



Above: Winter road conditions captured by a snow plow operator during a test run.

IN ADVANCE OF THE STORM

“If you don’t like the weather in Oklahoma, wait a minute and it’ll change,” quipped beloved statesman and Cherokee entertainer Will Rogers, who experienced the unpredictable weather patterns of his home state growing up near Oologah.

Although Rogers’ sentiment still rings true with Oklahomans, the ability of forecasters to predict weather events is dramatically different today due to advances in technology.

Travelers and roadway personnel are aware that winter weather changes can be deadly, especially in areas that experience extremes like the Oklahoma panhandle. “When a winter storm hits out here, it’s all hands on deck,” said Oklahoma Department of Transportation (ODOT) Division Six Maintenance Engineer Jon Logan in Buffalo, Okla.

“It’s a long ways from one end of this division to the other, and the weather can be doing very different things across the area,” said Logan, referring to the nine county region which stretches over 300 miles across, at the northern border of the state.

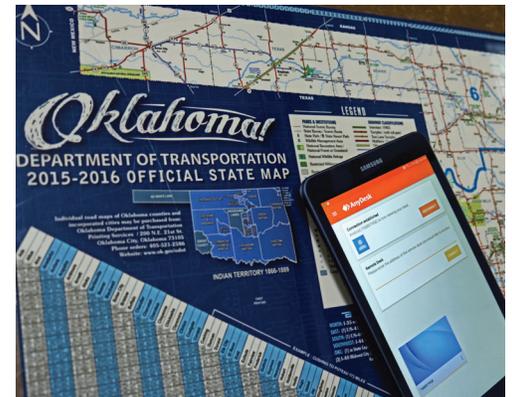
TRANSFORMING ALL-PURPOSE VEHICLES

To enhance road weather operations, ODOT began installing technology in 2016, that would transform their multi-purpose trucks into mobile data collectors, following recommendations



Above: Trucks with onboard computer systems maintain and construct roadways, clearing snow and ice when equipped to do so.

Right: All-purpose vehicles across the state will soon have capability to share road condition, materials use and location data from the field using custom software installed on tablets.



outlined in the Federal Highway Administration (FHWA) Every Day Counts (EDC) Road Weather Management:

Integrating Mobile Observations (RWM-IMO) initiative. The Oklahoma State Transportation Innovation Council (OKSTIC), a taskforce that encourages the deployment of transportation technology in the state, supported the ODOT effort to collaborate with the University of Oklahoma (OU) to adapt new weather data collection technology to function in Oklahoma.

“Our goal was to create custom software that could send and receive data from tablets and onboard computers installed in ODOT trucks,” said Professor Hazem Refai of the OU School of Electrical and Computer Engineering (ECE) Telecommunication Program in Tulsa. “The technology has the ability to monitor ODOT’s efforts in snow and ice events, as well as construction and maintenance activities.

After Refai and his team developed the software and perfected the prototype, ODOT installed the first 99 tablets in snowplow-capable trucks by October

2017. By October 2018, ODOT will install an additional 130 tablets.

“With 550 trucks located throughout the state, we needed to bite this off in chunks,” said ODOT Assistant Maintenance

Division Information Technology Systems (ITS) Engineer, Alan Stevenson.

“The collected information over time will provide the agency with accurate big picture data useful in reducing response times, lowering costs and optimizing resource deployment.”

Currently, each ODOT superintendent in the field determines how much salt and sand to apply to roads in snowy conditions. “They have a wealth of experience and they know their stuff,” said ODOT ITS Traffic Operations Specialist Reina Wilson, who helped load salt and sand into trucks in the Guthrie office around her dispatch duties before becoming an integral member of the ITS Maintenance and Operations Branch. “Once we fully implement the Integrating Mobile



Above: The Truck Embedded Encapsulated Computing Equipment, or TEECE hard drive developed by OU Professor Hazem Refai.

Observations project, the data we collect can be used by the superintendents and the divisions to fine tune exactly how much salt and sand they deploy, as well as determine which ratios of salt and sand mix is most efficient in specific conditions.”

ENHANCING EFFICIENCY AND SAFETY

During winter weather emergencies, up to 1,000 ODOT employees work in shifts around the clock until all highways are cleared. Crews equip multi-purpose trucks with plows and salt spreaders, then load salt and sand from the 127 salt sheds across the state to quickly clear state highways. Removing snow more quickly, reducing environmental impacts, and lowering costs are goals ODOT strives to meet each winter.

The RWM system will allow snowplow drivers to send road condition and stranded motorists notifications with the push of a button. “If a truck operator sees a stranded motorist, they can first rate the severity of the incident, and then publish that information by sending eight seconds of audio and video to division headquarters,” said Refai.

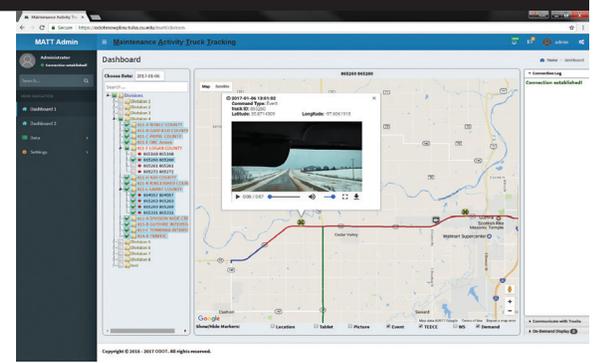


Right: Reina Wilson and Alan Stevenson in the ODOT ITS Command Center in Oklahoma City.

Right: Hear more about how ODOT Division 4 Maintenance Engineer Brantley Hendrex sees the RWM-IMO system will enhance winter operations at: <https://vimeo.com/275719592>



Right: Screenshot from Maintenance Activity Truck Tracking (MATT), showing past routes of a snow plow in a test run near Guthrie, Okla.



The tablets also send electronic stamps noting time, location, past route, and amount of salt and sand spread. “All of our software-compatible trucks are equipped with the tablet technology,” said Logan of the division that covers the panhandle. “Our guys know how to use the tablets and each one of them has practiced sending a video back to headquarters. It’s going to help us to be more efficient with the advantage of being able to track routes in real time.”

In Perry, Okla., ODOT Division Four Maintenance Engineer Brantley Hendrex explained the benefits the innovative weather management system would bring to his team. “When we have a weather event, we will know exactly where each truck is, how many material passes they made, and what time they made them. We can also see if they need to be re-directed to another location. Besides helping us be more efficient as a division, having this information really helps us address questions we get from the public.”

Data from every truck collected over time will create a large pool of road weather management information to be analyzed by researchers at OU and ODOT. “Big data is very important,” said Refai, referring to the ability to combine data with complex mathematical algorithms and computing power. Activities on the horizon for Refai include developing data mining algorithms to detect hidden patterns related to weather, road surface temperature, material type, and truck velocity. “Our goal is to develop truck deployment algorithms to optimize road condition improvements for the traveling public.”

SOURCED IN OKLAHOMA

Oklahoma opted to develop a custom system with local resources that addressed deployment issues unique to the state and saved money by doing so. To serve the entire state, ODOT needed to adapt the system to operate in areas with limited or no mobile phone connectivity. “There are places throughout Oklahoma where mobile phone service and connecting to the internet are not easily available,” said Stevenson. “ODOT maintains a network of Land Mobile Radio (LMR) towers and uses two-way radios to maintain communication in areas where cellular communication is unreliable.”

By sourcing the technology locally, Oklahoma realized an immense cost savings. In Weather-Savvy Roads Benefits and Costs,” FHWA noted per truck costs for other state transportation departments range from \$3000 to \$4500 per vehicle. “As far as a per truck cost, we are probably looking at around \$2000,” said Stevenson. “That would include software, hardware, maintenance, and development costs, all of which offer significant savings compared to what we’re seeing around the country.”



Left: Ron Bruce prepares to install a mini-harddrive in Perry, Okla. Below: Kirt Schweer installs a switch that allows the hydraulic system to communicate with the tablet and mini-harddrive.

INSTALLATION PROCESS

To learn more about the installation process for Oklahoma’s custom RWM-IMO solution, visit:

<https://spark.adobe.com/page/wOZCY6ACgLjIK/>

ODOT Transportation Maintenance Specialist Ron Bruce installs the mini-hard drives and tablets in ODOT vehicles around the state. “I can install three systems a day, especially when I have help like I did in Perry. Fleet specialist Kirt Schweer and the shop mechanics installed the switch that sends information about the plow position to the Truck Embedded Extensible Computing Equipment, or TEECE hard drive, before I got here.”

Bruce trains truck operators how to use the system and collects their feedback for the software user experience team. “We need the driver interaction to be minimal for safety reasons,” said Bruce, who was an ODOT heavy equipment operator before his mechanical ingenuity with computer systems led to his current role in the ITS Maintenance and Operations Branch in 2014. Bruce devised improvements that make touch input on the tablet less finicky. “Our goal is to keep it as easy for operators as possible.”

Seeing all the pieces of the RWM process come together are extremely rewarding for Refai. “As an engineer, it’s always satisfying to see something working right. This technology’s impact on public safety, its ability to provide cost savings, and its positive effect on environmental effects are important to my team.”

By fall 2018, every capable truck will be equipped and every snowplow operator trained to test the new system during the next big storm.

Once the system is deemed fully-operational, next steps include integrating snowplow data with public road condition updates that ODOT publishes on okroads.org, a website used by state agencies to manage weather events in Oklahoma.

“We’re excited to get this technology fully integrated,” said Hendrex. “Our team always takes a lot of pride in their work, but winter weather events is where they really shine. They work long, hard hours, and they don’t quit until the job is done.”



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