**Project 16-01: Utilization of AVL/GPS: Case Studies**

**Summary of Washington State DOT In-Person Interviews**

*Overview*

Interviews were conducted by Ming-Shiun Lee and Dan Nelson of AECOM and coordinated with Joe Schmit of the Washington State Department of Transportation (WSDOT) on December 19th, 2017.

*WSDOT Staff Interviews*

Meeting attendees on Tues. Dec. 19th included the following individuals in person and via teleconference:

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| * + *Joe Schmit, Technology Resource Manager, Maintenance Operations Division*   + *James Morin, Snow and Ice Program Manager*   + *Andrea Fortune, Maintenance Policy Branch Manager*   + *Kimberly Williams, WSDOT Purchasing Manager*   + *Oai Tang, Maintenance and Operations Specialist* | * + *Keisha Chinn, GIS and Data Systems Manager*   + *Peter Burkhard, Technology Resource Program Specialist*   + *Additional IT Support Staff (via phone)*   + *Additional Maintenance Superintendents and Supervisors (via phone)* |

Group met at the WSDOT Materials Laboratory in Olympia, WA to discuss how WSDOT staff have implemented their AVL / GPS system. The group participated in the interview included staff representing executive management, maintenance managers, supervisors, technicians, IT and research. Brent Schiller and Joe Schmit of WSDOT provided an overview on the early history of WSDOT with AVL / GPS technology, which began as a pilot project in Tacoma, WA where the WSDOT was initially using Precise AVL system in combination with pre-existing Force America spreader controllers. Over time, WSDOT allowed for other Regions to install Precise hardware for integration with existing Force America spreader controllers, while some WSDOT Regions installed Location Technologies (LT6) as an AVL / GPS provider around 2010. The LT6 hardware installed on WSDOT vehicles was utilizing 2G cellular technology as a means of center-to-field communications.

WSDOT was notified by Location Technologies around 2014-2015 that an upgrade of the vehicle’s LT6 AVL hardware would be required in order to prevent disruption of WSDOT’s center-to-field communications with those vehicles while in operations. This was due to a phasing-out period of the 2G cellular technology.

Given that new LT6 AVL hardware would need to be procured, and that different AVL systems were being used by different Regions, WSDOT saw this as an opportunity to procure and upgrade the system as well as to establish a consistent approach with their AVL / GPS system. As such, WSDOT developed and issued an RFP to procure a vendor to provide AVL hardware and software for all WSDOT snow plows through­­out the state. The solicitation only requested the vendor to provide AVL hardware and meet a hardware / software specification that was included, and the solicitation occurred in early 2015. Location Technologies was selected by WSDOT through the review process, and they provided the requested quantities of AVL hardware to WSDOT within a short amount of time after being selected. The procurement also expanded the AVL installation to sweepers and emergency response vehicles. Vendor demonstration was not included in the procurement. Instead, WSDOT relied on its prior experience with the pilots as well as peer exchange to gain knowledge on vendor qualifications from other states experience.

WSDOT noted that the procurement process was very smooth given the unique nature of how the state was able to purchase AVL equipment in this manner. ­ The Transportation Equipment Fund (TEF) is a revolving fund within WSDOT which provides vehicles and equipment to WSDOT programs so that they can accomplish their missions. The fund is a non-appropriated program responsible for the acquisition, management, support, and disposal of a wide variety of state vehicles and support equipment, which also includes the agency's wireless communications equipment. Funds within the TEF were utilized to purchase the LT6 AVL hardware needed for the snow plows within the WSDOT fleet.

The main driving forces for the AVL system implementation included:

* Real-timing tracking of vehicle locations and material usage to support and improve operational efficiency
* Supporting and minimizing tort liability
* As an advisory tool for improving resources planning and adjustments

WSDOT then coordinated with local contractors within each of the six WSDOT regions, who were already responsible for the up-fitting / assembly of WSDOT snow plows with spreader controllers and other on-board equipment, to perform the installation and integration of the AVL hardware per the recommended instructions from Location Technologies. These contractors also perform the required maintenance of the AVL system and coordinate with Location Technologies as needed for hardware repair and / or replacements.

For center-to-field communications, WSDOT utilizes cellular communications in most areas of the state, which is primarily Sprint as the vendor, although Verizon is utilized in some Areas where it provides greater and more reliable coverage. As part of the contract, Location Technologies secures cellular communications services and bill WSDOT monthly. WSDOT also utilizes a state-owned 700 MHz radio system two fill the communications gaps in two Regions that feature more remote areas of the state and do not have adequate cell coverage. The combination of cellular and state-owned radio system works well for WSDOT. WSDOT noted the costs of cellular communications were half of that prior to the statewide procurement.

WSDOT has integrated the vehicle’s snow/ice spreader controllers and air/pavement temperature sensors on the vehicle with the LT6 AVL hardware unit. WSDOT vehicle technicians reported some issues with the integration of existing Force America 6100 model spreader controllers with the LT6 AVL hardware. WSDOT staff were unable to configure the data polling rate initially and this led a time-out issue with the communication of data from the spreader controller. WSDOT noted Force America was willing to work with them on the issue through a firmware upgrade to the controller which resolved the issue. Joe Schmit also noted that air and pavement temperature sensors may be providing faulty readings to the AVL equipment if the sensors were improperly installed and / or maintained by Area vehicle technicians. WSDOT mostly uses Vaisala temperature sensors and some RoadWatch sensors. The majority of the temperature sensors were tied into spreader controllers. WSDOT is currently testing a Precise wireless sensor.

WSDOT experienced issues with integrating plow position sensors with the AVL system. WSDOT was working on identifying causes to resolve data consistency issues. WSDOT was also investigating the possibility of integrating plow hydraulic sensors with spreader controllers and using hydraulic sensors for plow position indicators.

The LT6 AVL hardware was not integrated with the vehicle’s OBD-II port to gather vehicle diagnostic information, given that as a separate effort the WSDOT Fleet & Equipment Operations, commonly referred to as the Transportation Equipment Fund (TEF), was implementing Verizon NetworkFleet on vehicles to collect, track and report vehicle diagnostics back to Area Maintenance Superintendents.

Joe Schmit also noted that the WSDOT TEF is the state fund that is responsible for the acquisition, asset management, upkeep, and logistical support of the state’s 500 snow plow vehicles and the AVL / GPS system. The TEF is a revolving fund within WSDOT that provides vehicles and equipment to WSDOT programs so that they can accomplish their missions. For winter maintenance operations, the TEF program provides funding for snow plow vehicle support and AVL / GPS system maintenance through 35 equipment repair facilities and 130 fuel stations across the six WSDOT Regions within the state.

WSDOT is split into six Regions that cover different parts of the state. Within each region, WSDOT winter maintenance staff are structured into the following general positions:

Region Maintenance Engineer: Responsible for overseeing all Areas within the Region in terms of response to winter storms. May be responsible for allocating some of the Region’s resources to other Regions of the state in the event of severe weather impacting that specific region.

Area Maintenance Superintendent: Responsible for monitoring maintenance supervisors within each of the respective 24 Areas of the state, and how each Area is responding to winter storms within that Area / Region. Reports to Region Maintenance Engineer and communicates with Maintenance Supervisors during winter events.

Area Maintenance Supervisor: Responsible for overseeing multiple snow plow drivers performing along assigned snow plow routes within that part of the Area within the Region.

It was noted that Area Maintenance Superintendents and Supervisors maintain communication with each other utilizing vehicle radio equipment. Snow plow drivers within an Area may be called upon to divert from their planned route to assist with snow clearance along other roads as needed.

It was also noted that each of the 24 Areas within the state determines their own respective maintenance priorities related to vehicle maintenance. This can lead to some Areas placing less of a priority on the installation and maintenance of the AVL system than other Areas, which can present challenges to the use of automated reports that gather data on material usage and snow plow operations. Leadership for some Areas was very engaged and pushed for quick AVL implementation. As a result, those Areas has the AVL system installed very quickly.

Joe Schmit provided a memo developed within the Olympic Region that provided an example for how Region Maintenance Engineers can set the use of an AVL system as a priority within a Region. This type of emphasis on the importance of properly maintaining the AVL system can enable a higher confidence in the automated reporting of material usage coming out of the LT6 AVL system. In turn, this can lead to improvements in the use of reports on material usage to increase the overall efficiency of material usage by each WSDOT Region.

Location Technologies provided WSDOT two views of the AVL data: a web map view and a reporting engine that includes user tools. Through the LT6 software interface, WSDOT staff can generate pre-defined reports that provide information on vehicle operations and material amounts utilized per vehicle within an Area. Currently, WSDOT only utilizes a “General Activity” and Material Summary” report from the software. WSDOT noted the most desired reporting feature of the system was the material usage reports. WSDOT noted the biggest challenge was the accuracy of material usages. Joe Schmit noted material usage was calculated based primarily on application rates and miles of vehicle traveled. He noted the in the past, mileages used for material usage calculation were based on GPS not odometers. WSDOT experienced issues with GPS accuracy in the past. As a result, material usage calculation was not close to accurate. Joe Schmit noted that reports on material use would eventually be able to provide a quality baseline of material usage, as issues related to AVL system installation and its usage are resolved over time.

Joe Schmit noted that in addition to vehicle location data, the AVL system collected the following information:

* Material name and type
* Pre-wetting or not
* Application rate
* Pavement surface and air temperatures
* Plow position (up/down) – front plow only

WSDOT performed an internal backup of the AVL data generated from the LT6 AVL system, and has created an in-house web-based software interface that displays the locations of WSDOT snow plows throughout the state for use by Area Maintenance staff. WSDOT noted that LT6 made its Application Programming Interface (API) available for the purposes of getting key AVL system attributes, such as GPS coordinates, vehicle ID numbers, and material names, to enable the vehicle location and other attribute reporting on the in-house software interface. WSDOT polled the data from Location Technologies server every minute. This data is stored on a high availability server and would be saved for at least seven years. AVL data was primarily used by WSDOT Maintenance Supervisors and Superintendent for vehicle location monitoring and situation awareness. The stored data were used primarily for material usage reporting and occasionally for post event review/analysis and for review in the event of a tort claim of WSDOT liability in a traffic accident.

One of the primary benefits that WSDOT has observed with the AVL / GPS system is the overall savings to WSDOT in terms of tort liability in the event of claims of damage by WSDOT snow plow vehicles. James Morin noted that if WSDOT snow plows are found to be at any amount of fault in the event of a traffic accident with another vehicle or vehicles, WSDOT is entirely responsible for the financial coverage of vehicle repairs and other damages incurred from the accident. With the ability to provide detailed bread crumb trails on where WSDOT snow plows have traveled and when, this has significantly reduced the annual average of payments made by WSDOT resulting from tort claims. WSDOT paid an average of $2 million for winter maintenance related tort claims in the past. After the installation of the AVL system, the average went down to $500,000 per year.

One of the other main benefits that WSDOT has observed with the AVL / GPS system is the improved operational awareness of maintenance superintendents as they respond to winter storms. This has been noted by Maintenance Superintendents and Region Maintenance Engineers that have used either the LT6 software interface and / or the in-house developed WSDOT interface for viewing vehicle locations and making operational adjustments based on situations.

Joe Schmit explained the organizational structure related to the WSDOT AVL program. The WSDOT Central Maintenance Office managing funding and coordinate with Regions. The Central Office does not set policies and replies on Regions’ buy-in to support the AVL program. As such, outreach and buy-in from Regions is crucial to the success of the program. An added challenge to this de-centralized structure was the difficulty of achieving statewide consistency.

Joe Schmit noted that one of the main challenges with the hardware installation and wiring process was that there was no standard procedure followed in a consistent manner across WSDOT Regions. The information provided by Location Technologies did not include explicit wiring requirements. WSDOT needed to perform additional investigation on the specifications of the AVL device and spreader controllers to understand the wiring requirements. Once the wiring requirements were defined, the installation went through smoothly. One of the basic installation requirements was to ensure the visibility of the power and communications indicator lights on the front of the AVL device. This allows drivers to perform a visual check of the AVL hardware to confirm an operational status prior to beginning snow plow operations, and is a primary check for AVL equipment repair and replacement. Another requirement was to ensure the AVL device was installed at a location that was accessible for maintenance.

A lesson learned offered by WSDOT was that WSDOT did research in house to ensure smooth integration of the AVL system and spreader controllers. The research helped WSDOT staff understand the specifications of both the AVL system and spreader controllers. It also enabled WSDOT staff to interpret data from the systems/devices. WSDOT also contacted vendors of the AVL system and spreader controllers to confirm their research findings.

WSDOT also noted issues with the antennae for the AVL system. The GPS antenna for LT6 hardware carries current, but it would short out if it was not installed correctly. WSDOT has now standardized on a dual GPS / cellular antenna after experimenting with multiple types of antennae over the years. The procurement of LT6 AVL system hardware excluded the antennae from the manufacturer given the ability of WSDOT to provide the antennae for the system.

Joe Schmit also noted that a high staff turnover rate in some WSDOT Regions and Areas is one of the reasons for keeping the operation of the AVL / GPS system as simple as possible. Training becomes very important to address the high rate of staff turnover. The main responsibility for WSDOT snow plow drivers with respect to AVL operations is to monitor the power indicators on the AVL hardware within the vehicle before they begin their snow plow route, and to report on faulty hardware when detected. This reduces the amount of work to be performed by snow plow drivers related to AVL operations that may be new to the work, and simplifies the overall driver training procedures.

WSDOT noted the importance of training, for both operations and maintenance training. The training program was geared to the ground level staff involved in operations (drivers) and maintenance. WSDOT also had a “train the trainer” program to ensure knowledge resided in each Region and many Areas. The Train the Trainer program also helped build a network to share knowledge and best practice as well as support on-going operations and maintenance of the system.

Other challenges include different WSDOT Areas placing different priorities above that of properly installing and maintaining the AVL / GPS system perhaps due to staffing and other vehicle repair issues that may be straining resources.