



Drivers of snow removal equipment have been field-testing the Mountain Pass Road Opening (MPRO) system in the Sierra Nevada for several years, including the monumental winter of 2016-17 along Tioga Pass in Yosemite National Park. Caltrans plans to deploy eight MPRO systems in the Sierra.

Way Paved for High-Tech Snow Clearing

Caltrans, Research Partners Devise System to Protect Workers, Spare Equipment

The development of the Mountain Pass Road Opening (MPRO) system provides a good example of how Caltrans' research projects can pay big dividends.

More than a decade after initiating studies to improve safety and efficiency for work crews clearing snow and ice from Sierra Nevada routes, Caltrans is now committing to a laser-based mapping system that gives exact coordinates of road locations — critical when you're working on the icy sides of precipices that can drop thousands of feet.

Until recently, snow equipment operators on Sierra passes had few visual indicators or landmarks to guide them as they drove 10-foot-wide snow removal machines along roadways often only 18 feet wide. Caltrans staff relied on techniques such as probing snowpack with poles, path staking, and using cable systems to mark road centerlines. Road markers can be damaged, or vandalized by winter users, resulting in operations delays and expensive repairs to guardrails, signage, roadside structures, and snow blowers — sometimes up to \$30,000 to \$40,000 for each incident.

Caltrans' Division of Research, Innovation and System Information (DRISI) first began looking for new ways to improve safety and efficiency on mountain snow-clearing operations in 2005. Working with the Advanced Highway Maintenance and Construction Technology Research Center at University of California, Davis, researchers developed an initial mapping system that created a high-accuracy Geographic Information System (GIS) map. After being successfully tested on State Route 108 (Sonora Pass) in Tuolumne County for five snow seasons, a more portable version of the MPRO system was developed and brought to State Route 120 through Tioga Pass in Yosemite National Park for a thorough evaluation.

The GIS map outlined buildings, road signs, and guardrails, based on information gathered with a Mobile Terrestrial Laser Scanner (MTLS) mounted on a Caltrans van during the summer months. The map's high-precision reference information is converted by the MPRO software into an image viewed by the equipment operator on the in-vehicle computer. The MPRO system also relies on a Global Positioning System receiver that

The MPRO system helped drivers safely navigate through deep snow, tracking the contours of the roadway underneath, and kept the snowblowing fleet out of harm's way.

receives satellite updates to enhance the GPS signal and improve accuracy.

Earlier DRISI research led to the development of the MPRO system. Stationary and airborne GPS data provided a foundation for the MTL technology. Developed in collaboration with the UC Davis research center and Caltrans' Office of Land Surveys in 2008, the laser scanning system produces three-dimensional, photo-realistic geospatial data that combines high accuracy map coordinates with photos, and is used to help build the base data that guides the MPRO system.

The MPRO system got its real test during the 2016-17 winter, when more than 25 feet of snow buried Tioga Pass. Despite the challenging conditions, the system proved its worth in numerous ways, according to Caltrans managers.

Most important was the safety benefit for work crews. The MPRO system helped drivers safely navigate through deep snow, tracking the contours of the roadway underneath, and kept the snowblowing fleet out of harm's way.

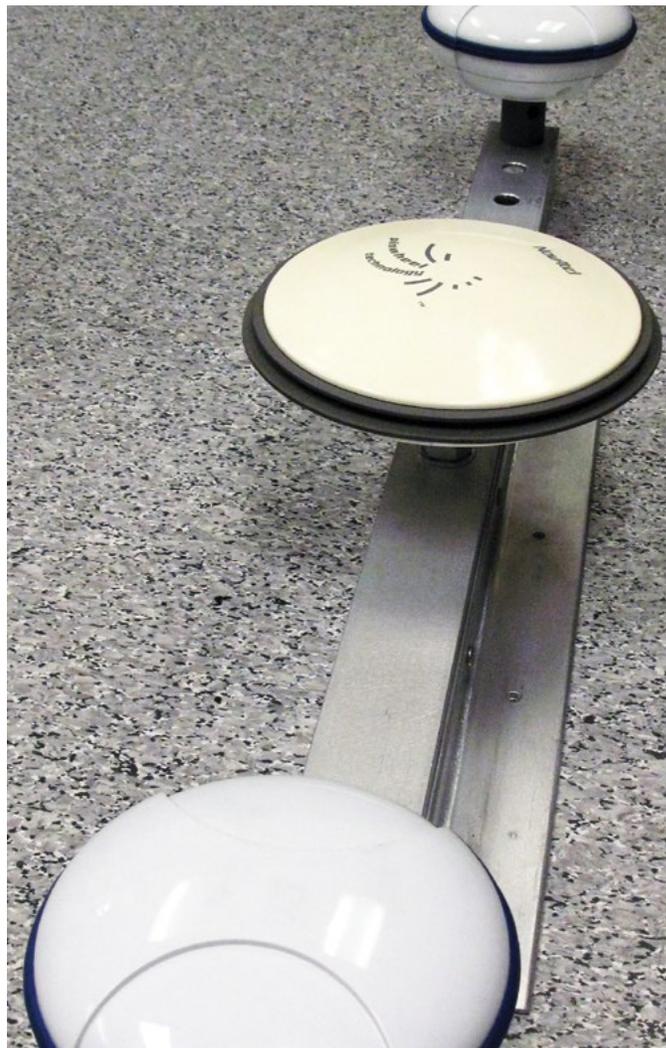
The system also allows newer employees to get up to speed faster, and with more protections, on the hazardous job of pass clearings. Many years of light snowfall (with the exception of the 2016-17 drought-buster), and the difficulty in retaining seasoned personnel has cut into the amount of experience that Caltrans can call on during critical pass opening periods.

Obstacles hidden under mounds of snow and ice also pose a danger to crew and equipment. With an MPRO unit mounted on a snow removal vehicle, giving exact coordinates, operators can keep costly machinery out of debris fields outside of the roadways and avoid large rocks, trees, brush, and guardrail that can cause serious damage to equipment.

The task of mountain pass clearings is critically important to the economy of those regions. The spring openings turn on a spigot of tourist and recreation dollars that many mountain and foothills regions depend on until the next winter's arrival, when the gates again swing shut on high-country highways.

The MPRO system, and the research that went into it, demonstrates Caltrans' commitment to improving the efficiency and effectiveness of California's highway system, and also aligns with the Department's Strategic Management Plan goals of sustaining stewardship and efficiency. Caltrans plans on deploying eight new MPRO systems that will be redesigned on a tablet for portability. These systems will be used on SR 120, SR 108, and SR 4 (Ebbetts Pass) and are expected to be ready for use by spring 2020. **MM**

Source: Elaine Chan, Communications and Outreach analyst, Larry Baumeister, Project Engineer, Caltrans Division of Research, Innovation and System Information; Russell Modrell, Maintenance Manager, Division of Maintenance



A Mobile Terrestrial Laser Scanner was mounted on top of a Caltrans van in summer to map fixed road features for MPRO software.