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LRRB
LOCAL ROAD RESEARCH BOARD

TECHNICAL SUMMARY

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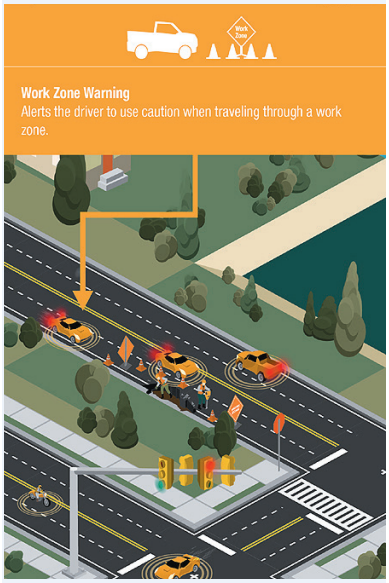
PROJECT COST:
$51,503



Intelligent transportation system features like work zone warnings may be incorporated in CAVs.

DEPARTMENT OF TRANSPORTATION
OFFICE OF RESEARCH & INNOVATION

Preparing Roads for Connected and Autonomous Vehicles

What Was the Need?

For transportation agencies, which manage infrastructure in time frames of decades, the potential of connected and autonomous vehicle (CAV) technology influences infrastructure upgrade plans.

New pavements and overlays, traffic signal systems and signs may serve for decades, while pavement markings face shorter life cycles. Optimizing spending today requires anticipating future infrastructure needs, and the infrastructure requirements of CAVs may differ from standards currently in place.

It remains unknown how imminent the CAV future is, and competing technologies and designs for guidance systems, sensor formats and other facets of the developing vehicle technology keep outcomes unsettled. Enthusiasm in the technology and automotive sectors for this new model of road user tools nevertheless suggests that short-term preparations warrant consideration within the current limited-budget environment for infrastructure improvements.

Proprietary technologies, industry competition and regulatory uncertainty are slowing the advent of defined standards for CAVs. Researchers described eight infrastructure categories in which CAV-friendly options should be considered, including ways to install pavement markings and signage that serve current drivers and CAVs.

How local agencies can best brace their roadway systems for a CAV-driven shift in road usage remains unclear, and public transportation officials cannot predict what the technology will look like if and when autonomous vehicles roll onto streets in significant numbers.

What Was Our Goal?

Researchers sought to create a toolbox for local road agencies to use in preparing for CAVs in the next five to 10 years. Recommendations would help agencies leverage ongoing infrastructure plans and expenditures to prepare for CAVs and the potential technologies for roadway navigation and travel the vehicles will deploy.

What Did We Do?

Researchers began by studying the literature, attending conferences and consulting with industry experts to describe likely CAV technologies and potential implementation timelines. Based on this research and discussions with the project's Technical Advisory Panel, investigators developed recommendations in eight categories of infrastructure needs. The research team also prepared seven case studies showing how road agencies have addressed different aspects of preparing for CAV fleets.

What Did We Learn?

Industry competition and proprietary technologies make CAV outcomes difficult to project, and federal standards and regulations have yet to develop to meet potential forms of the technology. Some consensus within the CAV industry suggests truck platooning, in which two or more CAV trucks follow one another at distances of 30 to 50 feet, seems the most promising initial implementation of CAV technology within the next five to 10 years. In addition, optical cameras will be a likely early iteration of sensing technology. Accommodating these technologies will impact two infrastructure categories—pavement markings and signage. Recommendations for these infrastructure needs follow:

continued

"Making sure that signing and striping are visible will be essential for accommodating autonomous cars. It's also going to be good for all drivers, especially with an aging population."

—Douglas Fischer,
Highway Engineer,
Anoka County

"Connected and autonomous vehicles are further away than we think. Full integration of driver assistance technologies—which is where the real power in CAVs is at this time—may be a slow process."

—Shauna Hallmark,
Professor, Iowa State University Department of Civil, Construction and Environmental Engineering

Pavement marking is one area in which road managers can begin preparing for the needs of large CAV vehicle fleets.

- **Pavement Markings.** Consider California's plans to install 6-inch-wide lane lines (the current Minnesota standard is 4 inches) on highways and Interstates during regular maintenance and new construction within three years.
- **Signing.** Ensure that signs are standardized, easily visible, and not blocked, damaged or faded.

The other six infrastructure categories impacted by CAVs entail less-specific recommendations:

- **Traffic Signals.** Create space at signal control cabinets for additional hardware related to CAV technologies.
- **Consistency and Standardization.** Install and maintain striping, signing and signals consistent with CAV algorithms and technologies.
- **Pavement Maintenance.** Continue to keep road surfaces well-maintained.
- **Data Capture and Information Sharing.** Begin or continue collecting and organizing data for bridge heights, speed limits, load restrictions, crosswalks, roadway curvatures and other infrastructure characteristics.
- **Communication Infrastructure.** In new construction and information technology infrastructure built for agency use, ensure adequate conduits for power and fiber optic cables.
- **High-Resolution Mapping.** Consider developing high-resolution mapping capabilities.

What's Next?

Case studies about developments in Los Angeles and in Iowa, Michigan, Ohio, Virginia and Wyoming explain how agencies are preparing for the needs of a CAV-friendly infrastructure.

A pilot project in Anoka County, Minnesota, informed decisions about signage to ensure visibility and consistent placement. Pavement markings were also addressed; currently the county continues to place 4-inch edge lines, lane lines and centerlines after resurfacing projects, and painting lines to 10-foot lengths at 40-foot gaps. Conversion to 6-inch markings could be accommodated on existing pavements; however, if a new standard is required for skip stripe spacing, it may only be economically feasible to do so on new surfaces.

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