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Maintenance Decision Support System (MDSS) For Nevada By: Eric Wang

The College of Engineering at the University of Nevada, Reno (UNR) and the Nevada Department of Transportation (NDOT) have been working toward developing a Maintenance Decision Support System (MDSS) for Nevada. The MDSS concept started in 1999 as a Federal Highway Administration (FHWA) project aimed at helping winter road maintenance personnel make decisions. The key component to an MDSS is accurate weather and road condition information. Using these data, the MDSS software can predict local weather conditions with a much higher accuracy than is typically available. Knowing more about the local weather conditions would allow NDOT to increase the efficiency of winter road maintenance and, thus, both reduce the cost of winter maintenance and increase the level of service. For the average driver in Northern Nevada, this means safer winter driving conditions at a reduced cost. In fact, other states have shown an MDSS has the potential of reducing winter material costs (e.g. salt) by up to 30%. (Western Transportation Institute, "Analysis of Maintenance Decision Support System Benefits & Costs," Technical Report SD2006-10, Montana State University, 2009.)

In This Issue:

When it is finally operational, there will be two basic components of an MDSS in Nevada. The first component will reside in the snowplows that are out during a winter storm. The second component will reside at an NDOT district office. Combined, these two components will allow NDOT to make fast, efficient, and economical decisions about which roads to plow and where to spread road treatments like salt.

The snowplow part of the system includes a computer mounted in a snowplow along with various sensors that indicate the snowplow's location and speed, the current weather conditions (temperature, pressure, humidity), the current road conditions (temperature, snow/ice coverage), and treatments (e.g. salt) currently being applied by the snowplow.

The district office part of the system will consist of a group of computers running custom software. As shown in Figure 1, there are 4 modules of this sub-system. Module 1 will receive all of the data from the snowplows and other weather sources and use that information to make highly accurate local weather predictions. With these local weather predictions, Module 2 will predict the local road conditions. Knowing how much snow/ice will accumulate on each road will allow Module 3 to determine how to deploy the snowplows and where to spread road treatments like salt. All of the information along with the computer's suggested treatment schedules will be displayed to NDOT personnel via a graphical user interface (GUI) in Module 4.

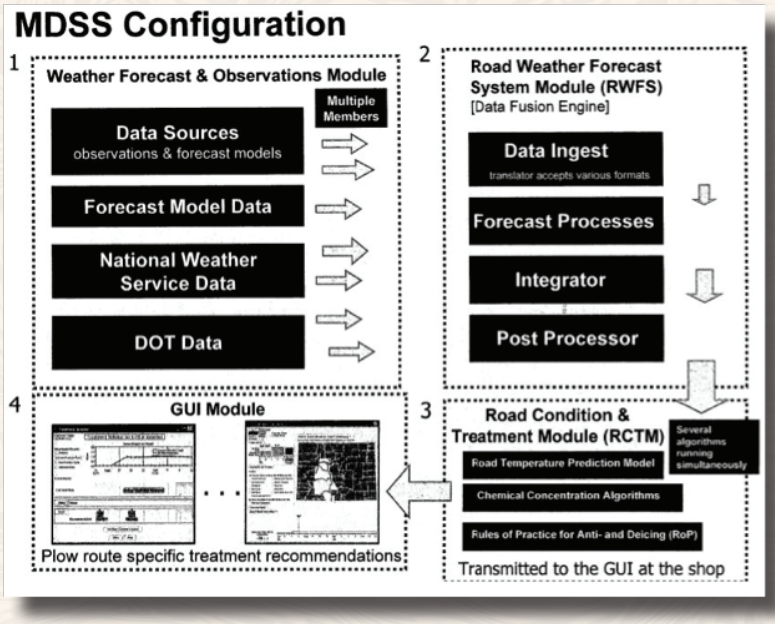

Figure 1. Overview of a typical MDSS system

Continued on page 2

Continued from page 1

Exactly how the data will be transmitted from the snowplow to the district office was one of the areas of research that the team investigated as part of Phase I of this project. The first option looked at was the existing EDACS radio system that is currently used by NDOT, NV Energy, and the Nevada Highway Patrol. The second option investigated was the cellular phone network. The third and final option was the satellite phone network. Table 1 summarizes the key parameters for each system.

Table 1. Communication Methods

EDACS Radio	
Availability:	Extensive; available in most remote locations
Speed:	Slow
Cost:	Low
Cellular	
Availability:	Moderate, not available in remote locations
Speed:	Variable depending on location
Cost:	High
Satellite	
Availability:	Extensive; available in most remote locations
Speed:	Moderate
Cost:	High

Whereas many other states with working MDSS systems use cellular phone based systems, this is not viable in many areas of Nevada, which have little or no cellular network coverage. Satellite-based systems have the advantage of wide area coverage but the cost of both the initial hardware and data transmission is much higher than the cellular option.

Based on this, we decided to evaluate and test the use of Nevada's existing EDACS radio system, which has data transmission capabilities. For the proof-of-concept tests, GPS and temperature (both road and air) were selected as the data to be sent. A vehicle owned by the College of Engineering was outfitted with an EDACS radio, computer, GPS and temperature sensor. The data was transmitted over the EDACS radio to a receiving station at UNR, thus demonstrating the ability to send road and weather information from a moving vehicle using the existing radio infrastructure. We also identified a typical list of MDSS data that needs to be transmitted in the future (Table 2).

Table 2. Typical vehicle sensor data used for MDSS

Onboard Vehicle Sensor	Derived Information
Date time stamp	Timeframe
GPS vehicle location	Vehicle location, altitude and direction
Vehicle speed	Traffic data / implied surface conditions
Wiper system state	Precipitation detection
Infrared temperature sensor	Pavement surface temperature (non-snow covered)
Plow blade position	Surface treatment information
Chemical type	Type of chemical applied
Chemical application rate	Amount of chemical applied
Antilock brake status	Pavement surface state
Traction control status	Pavement surface state
Vehicle stability control	Pavement surface state
Steering inputs	Pavement surface state
Steering inputs & accelerometer outputs	Deduced vehicle skid
Steering inputs w/o accelerometer outputs	Snow accumulation on the road
Heater/defroster state	Nature of precipitation, visibility index
Window heater state	Visibility index, road conditions

Maintenance Decision Support System (MDSS) For Nevada continued from Page 2

In Phase II of this project (2011), we will be conducting a pilot study where 10 snowplows and 10 NDOT trucks will be outfitted with the computers and a complete suite of sensors. Competing MDSS software packages will be tested and evaluated for use in Nevada. Finally, a cost-benefit analysis will be completed to predict the costs and potential savings associated with each winter storm event and the benefits provided by an increased level of service.

RESEARCH TEAM

Eric Wang is an Associate Professor of Mechanical Engineering at UNR. Dr. Wang earned his Ph.D. from the University of California at Davis in 1996. He conducts research in the area of mobile robotics, autonomous systems, telescience, and off-road vehicle dynamics. Dr. Wang is also an FCC licensed amateur radio operator. He has published 4 single-author books and more than 100 technical publications. His research activities have been sponsored by government, corporate and charitable entities such as NSF, NASA, Texaco, and the Hewlett Foundation. Dr. Wang has also received two NASA research fellowships and was named the 2003 University Distinguished Teacher and the 2009 Regents Outstanding Teacher.

Jeffrey LaCombe is an Associate Professor of Materials Engineering at UNR. Dr. LaCombe earned his Ph.D. from Rensselaer Polytechnic Institute, in Troy, NY in 1998, and also holds a degree in Mechanical Engineering from the University of Connecticut. He brings expertise in telescience—an area in which he has been conducting federally-funded research for over 15 years. His research has been supported by the NSF, DOE, and NASA, including the remote control of several experiments aboard the Space Shuttle Columbia. Professor LaCombe was the recipient of the 2007 Lemelson Award for Innovation and Entrepreneurship at the University of Nevada, Reno.

PRODUCT EVALUATION COMMITTEE (PEC) MARCH 8, 2011, MEETING SUMMARY

- A motion was made to remove the Equipment section representative from the PE committee.
- Maintenance section requested that two new categories be added to the Qualified Products List (QPL); 508.02.04 Crack Filler and 408.02.05 Asphalt Cold Patch. These products are purchased through annual open-term contracts through State Purchasing. The bidding of this product would not change; but the State purchasing agent would request in the bid that the participating bidders be chosen from the QPL. This allows the participants to be pre-qualified. Due to time limitations, the evaluation criteria was not available in time for the members to review the document, so it was moved to table the topic until the June 14th Product Evaluation Committee meeting.
- Traffic Operations requested approval of a field test for an LED Lighting System for Guardrails. The LED lights are rectangular units that are placed under the curve of the guardrails. Each unit cost about $35/each. The units can be programmed to blink in several patterns or remain constant. A grant is being sought to fund the project. The motion passed.
- The Product Evaluation Committee discussed QPL designations and determined that a designation could be placed, upon request of an NDOT employee, on products, identified under “remarks” on the QPL, if the restriction would enhance the performance of the product. This practice was expanded to include restrictions based on more specific criterion such as elevation. If the restriction overlaps on a contract, the most conservative limitation applies to the whole contract.

VENDOR PRESENTATION

Gary Champ, representing Shur-Tite® Products, shared information on a three-component delineator system. Texas has introduced over 500,000 of these units and Arizona just ordered 18,000. The units have been FHWA tested and independently crash tested in both freezing and hot weather locations and meet all FHWA standards. The system consists of a perforated square tube that can be cut into the desired lengths appropriate to the soil condition. This unit is driven into the ground with a base attached. A round tube fits over the base and is clipped onto the base using cotter

Continued on page 4

Continued from page 3

pins. This allows quick replacement (3 minutes) of any damaged units and usually last 10 or more years.. The posts can hold heavier signage, which is impervious to weather, UV, and pitting. One of the independent tests conducted hit the units 20 times without any noticeable damage. The base also allows for angled mounting. The company provides training on all new installations. The cost of the unit is about $22.00 and each section can be independently purchased. District II will be testing these units.

Ground Mounted Delineator

Traffic Channelizer Delineator

Surface Mount Delineator with Angled Base

Library Corner

The library is here to help! It holds a large selection of magazines, journals, study materials, and publications from AASHTO, FHWA, TRB, TRR, and US DOT. If the library doesn't have what you want, the librarian can get it! We can purchase items for the library that you feel would be beneficial for everyone to have access to as well! The library is located in room 115 of the NDOT Headquarters building.

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This library of journals is accessible at each of your workstations authenticated by an IP Address (NDOT employees only). This means that by accessing this URL, *(http://www.ascelibrary.org/)*, you will have access to approximately 73,000 papers.
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The NDOT Research Section administers the NDOT's research, development and technology transfer program and serves as the "clearing-house" for product evaluations.
Research and Technology Review is published quarterly by the NDOT Research Section. Its purpose is to provide the latest information on the NDOT research activities including product information and other pertinent research topics.

If you have comments or need additional information regarding any of the topics discussed in this issue, please contact the Research Section.
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