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Best Practices in Winter Maintenance from the U.S. Domestic Scan Program

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ABSTRACT

The mission of the Best Practices in Winter Maintenance team for the U.S. Domestic Scan Program is to find innovative practices of high-performing transportation agencies that can beneficially be adopted by others. The emphasis of the presentation will be the work of the team to transfer technology based on what is working for others. The efforts of the team, their visits to other locations, and final report provide practical insight for winter maintenance.

KEYWORDS

Maintenance Decision Support Systems / Equipment Technologies / Workforce Training / Resource Management / Winter Traffic Management

INTRODUCTION

The purpose of the Winter Maintenance Scanning Tour was to seek out and observe the progress that State and local highway agencies are making in advancing today's technology in the area of winter roadway maintenance. While this was the first *domestic* tour in the United States, it was tailored after three previous scanning tours that had been conducted in European and Asian countries in 1994, 1998 and 2002. Much of what had been learned from these earlier international scans had become a new benchmark to several USA counterparts, inspiring them to pursue similar advances. Knowing this, the National Cooperative Highway Research Program (NCHRP) Project 20-68A, US Domestic Scan Program was developed under the auspices of the American Association of State Highway and Transportation Officials (AASHTO), Federal Highway Administration (FHWA) and NCHRP to assess the state-of-the-practice of several transportation subject areas in the USA and to evaluate the extent to which the international scanning tours had an

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impact on domestic operations. One of the nine tours included in this program is Scan 07-03 Best Practices in Winter Maintenance.

The Winter Maintenance Scan was conducted from March 25-April 7, 2009 by a six-member team that consisted of:

- Ben McKeever, Co-Chair, United States Department of Transportation
- William Hoffman, Co-Chair, Nevada Department of Transportation
- Steven Lund, Minnesota Department of Transportation
- Terry Nye, Pennsylvania Department of Transportation
- David Ray, Ohio Department of Transportation
- Mike Schwartz, Virginia Department of Transportation

Also traveling with the team were Rodney A. Pletan, who served as Subject Matter Expert (SME) and is charged with preparing follow up reports and presentations, and Armando Perez, American Trade Initiatives, who arranged for and coordinated all logistics relative to the tour.

While the initial composition of the team membership changed along the way, early in the process the Scanning Team met and agreed the best locations would be those originally developed and reported on as represented in the Desk Scan Report prepared by the SME in October 2008. Clearly, several good examples of the state-of-the-art in winter maintenance exist today in multiple locations. These sites were scattered among several states and local agencies throughout the snow-belt states. It was necessary to narrow down the list to a workable number. In some cases, sites were chosen because they had several examples to observe at one time. In other cases, sites in close proximity to other good candidates were selected. Emphasis was made to include examples of state, county, city and toll road operations. After lengthy discussions, the following locations were selected and are presented in the order that each was visited:

- Minnesota Department of Transportation & Traffic Operations Center
- Colorado Department of Transportation & Traffic Operations Center
 - Eisenhower Tunnel and Holland Tunnel Traffic Operations Centers
- Cities of Denver, Ft. Collins & Grand Junction &
- E-470 Toll Road Authority, Denver, Colorado
- Utah Department of Transportation & Traffic Operations Center
- Indiana Department of Transportation
- Virginia Department of Transportation

To assist the host locations to prepare for the Scanning Team visits, they were provided, in advance, a list of topic areas the team would be focusing on to provide guidance related to the main areas of emphasis. The focus areas were:

- Maintenance Decision Support Systems (MDSS)
- Automatic Vehicle Location System (AVL), Geographic Positioning System (GPS) and Vehicle Infrastructure Integration (VII)
- Equipment Technologies
- Training and Development
- Management Issues
- Integration of Weather, Traffic and Maintenance Operations

B. Summary of Initial Findings

While the objective of the scanning tour was to seek out and observe *best practices*, once the tour limited itself to a specific number of sites to visit, it was discussed that although the *best-of-what-was-seen* may be innovative, it may not necessarily be the *best-there-is*. The fact remains that the Desk Scan did not identify every *best practice* that exists because it was only conducted from the *desk* and was limited to the phone calls and information gathered from the *desk*.

So for purposes of this report, while it may be a play on words, the word *findings* and *best practices* are often used synonymously, meaning that they are findings that were found to be the *best-that-was-seen* **compared to** what was seen at the other places visited. That may mean that the findings are the *best-there-is* but the scope of study made during the scanning tour did not look at everything-everywhere.

The following annotated outline captures the key practices observed during this scan and are worth documenting. This material is preliminary and will be captured in a final report that is forthcoming:

1. Maintenance Decision Support Systems (MDSS)

- Data is successfully being communicated back and forth between the:
 - i. Truck
 - ii. Dispatch center
 - iii. MDSS provider (who generates treatment recommendations and the site specific weather/pavement forecasts, and
 - iv. Others
- During winter events, data elements include:
 - i. Before event
 1. Pavement forecast
 2. Treatment recommendations
 3. Start time
 4. Route assignment
 - ii. During event
 1. Truck location (GPS, AVL)
 2. Video views of pavement condition from cab
 3. Radar
 4. Current pavement and atmospheric temperature

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5. Material usage, application rates
 6. Plow up/plow down
 7. Travel speeds
 8. Revised forecast
 9. Revised treatment recommendations
- iii. After event
 1. Routes covered
 2. Material usages
- In summer, some new MDSS applications are being pursued (chip seals, paving, grass mowing, weed spraying, lane striping, roadside assistance, etc)
 - Some agencies are beginning to identify cost benefits, with savings potential from saving chemicals and number/length of shift deployments, forced accountability, etc.
 - Various marketing and implementations strategies are being used
 - i. Grass roots involvement and research
 - ii. Statewide vs. by regions vs. by crew vs. scattered unit implementation
 - iii. Top-down direction
 - iv. Combinations of above
 - MDSS hopefully can be used to establish, supplement or replace winter severity index
 - MDSS is having positive impact on management and employee culture

2. Automatic Vehicle Location (AVL)

- A variety of vendors are involved with AVL and systems related to AVL like MDSS
- AVL is being used for multiple purposes, ranging from route reporting, to resource consumption to incident response
- Benefits to both management and operators becoming more universally understood
- Low resolution (like >5 min intervals) meets some decision making needs but high resolution (like <30 second intervals) is required for replacing manual data collection systems

3. Equipment Related Technologies & Facilities

- Plows & Wings
 - i. Underbody plows are common in several agencies
 - ii. Wider front plows and dual wings are being experimented with
 - iii. Tow plows allowing full two lanes per pass are being successful
 1. Tow plows can also distribute solid or liquid chemicals
 2. There have not been any safety issues or unfavorable accident history with the tow plow to date.
 - iv. “Hydraulic Assist” engineering is being used to reduce plow weight on the blade when conditions warrant, thus reducing cutting edge wear and extending life up to two winter seasons.
- Plow cutting edges (plow blades)
 - i. Composite carbide and rubber blades (Joma) are getting good reviews
 - ii. Triple blade (carbide, seriated and rubber slush blade) units are being tried

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- iii. Lighter poly blades have potential to replace some heavier steel blades
- Saddle tanks for pre-wetting solids are being designed and integrated into dump boxes and beds on both tailgate and V-box spreader trucks, leading to better weight distribution and higher carrying capacity, allowing for longer route coverage during pre-wetting operations at optimized application rate of 20-30 gal/ton.
- Spreaders
 - i. The zero-velocity concept is continuing to be pursued
 - ii. Slurry augers are being used so chemicals in slurry form can be distributed
 - iii. Agencies using slide-in spreaders justify them for overhead clearance and tailgate sander users justify theirs because of reduced dead load, initial investment and maintenance costs
 - iv. 5000 gallon tankers are used to during anti-icing as well as resupply station between storms
 - v. Off season rental water tank trucks are rented as anti-icing units
- New equipment accessories being tried include:
 - i. Video cameras on plow trucks to provide
 - 1. Front view images of driver's front windshield perspective back to the dispatcher
 - 2. Side and rear of truck views for the operator
 - ii. Wiper blade vibrators to reduce ice buildup
 - iii. Air blowers to keep side mirrors clear of snow
 - iv. HID headlights
 - v. Fog Busters to lift fog above drivers line of sight
 - vi. Laser beam guides to tell operator how far out the wing or tow plow is
 - vii. Collision avoidance systems have potential in white-out conditions
- Fixed Automatic Spray Technology (FAST) systems have developed and proven to the point that they are no longer experimental
- Equipment replacement purchases are funded by a variety of mechanisms, including:
 - i. Annual appropriation from legislature or council
 - ii. Revolving accounts (where user units pay rent to owning units)
 - iii. Escrow accounts (where agency puts money every year for every unit so it is fully funded when replacement is due)
- Road Weather Information System stations advancements include:
 - i. Low cost portable units
 - ii. Solar or wind powered units
 - iii. Stations that include remote controlled cameras providing streaming video
 - iv. Non-invasive sensors to replace pucks embedded in pavement
- Friction measurement systems continue to be developed both domestically and internationally for purposes of measuring winter performance
- Progressive and environmentally sensitive agencies store all solid chemical under roof year-around with space available to load trucks inside the same building
- Brine making and brine storage systems have become automated and controlled
 - i. Some are housed inside in same building as solid salt

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- ii. Some are dispensed using fuel management systems to permit easy sales to other local agencies and to internally keep track of amounts loaded onto individual trucks
- Sophisticated truck washing facilities employ sediment traps, reuse wash water
- Contaminated truck washing water and runoff from stockpile sites and loading areas are being collected and used to make brine so as to avoid entrance into the environment at equipment and chemical storage sites

4. Training & Development

- Downsizing government is leading to more and more agencies setting up flexible workforces where generic “transportation worker” classifications are replacing separate “construction” and “maintenance” classifications at time of hire. Where this is not happening, non-maintenance employees are being cross trained to operate snow and ice equipment during winter storms or otherwise supplement/support the winter maintenance effort. In either case, such changes are causing both challenges and opportunities for training and retraining workers for winter emergencies
- Several agencies are setting training programs using simulators, training academies, symposiums and other systems (like iPod based) to incorporate internally and externally developed training programs like the AASHTO Computer Based Training (CBT) program.

5. Management Issues

- Funding for maintenance operations research & development are important.
- Culture & management/employee relations are especially important during times of change.
- Outsourcing and in-house efforts need to be managed the same yet are often managed differently.
- Winter maintenance performance measurement is best done at the outcome level.
- Consistency (or lack thereof) of level of service between winter plow routes or across internal organizational lines and even jurisdictional boundaries is something customer measure government by.
- Internal and external communications are important to the success of winter service providers.
- One agency provides designated drop zones so that stalled and stranded vehicles can be moved off the highway during winter events

6. Integration of Weather, Traffic & Maintenance Operations

- Traffic Operations Centers (TOC) are being designed and organized to physically integrate representatives of several disciplines together during winter and other emergency/incident management type events. Examples already incorporated into one or more TOC are:
 - i. Full-time salaried Meteorologist
 - ii. Maintenance Operations Dispatcher
 - iii. 511 Coordinator
 - iv. Highway Patrol Dispatcher
 - v. Courtesy Patrol, Motorist Assistance Dispatcher
 - vi. Snow and Ice Operations Coordinator
 - vii. Traffic signal control coordinator

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- viii. Retired maintenance supervisor on-call as TOC operator during events
 - ix. Public funded, on site, FM Radio announcer who, on moments notice, provides continuous traffic reporting during incidents, including winter weather, and reverting back to broadcasting jazz music at other times.
 - x. Special space and provisions for housing media representatives during events
- Some of the above integration is full time, year around and others are only during incidents, including winter events
 - One agency has a former radio announcer on staff as a TOC operator
 - In the case of an agency having a full time meteorologist, that position manages a private meteorology team under contract who does the actual forecasting from space provided in the TOC. The staff meteorologist teams with maintenance operations in the agency to best utilize the forecasts.
 - The key benefit to having up-to-date weather forecasting and road conditions in the TOC is that it allows for more timely updates to 511, web sites and other sources of information that the public has access to
 - Some agencies have converted to statewide 800 MHz for all emergency services, including maintenance operations (Voice-over "ARMER" system was extremely valuable during 35W collapse)
 - Traffic signal timing is adjusted on key corridors in response to winter events.

C. Recommendations

Based on the above listed findings, the preliminary general recommendations of the Scanning Team are as follows:

1. Maintenance Decision Support Systems (MDSS)

- MDSS has proven to add effectiveness and efficiency to winter operations. The return on investment will greatly increase as it becomes applied to summer activities as well.
- In order to be successful and be able to implement MDSS expediently, there are some marketing and implementation strategies that have been tried and proven to be more effective than others.

2. Automatic Vehicle Location Systems (AVL)

- AVL systems have multiple uses, many of which are beneficial to employees and operations, and its use is expected to be universally expanded into maintenance operations. The higher the resolution (frequency of readings recorded), the greater the cost; but the lower the resolution, the lower the potential value received.

3. Equipment Technologies

- Indications are that the tow plow has great potential in many areas. They are able to be operated with a single driver and accidents have not been a problem. Tow

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plows do, however, required a truck to pull it that meets certain minimum specifications, probably not available today in existing winter maintenance fleets.

- The concept of “hydraulic assist” should have potential of extending life of some cutting edges (plow blades) up to two years.
- The Joma plow blades (composite of carbide blade inserted in rubber) are well liked, thus showing promise nationwide.
- Polyethylene plow blades (entire plow blade body is a high-density polyethylene material) should be considered, at least in certain environments.
- The use of video cameras to expand the range of view of a snowplow truck operator should be considered as a safety enhancer.
- Wing and tow plow laser guidance systems indicate extended wing or tow plow position appear to be economical.
- Though evidence of research was limited, vibrating wiper blades shows promise.
- Visibility enhancers like Fog Buster, High Intensity headlights and other technologies that enhance ability for operators to see and be seen should always be pursued and employed once they have proved successful.
- It is very important that agencies do whatever is necessary to 1) prevent the formation of salt brine at stockpile sites and 2) collect any brine formed from runoff or truck washing at a storage site. Sediment traps permit salt brine runoff to be reused or recycled.

4. Training and Development

- Flexible work forces need to be considered as demand for services continue to rise and downsizing government is being expected.
- Cross training can be successful in supplementing snow plow operators.
- Several generic and custom made training programs are available as state-of-the-art examples for use at training academies or symposiums. Real life simulators coupled with classroom lecturing and computer-based programs (AASHTO CBT) can be used for both initial and retraining purposes.

5. Management Issues

- Inter-jurisdictional relationships are important to promote consistency of levels of service between otherwise invisible governmental boundaries.
- More work needs to be done to develop improved outcome-based and customer-oriented performance measurements (like regain time, friction measurement, speed monitoring, road closure frequency/duration, etc) and such measurements need to be implemented, applied and reported to better manage both in-house and outsourced winter maintenance services.
- Models of dedicated and recurring funding for operational maintenance research funding needs to be copied by more winter maintenance agencies. Successful models lead grass roots ownership, thus a creation of a continuous improvement culture and improved relationships between employees and management.

6. Integration of Weather, Traffic and Maintenance Operations

- Integrating traffic operations, weather forecasting, maintenance operations, highway patrol, media and incident management into Traffic Operations Centers is proving to be a best practice.
- Better approaches for conveying real-time traveler information to the public using 511, web sites, e-mail alerts, text messaging, etc. are emerging. Information

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related to traffic conditions, surface conditions and weather forecasting is being disseminated.

- Implementation of special signal timing plans during winter events has the potential of improving traffic flow for the traveling public, as well as the snow plow operators.

A few State Departments of Transportation had been realizing and publishing information on the efficiencies gained through the use of snow and ice operations performed in their traffic operations centers. This scan verified these efficiencies and documented AVL and GPS systems are being used to develop real-time communication from the truck to the dispatcher to make adjustments during the storm and automatically collect data that otherwise had to be done by hand. Seeing this technology and cultural mindset first hand was truly an honor. It is anticipated that the scan information gained from these innovative agencies will aid in an implementation program which is consistent with the use of these best practices and open the door for nationwide implementation strategies. Extraordinary management philosophies and leadership guidance helped focus many states on sophisticated training programs that recognize the daily necessity to keep up with a changing workforce. Technology-driven systems are here and are being used effectively to make critical operational decisions. More and more Traffic Management Centers (TMC) and Traffic Operations Centers (TOC) are integrating weather data with critical real-time traffic operations information to better serve the needs for safety and mobility of their customers. This Domestic Scan of Best Winter Practices was extremely successful in identifying several progressive areas, and the hope is to disseminate this information as quickly and effectively as possible to benefit as many people as possible.