
TRUCK
FRONT: ↑
↑ WINGS ↓
UNDERBODY: ↑

80% / 20% Sand/NaCl
Rate: 700 lb/min

MATERIAL
30% Other
Rate: OFF

HIGHWAY
Speed: 15 mph
GPS: 43.241543°N
97.577828°W

SNOW
<1/4 Mile

WEATHER
14.4°F

ICE
12°F

ROAD

WEATHER
14.4°F

COMMUNICATION
AVAILABLE
MDSS

Recommended Actions:
- For I-70A, MP 258.73-258.73, Passing: Wed 02:16 MDT Ice Slicer 100lbs
- For I-70A, MP 265.73-269.01, Driving: Wed 02:16 MDT Ice Slicer 100lbs
- For I-70A, MP 265.73-269.01, Middle: Wed 02:16 MDT Ice Slicer 100lbs
- For I-70A, MP 265.73-269.01, Passing: Wed 02:16 MDT Ice Slicer 100lbs

Forecast:

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<thead>
<tr>
<th>Time</th>
<th>Wind Speed</th>
<th>Wind Direction</th>
<th>Precip Type</th>
<th>Prob (%)</th>
<th>Rate</th>
<th>Cover (%)</th>
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<td>RA 80</td>
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Training & Evaluation Achievements

- Capability for ‘storm playback’ of recent or saved storms at user-defined pace
  - Aid post-storm evaluation of maintenance operations
  - Review what information was available for making decisions, and when
  - Aid in training new employees
    - winter maintenance concepts
    - use of MDSS in storm situations
Performance Tracking Achievements

- Use of MDSS in benefit-cost study pointed out potential new application for assessing winter severity from a maintenance-centric perspective

- Developing new analysis capability
  - Select arbitrary time periods
  - View various measures of winter or storm severity
  - Compare with agency cost and performance data
MDSS Benefits: Projected

- Achieve same level of service with less material & effort
  - 23% material savings in New Hampshire study

- Achieve better level of service with same material & effort
  - 10-15% less “unacceptable” conditions in New Hampshire study

- 8:1 Benefit/Cost Ratio New Hampshire

- Similar studies performed in MN, CO
MDSS Benefits: Realized

- Indiana first-year statewide deployment in winter of 2008/2009
  - Substantial reduction in salt use ($12M)
  - Reductions in overtime ($1.3M) & fuel
  - Estimated savings of $11M overall after normalizing for winter conditions

- Mitchell Region (SD) event example $60/mile versus $300/mile
PFS: Current Technical Directions

- Fostering initial deployments
- Integration w/DOT Information Systems
  - Equipment, scheduling, traveler Information
- Evaluation, validation, and refinement
- Improving physical models supporting MDSS
- Improving remote assessments of weather conditions
- Development of more management-oriented tools and reports
PFS: Lessons Learned

- MDSS science is complex
- Although valuable, MDSS technology is still young and will continue to mature
- MDSS requires and drives culture change
- Training is crucial to user adoption & acceptance
- MDSS does not replace the decision-maker and is intended to be a guidance tool
- Benefit of using MDSS as an information and management tool is substantial & may exceed direct benefit of recommendations
PFS: Sustainability Issues

- Intellectual Property
  - **NOT** Public Domain
  - Equity for partners and non-partners

- System Architecture
  - Open Architecture
  - Interface Standards
  - System Modularity

- Institutional Issues
  - Fit MDSS to specific DOT cultures & practices

- Advance the State of Art & Practice
PFS: Benefits of Membership

- Opportunity to “test drive” MDSS
- Convenient funding mechanism
- Learning environment
  - State ↔ State
  - State ↔ Vendor
- Peer exchange process to identify and address technology challenges through research and development activities
- Nationally prominent forum for moving MDSS and related technologies forward
PFS: Member Responsibilities

- Contribute Financially
- Contribute Intellectually
  - Project Panel Meetings (3/year)
  - Conference Calls
  - Technical Product Reviews
  - Assess Technology Gaps & Needs
- Conduct Field Trials
- Intellectual Property Stewardship

New States Are Welcome
Questions?

For additional information, please contact:

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