Strategies for Ensuring Optimal Guidance in Decision Support Systems for Winter Maintenance Operations

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A Common Challenge

- How to use disparate road weather data and information to make critical decisions concerning roadway operations

Road Condition Data
Atmospheric Data
Radar Data
Satellite Data
Forecast Data
Field Observations

I don’t really care about weather…just tell me what to do!
Decision Support System: One Perspective

- An information system that uses an interactive analytical modeling process to recommend an action (or no action). System is based upon
  - decision models (e.g., industry best practices)
  - a database
  - a decision maker's own insights

- Road Weather Decision Support System
  - Fully automated
  - Objective, repeatable guidance
  - Targeted guidance (weather and road)

- If properly constructed, can serve as a single repository of road weather information and guidance
Essential Elements of a DSS for Winter Maintenance
Data Inputs

DSS DATA INPUTS
(High-level)

Input Data

Forecasts
  - Atmospheric
  - Road

Observations
  - Environmental Sensor Stations
  - Radar
  - Satellite
  - Mobile Platforms

Road Authority Specific Data and Information
  - Routes of Interest
  - Road As-built Properties
  - Maintenance Fleet
  - Available Chemicals
  - Agency-specific Procedures
Quality Forecasts

- A DSS is only as good as the forecasts (weather and road) that drive it!
  - Provides tactical (0 – 3 hrs) and strategic (beyond 3 hours) weather and road condition information
  - Directly impact the treatment recommendation process

- Forecasts should be optimized through the use of observations
  - Model initialization
    - Weather
    - Road
  - Post-processing routines
Road Condition Assessment and Prediction

- Proper assessment of road conditions is fundamental in a DSS’s ability to provide tactical guidance.
- Road Weather Information System (RWIS) Environmental Sensor Stations have become the backbone of the road weather community.

The future of road weather observations
- Non-invasive instruments with the capacity to deliver supplemental road condition observations
- Mobile observations (similar to marine and aviation operations)
  - Weather and road condition data
  - Maintenance operations data
    - Plow up/down
    - Treatment type
    - Treatment rate
    - Treatment location
- Traffic Data

DSS for winter maintenance operations should have the capacity to leverage both conventional and non-conventional observations
Road Condition Assessment and Prediction

- Optimal predictions are made at observing sites along a roadway.
- Any attempt to make road condition forecasts at non-observing site can result in low quality predictions, thus, inaccurate guidance
  - Lack of accurate initialization
  - No opportunity to do post-processing
- In cases where roads have been thermally mapped, forecasts can be extrapolated to other sections of the roadway to provide an understanding of what is occurring between stations or forecast points*
- Mobile observations will also serve as way to derive more accurate forecast between traditional observing sites

*This can be done in none-precipitation situations during nighttime hours
Event Characterization and Decision Models

- Need to construct the evolution of an event over the time period of interest (24 hrs, 48 hrs., etc.), utilizing road weather forecasts

- Serves as the foundation for the decision model
  - Best practices for winter maintenance operations
  - Eutectic properties of the materials used in operations.
  - Integrate understanding of an end user’s operations
    - Types of materials used
    - Operational philosophy
    - Maintenance fleet
### Characteristics of an Effective DSS

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<thead>
<tr>
<th>CHARACTERISTIC</th>
<th>USABILITY DESCRIPTION</th>
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<tr>
<td>Effective</td>
<td>A DSS should allow winter maintenance practitioners to fully achieve their goals and objectives, with an acceptable level of accuracy.</td>
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<tr>
<td>Efficient</td>
<td>The application should enable users to meet their goals and objectives in a timely fashion, maintaining the desired level of accuracy.</td>
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<td>Engaging</td>
<td>A DSS should employ an interesting, appealing interface.</td>
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<td>Error tolerant</td>
<td>A DSS should be designed in a way that errors are minimized and error recovery is supported.</td>
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<td>Easy to learn</td>
<td>A DSS should promote rapid, trouble-free adoption and high-level use, but should also enable more complex analysis and investigation.</td>
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Novel Visualization
Consultation

- Provides an added level of support (human interface opportunity)
  - Forecast clarification
  - Ascertain forecast confidence
  - System monitoring
- Consultants should
  - Be trained in weather and experienced
  - Be familiar with the region (e.g., microclimates)
  - Understand/speak winter maintenance operations
  - Understand specific end user perspective
  - Be Available 24 hours/day, 7 days per week
Essential Elements of a DSS for Winter Maintenance