HOW HAS THIS WORKED IN PRACTICE?

- The **California Department of Transportation (Caltrans)** recommends participation and input from various fields of expertise on each project development team during the planning, design, and construction phases. The traffic unit provides capacity studies and operational analyses and develops safety and delay indices.[4]
- The **Pennsylvania DOT** has developed design checklists for a number of ITS elements for both standalone projects and as components of a larger project. The checklists address the design of closed circuit televisions, dynamic message signs, highway advisory radio, vehicle detectors, ramp meters, and travel time systems. They ensure that a thorough list of location, safety, power, communications, maintenance, usability, and other factors or requirements have been considered in the design of the ITS element.[5]
- The **Colorado DOT** requires all projects to undergo a TSMO evaluation during the design scoping review phase of its projects. The three part assessment (safety, operations, and ITS) ensures TSMO elements are considered early in the project lifecycle (e.g., managed lanes, service patrols, real-time traveler information, incident response teams, transportation management centers).[6]

The SHRP2 Reliability by Design tool can help with analyzing how design strategies can improve travel time reliability. This is a spreadsheet-based analysis tool that helps agencies estimate the effectiveness and comparative economic benefits of design treatments at specific locations.

To download the tool, go to: http://www.trb.org/Main/Blurbs/169768.aspx.

4 Designing for Transportation Management and Operations: A Primer, FHWA, 2013. Available at: https://ops.fhwa.dot.gov/publications/fhwa-hop13013/fhwahop13013.pdf.
5 Ibid.
6 TSM&O Evaluation, Colorado Department of Transportation, 2018. Available at https://www.codot.gov/programs/operations/tsmo-evaluation.

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DESIGN

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Federal Highway Administration

ENHANCING TRANSPORTATION: CONNECTING TSMO AND DESIGN

Photo Source: Getty Images

The typical highway project life cycle starts with planning and then moves to design, construction, and maintenance. Historically, the day-to-day operation of the facility after project completion has received less attention. Design personnel, transportation planners, and operations staff can work together to enhance the linkage between design and operations. For example, some States are now working to more fully incorporate operations into their project development processes and design manuals. Considering facility operation during the design process and incorporating TSMO strategies into facility design can improve system performance for little cost.

TSMO strategies help agencies improve the safety, reliability, and cost-effectiveness of their infrastructure projects. Designing with TSMO in mind results in several benefits, including:

- A safer and more operationally efficient facility design for all users (motorized and non-motorized), emergency responders, maintenance staff, and other operators.
- Lower costs for future operational and intelligent transportation systems (ITS) deployments, as foundational ITS infrastructure can be included in highway designs during construction.
- Less congestion and greater travel time reliability from the implementation of TSMO strategies.

WHAT IS TSMO?

Transportation systems management and operations (TSMO) is the use of strategies, technologies, mobility services, and programs to optimize the safety, mobility, and reliability of the existing and planned transportation system. A significant cause of congestion and unreliable travel is non-recurring events, such as crashes, and transportation network disruptions, such as bad weather, and special events. TSMO enables agencies to target the underlying operational causes of congestion and unreliable travel through innovative solutions that typically cost less and are quicker to implement than adding capacity. TSMO expands the range of mobility choices available to system users, including shared mobility and non-motorized options.

This Fact Sheet is part of a series that explains how TSMO relates to other State and local transportation agency functions and offices. Other Fact Sheets focus on how TSMO relates to: asset management, performance management, maintenance, construction, environment, planning, human resources, and safety.

Designing for TSMO can reduce the frequency and impacts of temporary transportation system disruptions that cause congestion and unreliable travel times. For example:[1]

- Impacts from traffic incidents can be reduced by design treatments. Treatments can decrease the frequency of incidents (e.g., queue warning systems, runaway truck ramps), minimize the number of lanes they block (e.g., crash investigation sites, vehicle turnouts), reduce the time the lanes are blocked (e.g., emergency crossovers, drivable shoulders), and shield the incident from the view of passing drivers (e.g., extra-high median barriers, portable incident screens).
- Adverse weather conditions on the roads can be mitigated with treatments to prevent snow or sand from blowing across the roadway, limit the accumulation of snow and ice, or increase the efficiency of lane-clearing practices.
- Congestion caused by surges in demand can be alleviated by incorporating mechanisms into the design that temporarily increase capacity in the direction of major travel (e.g., divert demand to alternate routes, and limit freeway entrance and exit options).

Photo Source: Getty Images

TSMO CAN PLAY MULTIPLE ROLES IN THE INFRASTRUCTURE DESIGN PROCESS.

- TSMO can be an alternative to adding new capacity or reduce the new capacity needed.
- Future TSMO and technology needs can be incorporated into a traditional design to preserve capacity and extend the functional life of the facility.
- TSMO strategies can help mitigate substandard or problematic geometrics.
- TSMO strategies can serve as a useful tool in performance-based practical design.[2]

Sample design treatments that support TSMO:

- Emergency crossovers in medians
- Gated median barrier
- Queue-jump and bypass lanes
- Drivable shoulders
- Vehicle turnouts
- Crash investigation sites
- Ramp widening and closure
- Runaway truck ramp
- Improvements to detour routes
- Snow fences
- Wildlife fencing, overpasses, and underpasses

1 Strategic Highway Research Program (SHRP 2) Report S2-L07-RR-2: Design Guide for Addressing Nonrecurrent Congestion, 2014. Available at: http://www.trb.org/Main/Blurbs/169768.aspx.

2 Transportation Systems Management and Operations and Performance Based Practical Design Case Study 4: Demonstrating Performance-Based Practical Design through Regional Performance-Based Planning, FHWA, 2016. Available at https://ops.fhwa.dot.gov/publications/fhwahop16038/index.htm.

CONSIDERING TSMO IN THE PROJECT DESIGN PHASES

TSMO strategies can be implemented at each point of the design process to improve project outcomes and long-term operational efficiency. Agencies benefit from developing formal policies and procedures for including TSMO strategies and making operational considerations throughout the design process, as outlined in Figure 1.

- **Project Scoping Phase.** The project's fundamental purpose and need are identified, and the potential to include TSMO strategies is the greatest during this initial phase. This is an ideal time to develop agreements or requirements for project-specific TSMO strategies.

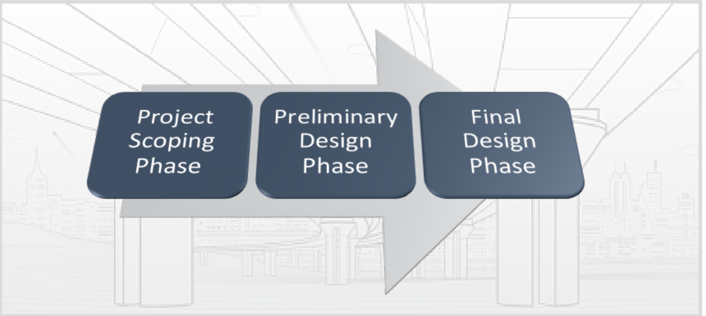

Figure 1. Project Design Phases

- **Preliminary Design Phase.** Many project alternatives are still being considered, providing an important opportunity to incorporate TSMO strategies instead of the more traditional or costly solutions such as adding lanes. At this point, items such as full-width shoulders may be considered since narrow shoulders may require maintenance personnel to shut down lanes to perform their duties.[3]
- **Final Design Phase**. Plans and detailed specifications for construction work are prepared. Adjustments to the design to accommodate TSMO are still possible, but may be more costly than at earlier stages.

Performance Based Practical Design modifies the traditional highway design process by taking a "design up" approach, where transportation decision makers exercise engineering judgment to build up the improvements from existing conditions to meet both project and system objectives. By taking into account TSMO strategies during the performance-based practical design process, designers can expand the variety of design options available to them and perhaps postpone or reduce the need for conventional capacity improvements. For example, designing shoulders to support the TSMO strategy of part-time shoulder use by public buses reduces delay during peak congestion periods and provides additional capacity as needed, but the shoulder reverts to its original use during non-peak travel periods.

3 Designing for Transportation Management and Operations: A Primer, FHWA, 2013. Available at https://ops.fhwa.dot.gov/publications/fhwa-hop13013/fhwahop13013.pdf