



THE INNOVATIVE DOT

Focus Area 4: Increasing Transportation System Efficiency

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It is often prohibitively expensive to add lane miles to relieve congestion. Where dollars for capacity are available, expansions may run counter to community development and environmental goals, and may only induce more traffic. Faced with this challenge, agencies have come up with operational improvements and other ways to improve the efficiency of existing systems without major new capital investments. Strategies include operational improvements, demand management, and cooperation with local governments to ensure that state and local systems work synergistically.

In this section:

- Reform Level of Service
- Use Practical Design and Context Sensitive Solutions
- Improve Street Connectivity
- Modernize Access Management Standards
- Use Transportation Demand Management
- Invest in System Management

Pictured: Ramp meters in the Minneapolis/St. Paul area. See *“Invest in System Management”* to learn more.

FOCUS AREA 4: INCREASING TRANSPORTATION SYSTEM EFFICIENCY

Reform Level of Service

The Opportunity

Transportation agencies constantly face the challenge of improving access to destinations with fewer resources. Measures of congestion such as level of service (LOS) are often cited as a major reason for making expensive capacity additions. However, this approach can lead DOTs away from the best investments because LOS is an interim measure—a measure of whether cars can move rapidly along a stretch of road—and not a measure of the ultimate outcome.

An overly rigid focus on LOS can lead to costly expansion projects built to serve narrowly-defined conditions that are not representative of typical infrastructure use, and can ultimately undermine desired outcomes related, for example, to economic development and safety. In some cases, free-flowing traffic may not be necessary; if traffic is slow but trips are short, travelers still get to their destinations quickly. Low volumes of traffic on high capacity streets may not be an indicator of good engineering; they may instead be an indicator of a dying town and an underutilized public investment (the road). Likewise, increasing speeds in a congested business district to improve LOS may negatively impact the businesses that rely on the traffic stopping to spend money.

Using LOS in a new way provides an opportunity for DOTs to ensure that investments achieve multiple intended goals.

What Is It?

Transportation engineering and planning have generally measured LOS as a ratio of actual traffic volume to the theoretical capacity of the road. There are two solutions DOTs can try to ensure LOS steers consistently toward high value investments: use LOS standards differently, and redefine them.

For instance, DOTs often measure LOS at the time of peak delay during the day and use that to decide if capacity additions are warranted. In the extreme example where service is bad for one hour of the day and then good for the remainder, a large amount of money may be spent to solve a problem that only exists for a very short time, while the road is hugely underutilized for the rest of the time, making the benefits low and the costs high.

Another important consideration is context. Some places are heavily congested because they are very desirable places to be. These places are often centers of economic activity that rely on a high volume of travel and may be harmed by wider roads or faster traffic. Since one of the goals of transportation investments is economic development, it may be counterproductive to “fix the traffic” by means of capacity expansion. Instead, it may be better to improve service by ensuring that people who choose to travel by walking, biking, or transit can do so. However, traditional measures of LOS don’t measure these changes, rendering these improvements virtually worthless as a means of improving the measured LOS.

To capture the impacts of multimodal improvements, LOS can be redefined to account for the capacity and utilization of all modes. Measures of pedestrian, bicycling, and transit LOS mirror roadway LOS measures in that they evaluate the adequacy/availability of the facility for accommodating existing and new travel. These generally include measures of capacity such as the presence, density, and extensiveness of sidewalks and bike lanes; measures of connectivity, frequency, quality, and size of the

transit system; and measures of utilization, such as people per square meter, volume of cyclists, and number of public transportation users.

Implementation

Redefining LOS and its application is a change in policy that requires little or no additional funding or enforcement, and may be instituted entirely within a transportation agency. Policies on infrastructure performance are not often codified in state legislation, so the agency has considerable flexibility to revise its benchmarks of what is an acceptable measure.

Successful implementation will involve close partnerships with and buy-in from cities and counties. State agencies should also engage the Federal Highway Administration in this discussion and partner strategically with elected officials. It is critical to ensure that communicating a revised definition of acceptable performance levels is done effectively, especially as agencies seek to advance long-delayed projects or other efforts that carry specific constituent expectations.

Detailed Steps

Moving forward with reforming LOS does not need to follow a set pattern of steps. As the case studies later in this narrative suggest, there is no single “right” way to pursue this approach, but rather multiple potential strategies, each of which is tailored to the specific needs of the state and communities that the project serves. However, there tend to be some common approaches to this type of reform, including the approaches described below that have been taken in state agencies.

- 1. Modify specific LOS requirements that emphasize peak hours, special events, or other exceptional scenarios of demand on infrastructure with an eye toward flexibility.** Criteria that focus on the most acute points of challenge to infrastructure performance, such as specific intersections or roadway segments, can be eased in favor of an understanding of an entire corridor’s average performance, or even an entire system’s. For example, rather than intersection-based levels of service, overall corridor levels of service, measured as a function of travel speed and time along a corridor, may provide a more meaningful measure of performance that also lessens the acute need for an expensive project to address performance issues at a specific location. If select intersections experience congestion but the entire corridor functions within an acceptable range of travel time and speed, there may be no real need for the project from the standpoint of providing regional access.
- 2. Consider different circumstances in different parts of the state, especially urban areas and rural areas.** Urban areas generally have a greater and more complex set of travel needs and, in many cases, warrant a different standard of performance than rural areas.
- 3. Incorporate language that emphasizes flexibility into design manuals.** This may include starting designs with minimum values to meet standards and not “desirable” or “preferable” values. It may also include removing language such as “desirable” or “preferable” entirely.

Because of the ability that most state agencies have to change these policies internally, action can happen fairly quickly. However, as mentioned previously, these policies are inherently tied to the eventual design-driven factors involved in transportation projects and, as a result, may take a longer period of time for their effectiveness to be demonstrated and understood.

The promise of cost savings and stretching budgets farther is highly appealing to elected officials, but careful communication of this message is essential to keep the true policy intent of a practical design approach from being distorted for political purposes. In particular, a policy approach that changes LOS

standards and that may result in projects that are more modestly designed may be misinterpreted by elected officials as providing less utility per project, or removing value. It is important to emphasize that, while this is lowering the cost, it is actually increasing the benefits per dollar spent and that remaining money is therefore available for other projects.

Case Studies

Florida

The Florida DOT has proposed relaxing standards for roadway design time periods and volumes.¹ These new standards are based on lower traffic volumes, but still founded in commonly accepted engineering methodology (even if the acceptable values differ from those used in conventional practice). Florida's approach is based on a system of standard K factors, or the ratio of peak-hour traffic to a roadway's overall traffic throughout the day, which is used to determine capacity needs and, in turn, guide roadway project design.² Engineers use this factor to calculate peak-hour volume from overall daily volume (or vice versa), and it serves as a general guide to how peak-oriented traffic flow is on a given facility.

Florida's proposed system specifies the K factors to be used on different roadway facilities and in different areas of the state, permitting lower K factor values (and thus lower peak-hour design volumes) in urban areas than in rural areas. This recognizes that roadway projects in urban areas are more costly in general, and especially more costly when they attempt to design for exceptionally high levels of traffic. At the same time, the proposed policy eliminates confusion in what factors to apply by specifying clear values to be used in a given combination of conditions. It gives the Florida DOT a solid and defensible approach to design criteria, and represents an acceptance of greater levels of traffic and a need for design flexibility in urban areas.

In addition to flexibility in its administration of LOS, the Florida DOT in 2002 gained national notice when it issued multimodal LOS Standards for the State. This practice was continued in its 2009 FDOT Quality/Level of Service Handbook³ which notes that, as LOS for one mode changes, others may be affected as well; that different roads play different roles in the system, with some focused more on mobility and some on access; and that there is a correlation between urban size and acceptance of some highway congestion in exchange for urban amenities.⁴

Pennsylvania

As a part of its Smart Transportation initiative, the Pennsylvania DOT (PennDOT) has taken a broad policy approach to 'right size' projects, focusing on a number of planned projects throughout the state that it determined it could no longer afford to deliver as initially designed. Instead of proceeding with original plans, PennDOT offered to continue with a less ambitious version of each project that would still address community needs and congestion issues, but at a lower cost.

1 Florida Department of Transportation, Systems Planning Office. "DRAFT Issue Paper on Improving Florida's Transportation Planning and Design Analysis Time Period Process." Retrieved 1/12/14 from <http://www.dot.state.fl.us/planning/systems/programs/sm/transition/information/District%20Pilot%20Study.pdf>.

2 *Ibid.*

3 Florida Department of Transportation. (2009). Quality/Level of Service Handbook. Retrieved 1/12/14 from http://www.dot.state.fl.us/planning/systems/programs/sm/los/pdfs/2009FDOTQLOS_Handbook.pdf.

4 Florida Department of Transportation. (2009). *FDOT Quality/Level of Service Handbook*. Retrieved 1/12/14 from http://www.dot.state.fl.us/planning/systems/programs/sm/los/pdfs/2009FDOTQLOS_Handbook.pdf.

U.S. Route 202, for example, was originally conceived as a 70 mile-per-hour grade-separated expressway through Montgomery and Bucks Counties northwest of Philadelphia, but the project stalled in the early 2000s due to funding constraints and local controversy. In 2005, PennDOT re-evaluated the nine-mile, \$465 million project and formed consensus around an at-grade, slower-speed, multimodal, and smaller-scale project called the US 202 Parkway through a collaborative process involving the local communities along the corridor and several federal and state agencies. In this case, the defined need along the Route 202 corridor was primarily for local access, not for significant volumes of regional traffic expecting a high-speed travel experience. The parkway option filled this need by completing the regional and local roadway network *without* attracting a significant volume of new trips.⁵

The project was under construction by 2009 and expected to be completed at a cost of \$206 million, less than half the cost of the original expressway concept. The approach also streamlined implementation by transforming a project that had been in plans for nearly four decades into a smaller project with less community impact, all in less than one decade.

Kentucky

Faced with an operating environment similar to Pennsylvania's, the Kentucky Transportation Cabinet (KYTC, the state transportation agency) has begun to use a different approach to defining project need.

Inspired by the project-based successes of the Missouri DOT, KYTC initiated a "Practical Solutions" approach to project development and design in 2008. As part of this initiative, KYTC reevaluated the traditional early indicators of performance that often drive the purpose and need of eventual projects as well as the specifics of project design. Senior management issued guidance throughout the agency encouraging project teams to use flexibility in their selection of design volumes, opting for intermediate design years and not always the conventionally accepted 20-year forecast. This guidance was intended to control project costs by managing the scale of eventual project design, keeping projects focused on the core purpose and need and preventing the over-design of roadways that occurs when traffic projections are extremely conservative.⁶

KYTC has also adopted Missouri's broadened focus on system performance over specific facility performance, preferring a "great system of good roads" over a single project that designs a "great road" at a significantly higher cost. It has not developed specific policies based on LOS or other conventional systems of measuring infrastructure performance. However, it has taken an approach based on relative performance, where current LOS or performance is understood as a baseline and any improvements realized from this baseline are considered with respect to project cost.

Kentucky has not set aside staff resources to track the performance of the Practical Solutions program, although numerous specific project designs based on revised policies that help to determine project purpose and need demonstrate that the concept has been successful.⁷ KYTC acknowledges that this lack of a formal monitoring system does not readily allow for an even comparison of policy approaches, but, at the same time, the non-bureaucratic nature of the concept within the agency has promoted flexibility in its use and has generally reduced the resistance to broad reform initiatives that many other agencies experience at the staff and management levels.

5 Pennsylvania Department of Transportation (2012) "US 202 Section 700 Parkway" Website. Retrieved 8/15/12 from <http://www.us202-700.com/>.

6 Interview with Jeff Jasper, Program Manager for the Practical Solutions program, Kentucky Transportation Cabinet. (2012, March 29).

7 Kentuckians for Better Transportation. (2008). "KYTC to Use Practical Solutions to 'Do More with Less.'" *Transportation News*. Retrieved 9/12/2013 from www.kbnet.org/uploads/TransportationNews2008_08_08.doc.

Denver, Colorado: A Different Approach to Measuring Travel Capacity and Demand at the Regional Level

Denver's Department of Public Works developed the region's Strategic Transportation Plan (STP) in 2008 through partnerships with other city agencies and stakeholder engagement. The plan takes an innovative approach to evaluating current and future transportation needs in the region and identifying strategies to address those needs. Rather than assessing capacity and demand on the corridor scale, the plan analyzes trips within "travel sheds," a concept based on the theory of a watershed. Travel sheds are geographic areas characterized by similar travel patterns on local routes, which feed into the larger transportation network. This approach enabled the project team to evaluate the effectiveness of the layout of and connections between the full network, including the grid and arterial system, transit routes, bike routes, and pedestrian throughways.

The project team also analyzed "person trips," rather than vehicle trips, to assess current travel conditions and forecast conditions for 2030, determining that this was a more accurate measure of the impacts of all types of travel. To do this, the team calculated the total "person-trip capacity" of corridors within each travel shed and compared this to the "person-trip demand," the total number of trips taken by all modes of travel within each travel shed. The project team identified areas where person-trip demand exceeded capacity as "gaps" in the transportation system and developed recommendations for improvement strategies for each travel shed based on the results.⁸

California

Concerns about the environmental consequences of level of service (LOS) requirements recently prompted action by the rule makers in the state of California. In September 2013 the state passed SB 743, which removes highway LOS considerations from traffic mitigation analyses in "transit priority areas" — those areas within one-half mile of a proposed or existing major transit stop — recognizing that these considerations reward projects that encourage automobile travel.⁹ In place of the conventional LOS measure, the bill calls for a more appropriate traffic impact criteria that will "promote the reduction of greenhouse gas emissions, the development of multimodal transportation networks, and a diversity of land uses." This action is intended to shift the focus away from vehicle delay and traffic congestion toward measures such as vehicle trip generation and total vehicle travel.

The prior version of CEQA (California Environmental Quality Act), which included LOS criteria, prevented multimodal projects from moving forward if they were perceived to negatively impact the nearby flow of traffic. The revised CEQA recognizes that projects in compact areas near transit offer environmental benefits because they generate small amounts of motor vehicle traffic and offer new opportunities for travel by other modes. The senate bill calls for the state's Office of Planning and Research to recommend new criteria for evaluating environmental impacts by July 2014. As specified in the bill:¹⁰

"Those criteria shall promote the reduction of greenhouse gas emissions, the development of multimodal transportation networks, and a diversity of land uses. In developing the criteria, the office shall recommend potential metrics to measure transportation impacts that may include, but are not limited to, vehicle miles traveled, vehicle miles traveled per capita, automobile trip generation rates, or automobile trips generated."

8 Denver Department of Public Works. (2008). *Denver Strategic Transportation Plan*. Retrieved from http://www.denvergov.org/Portals/688/documents/DenverSTP_8-5x11.pdf.

9 State Smart Transportation Initiative (2013) "California moves to reform traffic mitigation process." Retrieved on 10/30/2013 from <http://www.ssti.us/2013/09/california-moves-to-reform-traffic-mitigation-process/>.

10 State of California. (2013, September 7). Senate Bill No. 743. Retrieved 11/25/13 from http://leginfo.ca.gov/faces/billNavClient.xhtml?bill_id=201320140SB743.

Resources

Florida Department of Transportation, Systems Planning Office. DRAFT Issue Paper on Improving Florida's Transportation Planning and Design Analysis Time Period Process. <http://www.dot.state.fl.us/planning/systems/programs/sm/transition/information/District%20Pilot%20Study.pdf>.

This paper examines the best time period for planning and designing transportation facilities. It looks at both the positive and negative aspects of the approach that it recommended to the Florida DOT.

Florida Department of Transportation. 2009 FDOT Quality/Level of Service Handbook. http://www.dot.state.fl.us/planning/systems/programs/sm/los/pdfs/2009FDOTQLOS_Handbook.pdf.

This handbook and software are intended for planners, engineers, and decision makers for the review of roadway capacity and quality/level of service. It provides analytical techniques, updated generalized service volumes, and cost-effective methods for gathering input data.

Missouri Department of Transportation. Practical Design. <http://www.modot.org/business/documents/PracticalDesignImplementation.pdf>.

The "Practical Design" manual provides readers with steps for effectively implementing Practical Design, and it's written to allow for flexibility in project locations.

State Smart Transportation Initiative. (2011). Review of PennDOT's Smart Transportation Initiative. http://ssti.us/wp/wp-content/uploads/2011/02/SSTI_Review_of_PennDOT_Smart_Transportation.pdf.

This provides a comprehensive evaluations of PennDOT's reform program, exploring both internal operations and external outreach as well as connections to partner agencies. Chapter 9 focuses on new approaches to project delivery, with U.S. 202 project as an example.

FOCUS AREA 4: INCREASING TRANSPORTATION SYSTEM EFFICIENCY

Use Practical Design and Context Sensitive Solutions

The Opportunity

Transportation agencies across the United States are facing chronic budget shortfalls as they try to stretch declining gas tax revenues to cover ever-increasing infrastructure maintenance costs. In spite of this, DOTs often design projects to the highest specifications in the highway design manual, which can make the projects unnecessarily expensive to build and maintain. In addition, these investments may foster high-speed traffic and increase traffic volumes where they are unwanted, impeding access along and across the facility for non-highway users and potentially stifling the very economic development and community vitality that the project is attempting to foster. In these cases, agencies have sometimes been forced to retrofit overdesigned roads with traffic constraints, further increasing costs.

Rather than a one-size-fits-all approach, states can adopt an approach that ties project planning and design to core transportation needs. With this approach, designs are context sensitive, taking into account the surrounding community and environment rather than designing in a vacuum and treating design and mobility standards as rigid minimum requirements. This approach will encourage DOTs to make smart, cost-effective, and community-supported design decisions.

What Is It?

In essence, context sensitive solutions (CSS) and practical design are efforts to encourage planners and designers to consider the particular circumstances and needs of each project and to exercise greater flexibility and creativity in reaching design solutions. At the most basic level, they are simply attempts to recognize that a roadway passing through an urban or suburban area clearly has different purposes than a rural highway.

The two approaches outlined in depth here—context sensitive solutions and practical design—differ somewhat in focus and methodology (in ways described below), but both are aimed at the goal of introducing a more flexible, practical, and, ultimately, cost-effective approach to design. They put the focus on the end results of improving safety and access to destinations, making the most of limited funding, creating projects appropriate to their surroundings, increasing public engagement, and improving public satisfaction. A state DOT would not necessarily have to adopt either of these approaches whole cloth, though this is a viable option because each approach has been refined and has a body of materials and experience to rely upon. For instance, the U.S. DOT has been actively promoting CSS, primarily via the FHWA's Context Sensitive Solutions project.¹¹

Context Sensitive Solutions

CSS, sometimes known as context sensitive design, is a methodology that aims to better understand a given infrastructure project's context to enable the project to take account of community desires and to preserve local resources. Designers collaborate with a range of stakeholders to reach solutions that are tailored to the local environment, neighborhood needs, and traffic patterns in a cost-effective manner. The FHWA defines CSS as follows:

The concept of context sensitive solutions (CSS) has been evolving in the transportation industry since the National Environmental Policy Act of 1969 required transportation agencies to consider the possible adverse effects of transportation projects on the environment...

¹¹ Federal Highway Administration. "Context Sensitive Solutions." Retrieved 9/12/2013 from <http://www.contextsensitivesolutions.org>.

Context sensitive solutions (CSS) is a collaborative, interdisciplinary approach that involves all stakeholders in providing a transportation facility that fits its setting. It is an approach that leads to preserving and enhancing scenic, aesthetic, historic, community, and environmental resources, while improving or maintaining safety, mobility, and infrastructure conditions.¹²

These core CSS principles apply to transportation processes, outcomes, and decision-making.

1. Strive toward a shared stakeholder vision to provide a basis for decisions.
2. Demonstrate a comprehensive understanding of contexts.
3. Foster continuing communication and collaboration to achieve consensus.
4. Exercise flexibility and creativity to shape effective transportation solutions, while preserving and enhancing community and natural environments.¹³

The CSS methodology uses early and ongoing public and stakeholder involvement to help design projects that meet the core needs of the relevant community, and to identify and resolve potential problems and value conflicts before they cause dissatisfaction or delay. Ultimately, this results both in higher customer satisfaction and, in most cases, greater cost-effectiveness. A CSS approach relies upon broadly informed innovation and flexibility in planning, design, construction, and operations and maintenance decision-making to balance competing objectives and arrive at right-sized solutions.

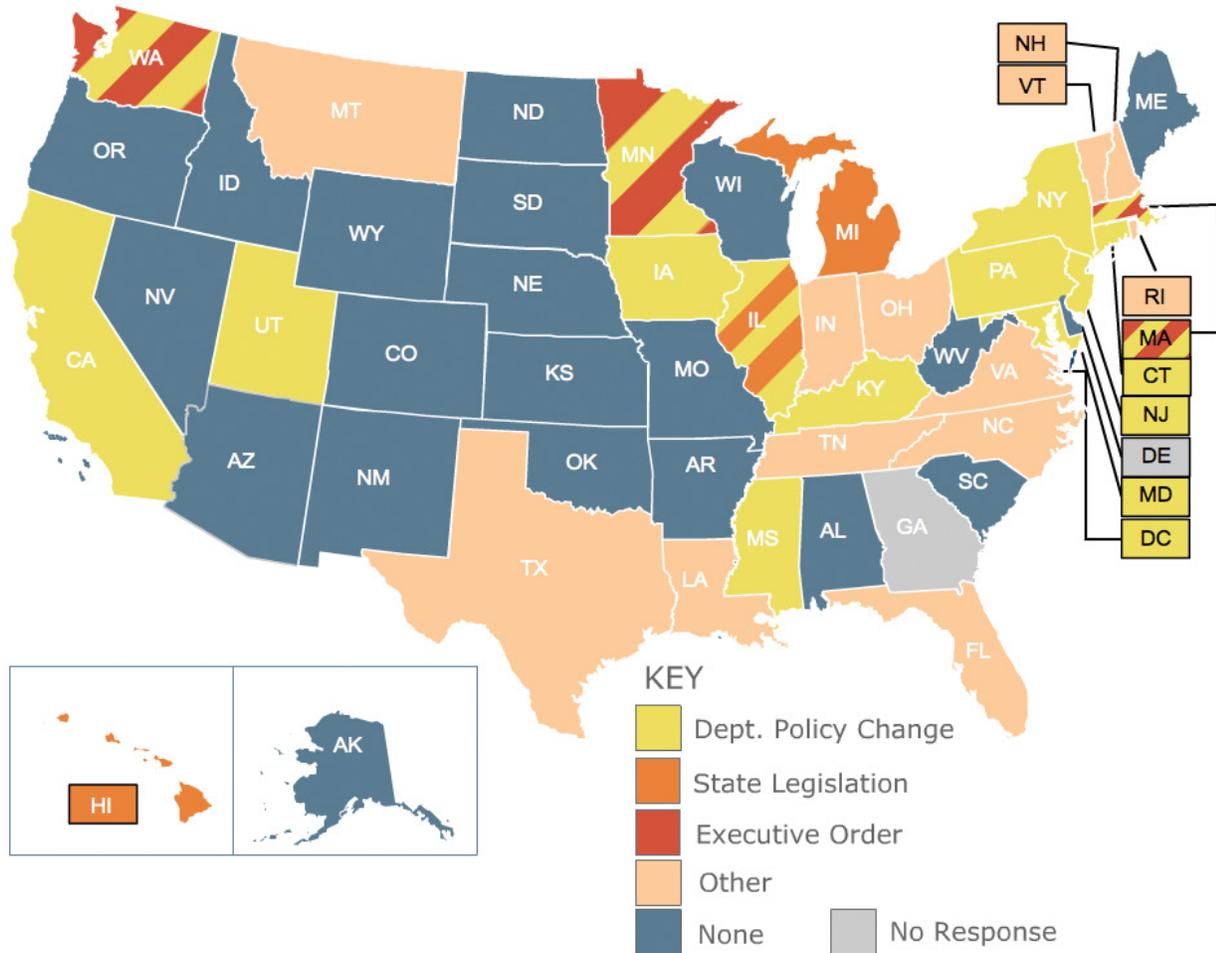
At this point, many states either have departmental guidance promoting context sensitive design—though these vary as to their strength and comprehensiveness—or have instituted department-wide training programs in CSS (see Figure 4.1 below). Only a handful of states have legislation enshrining CSS; a few more have issued executive orders.

12 American Association of State Highway and Transportation Officials & Federal Highway Administration. (2007, March). *Results of Joint AASHTO / FHWA Context Sensitive Solutions Strategic Planning Process*, Summary Report. Retrieved from 9/12/2013. http://contextsensitivesolutions.org/content/reading/results_of_joint_aashto_fhwa_co_resources/portlandsummary_final_050107.pdf/.

13 *Ibid.*

Figure 4.1

States with FHWA Context Sensitive Solutions Policies



Source: <http://contextsensitivesolutions.org/content/gen/state-profiles/sp-policy>

Practical design

Like CSS, the aim of “practical design” (something of a catch-all term for a range of approaches) is to allow for additional flexibility in infrastructure design and to move away from adherence to a single set of design standards and the automatic tendency toward maximum design parameters. Both rhetorically and in application, the practical design movement is driven more by budgetary constraints than by community, environmental, or aesthetic concerns. The approach also focuses strongly on the system or network, aiming “not to build perfect projects, but to build good projects that give you a good system” and to focus spending where it’s most effective.¹⁴ As with CSS, there is an increased emphasis on documentation of the design process, and of reasoned, on-the-record decision making. The approach is often credited to the Missouri DOT (MoDOT, see below).

Examples of the application of practical design are many, including:

- Deviating from standard right-of-way widths and acquiring only what is necessary to build and maintain a facility;

¹⁴ “America’s highway infrastructure needs money, manpower—and a new vision: How We Can Save Our Roads.” (2009, March). *Parade*. Retrieved 9/12/2013 from <http://www.parade.com/news/2009/03/how-we-can-save-our-roads.html?index=1>. Quoting MoDOT CEO Pete K. Rahn.

- Changing materials;
- Reducing asphalt depths where practical; and
- Reusing old materials such as bridge piers or barriers if they are still in good condition.

Another, more systemic example of the application of practical design is to improve overall safety by making certain improvements system-wide, rather than by making upgrades at individual crash sites. The approach deploys low-cost solutions over an entire system instead of a high-cost solution to an isolated problem.

Performance metrics and level of service

One component of implementing more practical design is use of flexible or redesigned performance metrics for roadways and other infrastructure elements. For instance, transportation engineering and planning have long emphasized LOS, a mobility metric. Agencies sometimes set an unnecessarily high standard for LOS, for instance, using automobile delay in the peak 15 minutes of the peak traffic period to gauge overall performance,¹⁵ and in many cases they do not balance the LOS of the facility with other goals. Judging performance via LOS at peak periods is likely to require costly transportation projects built to serve a narrowly-defined condition that is not representative of typical infrastructure use (for more information, see the section of this Handbook titled “Reform Level of Service.”)

Legal liability as a driver of overdesign

Another reason often given by DOTs for building to the highest possible design specifications is to preclude potential tort liability for the entity responsible for the project. Given the gradual rollback of state sovereign immunity by the courts and legislatures, this tends to be an issue of some concern to transportation agency personnel. In particular, both DOTs and contractors fear that if a crash occurs on a road that deviates from the highest design guidelines set forth in the American Association of State Highway and Transportation Officials’ (AASHTO) Policy on Geometric Design of Highways and Streets (commonly known as the “Green Book”), a victim will be able to claim that the DOT and/or contractor were negligent in failing to design the road in the safest way possible.

This concern is largely overstated, and proper recognition and incorporation of the factors that actually drive tort liability for design would allow for a more flexible approach to design and a reduction in the costs associated with overbuilding roadways. In fact, designers are likely to be at greater risk during litigation when they adhere uncritically to design standards than when they exercise sound engineering judgment and document their decision-making.¹⁶ That said, states can foreclose any remaining doubt by passing statutes explicitly limiting the liability of state DOTs that adopt a CSS or practical design methodology and/or make reasonable policy decisions to design to less-than-maximum specifications. Even absent such explicit exemption, there is a range of actions DOTs can take on their own initiative encouraging use of CSS principles, training staff in their application, and making clear the factors that actually give rise to liability (which do not include failure to build to the highest specifications).

Implementation

Creating design flexibility and incorporating context sensitive principles into the design process can be accomplished entirely via internal departmental policy changes, though it has frequently been

¹⁵ Although not always defined this way in state policy, the Highway Capacity Manual, the traffic engineer’s standard for determining road infrastructure performance measures, bases traffic characteristics in the peak hour on the 15-minute period within that hour that represents the greatest degree of peak conditions. The FHWA’s Traffic Analysis Toolbox series (Volume VI, which focuses on measures of effectiveness, is available online at <http://ops.fhwa.dot.gov/publications/fhwahop08054/fhwahop08054.pdf>) and discusses conventional traffic engineering methodologies for determining levels of performance.

¹⁶ Parker, T. L. & McDaniel, J. B. (2012). “Tort Liability Defense Practices for Design Flexibility.” *NCHRP Legal Research Digest*, 57. Retrieved 11/8/13 from http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_lrd_57.pdf.

initiated via state legislation or executive order (see below), and these latter approaches may be useful in establishing and maintaining the necessary political commitment. As with all such changes in policy, the more significant lift involves a commitment to changing both agency culture and the way the agency communicates with the public. Finally, flexible design may require the review and update of existing state design standards or the introduction of new context sensitive design standards (discussed in Focus Area 5).

1. Incorporation of design flexibility via departmental guidance. Most changes in design methodology are instituted at the departmental level. This can be accomplished via a range of memos (e.g., Kentucky¹⁷), secretarial directives (e.g., California¹⁸ and Washington¹⁹), technical memoranda (e.g., Minnesota²⁰), or other docs (e.g., Tennessee²¹), and embodied in guides (e.g., Florida²² and Connecticut²³). Many and perhaps a majority of states now offer at least some training in CSS.²⁴ A few useful models include:

- **Connecticut.** The Connecticut DOT has promoted context sensitive solutions through statewide awareness training, training courses for its managers, and development of an ongoing training course for engineers through collaboration with the Connecticut Transportation Institute at the University of Connecticut.
- **Maryland.** The Maryland DOT State Highway Administration was an early adopter of CSS. It developed an initiative called “Thinking Beyond the Pavement” to guide implementation, conducted charrettes to identify project development process strengths, designed a project evaluation instrument, and established teams to review and implement project improvement strategies.²⁵
- **Minnesota** (see below in case studies).
- **New Jersey.** The New Jersey DOT has implemented a training program for highway engineers and other transportation professionals, along with stakeholders in New Jersey host communities, to ensure context sensitive design awareness. This program emphasizes the use of effective public involvement techniques and the implementation of design flexibility, and introduces the concept and importance of “Placemaking.”

While there is great variation in both quality and methods in these trainings, the best results are achieved when training is mandatory for personnel, or is at least as widely applied as possible.

2. Incorporation of design flexibility via executive order. Many of the same ends can be

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- 17 For an example, see: http://transportation.ky.gov/Organizational-Resources/Policy_Manuals_Library/SHEPolicyDoc.pdf.
- 18 California Department of Transportation. (2001, November 29). *Director's Policy: Context Sensitive Solutions*. Retrieved 8/21/12 from <http://www.dot.ca.gov/hq/oppd/context-solution.pdf>.
- 19 Washington State Department of Transportation. (2011, March 17). Secretary's Executive Order Number E 1028.02, Context Sensitive Solutions. Retrieved 8/21/12 from http://www.wsdot.wa.gov/publications/fulltext/design/CSD/E0_10/1028.pdf.
- 20 Minnesota Department of Transportation. (2006, October 17). “Engineering Services Division Technical Memorandum No. 06-19-TS-07.” Retrieved 8/23/12 from <http://dotapp7.dot.state.mn.us/edms/download?docId=700077>.
- 21 Tennessee Department of Transportation. *Tennessee Environmental Procedures Manual*. Retrieved 8/23/12 from http://www.tdot.state.tn.us/epm/manual/02_2.shtml.
- 22 Florida Department of Transportation. *Project Management Handbook*. Retrieved 8/23/12 from http://www.dot.state.fl.us/projectmanagementoffice/PMhandbook/P1_Ch09.pdf.
- 23 Connecticut Department of Transportation. *Highway Design Manual: 2003 Edition* (Including Revisions to July 2012). Retrieved 8/23/12 from <http://www.ct.gov/dot/lib/dot/documents/dpublications/highway/cover.pdf>.
- 24 See FHWA's context sensitive solutions site: <http://contextsensitivesolutions.org/content/gen/state-profiles/sp-training>, which lists 35 states as offering some form of CSS training.
- 25 Maryland Department of Transportation. (1998). *Thinking Beyond the Pavement: A National Workshop on Integrating Highway Development with Communities and the Environment while Maintaining Safety and Performance*. Retrieved 9/12/2013 from <http://www.sha.maryland.gov/OCE/tbtp.pdf>.

achieved through executive order. In Michigan, for instance, Governor's Executive Directive 2003-25²⁶ directed the Michigan DOT (MDOT) to "pursue a proactive, consistent and context sensitive solutions process" in making decisions to "plan, construct, operate, and maintain infrastructure." The MDOT was instructed to develop or revise procedures and guidelines to do so. In response, it:

- Released a new project Scoping Manual which now contains a section on CSS.
- Issued new Guidelines for Stakeholder Engagement,²⁷ which provides the MDOT staff with techniques to engage local stakeholders early and often during project development. It has been formulated to allow the most flexibility in the approaches the department takes in order to maintain a consistent process for implementing stakeholder engagement statewide.
- Implemented a training program in 2006. As of 2008, over 900 MDOT staff and 60 consultants had been trained.

3. Incorporation of design flexibility via state statute. State legislation regarding design can be a helpful spur to, and useful political cover for, departmental reform. Take, for instance, Illinois Public Act 093-0545, which instructs the Illinois DOT to incorporate CSS principles into its operations. The bill instructs that "the Department of Transportation shall embrace principles of context sensitive design and context sensitive solutions in its policies and procedures for the planning, design, construction, and operation of its projects for new construction, reconstruction, or major expansion of existing transportation facilities."²⁸

As a result of its passage, the state DOT took a number of steps, including issuing departmental guidance clarifying (somewhat) that its use of CSS principles applies to all modal divisions within the DOT (Highways, Aeronautics, and Public and Intermodal Transportation) as well as to the Office of Planning and Programming.²⁹ Each of these divisions and offices has developed specific CSS implementation procedures. The DOT also instituted a staff training program in CSS principles,³⁰ including a half-day overview class designed to provide an introduction to CSS, a two-day approach class that provides hands-on training in the activities needed to implement CSS on a project, a similar class for local agencies, and an online CSS training course designed to educate stakeholders and others about CSS. Community impact assessment classes and facilitation training are included in the training.

Connecticut Public Act No. 98-118 is very similar in both wording and effect. Passed in 1998, the law led to a top-down internal review process, followed by a series of stakeholder meetings and ultimately a meeting of the Connecticut DOT's (ConnDOT) senior managers, chief executive officers (CEOs) of consulting and contracting firms, FHWA division office staff, and members of non-governmental stakeholder groups to develop an implementation plan for CSS.³¹ In 1999, ConnDOT revised its Highway Design Manual³² to incorporate CSS principles. According to a

26 Michigan Department of Transportation. (2005, May 26). *Governor's Executive Directive 2003-25*. Retrieved 8/20/12 from http://www.michigan.gov/documents/MDOT_CSS_Policy_159545_7.pdf.

27 Michigan Department of Transportation. (2009, January). *Guidelines for Stakeholder Engagement*. Retrieved 8/20/12 from http://www.michigan.gov/documents/mdot/MDOT_Guidelines_For_Stakeholder_Engagement_264850_7.pdf.

28 Illinois General Assembly. Public Act 093-0545. Retrieved 9/12/2013 from <http://www.ilga.gov/legislation/publicacts/fulltext.asp?name=093-0545>.

29 Illinois Department of Transportation. (2005, August 1). "Departmental Policies: Context Sensitive Solutions." Retrieved 8/20/12 from <http://www.dot.il.gov/css/SignedCSSDeptPolicy.pdf>.

30 Illinois Department of Transportation. Context Sensitive Solutions Training. Retrieved 9/12/2013 from <http://www.dot.il.gov/css/training.html>.

31 U.S. Department of Transportation. (Updated 2008, December 3). "State Profiles: Connecticut." Retrieved 8/3/12 from <http://contextsensitivesolutions.org/content/gen/state-profiles/CT>.

32 Connecticut Department of Transportation. (2012, July). *Highway Design Manual, 2003 Edition* (Including Revisions to July 2012). Retrieved 8/21/12 from <http://www.ct.gov/dot/lib/dot/documents/dpublications/highway/cover.pdf>.

report by the Michigan Environmental Council, “[t]heir focus on public communication led them to develop useful tools such as video simulations and models of road projects.”³³ ConnDOT also issued an internal memorandum in 2002 clarifying the department’s use of CSS. Finally, it developed a series of trainings, including institutionalized CSS training, for transportation engineering students and a class for stakeholders through the University of Connecticut’s Technology Transfer Center. As of 2008, approximately 1,800 people from Connecticut and the Northeast region have received some sort of formal training in CSS from ConnDOT.³⁴

The Hawaii legislature went a step further, passing S.B. No. 1876³⁵, legislation that both directs the state DOT to establish new guidelines that take into account the need for flexibility in highway design, and also limits the liability of the state and counties in the application of flexible highway design standards.

Case Studies

Minnesota DOT

In 1999, the FHWA designated Minnesota as one of five pilot states to help advance institutionalization of a context sensitive solutions approach in transportation nation-wide. The Minnesota DOT (MnDOT) issued technical memoranda to all engineering staff (see, e.g., Technical Memorandum 00-24-TS-03, Technical Memorandum No. 06-19-TS-07)³⁶, instructing them to employ a context sensitive approach that “incorporates flexibility within design standards, safety measures, environmental stewardship, visual quality, and community sensitive planning and design.” MnDOT’s approach to context sensitive solutions promotes six key principles:³⁷

1. Balance safety, mobility, community, and environmental goals in all projects
2. Involve the public and affected agencies early and continuously
3. Address all modes of travel
4. Use an interdisciplinary team tailored to project needs
5. Apply the flexibility inherent in design standards
6. Incorporate aesthetics as an integral part of good design

MnDOT’s application of CSS has been notable for both the range of materials developed and the extent to which it drives agency decision-making and project design at every level. In particular, the department has been quite aggressive about training—providing training to hundreds of state, county, city, and consultant staff over the years. MnDOT has also collaborated with the University of Minnesota’s Center for Transportation Studies³⁸ to produce a number of training programs, including

33 Michigan Environmental Council. (2005, December). *Community, Character and Cash: How You Can Reform Transportation with Context Sensitive Solutions*. Retrieved 8/21/12 from http://www.environmentalcouncil.org/mecReports/css_report.pdf.

34 U.S. Department of Transportation. (Updated 2008, December 3). “State Profiles: Connecticut.” Retrieved 8/3/12 from <http://contextsensitivesolutions.org/content/gen/state-profiles/CT>.

35 State of Hawaii. (2005). S.B. No. 1876. Retrieved 8/20/12 from http://www.capitol.hawaii.gov/session2005/bills/SB1876_cd1_.htm.

36 Minnesota Department of Transportation. (2006, October 17). Technical Memorandum No. 06-19-TS-07. “Design Policy – Design Excellence Through Context Sensitive Design and Solutions.” Retrieved 8/20/12 from <http://dotapp7.dot.state.mn.us/edms/download?docid=700077>.

37 *Ibid.*

38 University of Minnesota. (2012). “Context Sensitive Solutions.” Retrieved 9/12/2013 from <http://www.cts.umn.edu/contextsensitive/index.html>.

the use of visualization technologies to support CSS.³⁹ These trainings offer both basic introduction and high-level technical orientation and promote acceptance of both the CSS approach in particular and flexible design in general. The department has also developed a wide range of resource materials on CSS.

MnDOT's emphasis on CSS has resulted in a much more creative approach to project design, whether with regards to project materials — as with projects that employed brick facings or transparent noise barriers⁴⁰ — or to employment of “passive blowing snow control,” i.e., living snow fences.⁴¹ Rather than working from the book and requesting design exceptions, these projects approached challenges creatively — and with an eye to savings — from the beginning. One of the key findings over the years has been to allow flexibility in design speed selection, so that engineers can design highways for less than maximum travel speeds. One MnDOT training says that “[n]othing influences a highway's design more profoundly.”⁴² As a result, MnDOT is a widely recognized leader in CSS, and the department has earned national awards for projects and programs that demonstrate the benefits of applying CSS principles.

Washington State DOT

Washington State DOT's (WSDOT) implementation of CSS is also considered to be a model of departmental adoption, in terms of both the breadth of its application and the range of tools developed by the department to implement it. The policy was established by Departmental Order 1028.02,⁴³ which was itself an outgrowth of an earlier effort to promote livable communities, providing in key part that “Washington State Department of Transportation (WSDOT) employees are directed to use the Context Sensitive Solutions approach for all projects, large and small, from early planning through construction and eventual operation.” In furtherance of this directive, WSDOT employed a number of approaches, including establishing a CSS Interdisciplinary Group, which, in turn, drafted one of the most comprehensive state-level CSS guides⁴⁴ in the country.

Missouri DOT: Practical Design

In late 2004, MoDOT, like many state DOTs, faced current and projected funding shortfalls and little public appetite for gas tax increases. In response, it developed what has come to be known as the concept of “practical design.” As discussed above, the signature components of the approach were flexibility in design/designing to true need (“Start at the bottom of the standards and go up to meet the need. When you meet the need, you stop,” according to MoDOT CEO Pete K. Rahn⁴⁵), emphasis on cost savings, and emphasis on a system-wide rather than project-by-project approach.

In the process, MoDOT abandoned many long-held practices. For example, in the past, if a bridge had to be repaired or replaced because of deterioration, design standards would dictate that the replacement structure be wider, higher, and longer than the one being replaced. Occasionally these

39 Minnesota Department of Transportation. See <http://www.dot.state.mn.us/onlinelearning/engineeringservices/css/>.

40 Minnesota Department of Transportation. (2010). *A Mn/DOT Forum: Integrating Context Sensitive Solutions in Construction, Operations, and Maintenance, Final Report*, p. 7-8. Retrieved 8/20/12 from <http://www.cts.umn.edu/contextsensitive/workshops/documents/CSSForumSummary.pdf>.

41 *Ibid.*, p. 9.

42 Oregon Peer Exchange. (2009, July 28). “Design Flexibility in Minnesota,” p. 10. Retrieved 9/12/2013 from <http://www.oregon.gov/ODOT/HWY/TECHSERV/docs/pdf/3Minnesota.pdf?ga=t>.

43 Washington Department of Transportation. (2011, March 17). *Secretary's Executive Order Number E 1028.02, Context Sensitive Solutions*. Retrieved 8/21/12 from <http://www.wsdot.wa.gov/publications/manuals/fulltext/policies/1028.pdf>.

44 Washington Department of Transportation. (2005, April 26). *Understanding Flexibility in Transportation Design – Washington*. Retrieved 9/12/2013 from <http://www.wsdot.wa.gov/publications/fulltext/design/CSD/UnderstandingFlexibility.pdf>.

45 Swift, Earl (2009, March 8) “America's highway infrastructure needs money, manpower—and a new vision: How We Can Save Our Roads.” *Parade*. Magazine website Retrieved 9/12/2013 from <http://www.parade.com/news/2009/03/how-we-can-save-our-roads.html?index=1>. Quoting MoDOT CEO Pete K. Rahn.

increases would as much as double the size of the bridge. Under the new approach, the purpose of the improvement would be no more complicated than providing for a safe crossing. If MoDOT could effectively replace a deteriorating bridge with one half its size, the agency would do so, and apply the cost savings to replacing another bridge elsewhere in the highway system.

Previously, MoDOT tended to upgrade other highway features in the general vicinity of projects such as bridge replacements. In some cases, it would build miles of new highway alignment in the vicinity of one or two small bridge replacements. But fully upgraded, modern roadway facilities in the few miles immediately adjacent to a bridge made little sense when the remainder of the route, hundreds of miles in some cases, existed under a much older and lower standard.

MoDOT's take on practical design, while without the specific focus on or process for community involvement inherent in CSS, did incorporate local input on key elements. In crafting its system priorities, the department worked with the five Regional Planning Commissions (RPCs) and the two Metropolitan Planning Organizations (MPOs) to determine the highest priority projects. The department also instituted mechanisms for incenting and sharing cost savings: to wit, money saved when a project came in under budget would be returned to the district for future projects in that district. Likewise, if a project went over budget, the money would be taken from the district budget (an exception was made for major river bridges where the economies of scale made it impractical).

MoDOT's implementation of what was largely a change in culture entailed a combination of forced organizational changes, enterprise-wide collaboration, and inspired leadership. On the latter, for instance, MoDOT's chief engineer famously told districts and consultants at the outset of the change to put away their design manuals for a year and rely solely on common sense.⁴⁶ MoDOT also improved communication channels with FHWA, the state legislature, and the public. The department asked stakeholders to help prioritize the construction program and solicited local input on solutions during design processes; it communicated all such results to state leaders, FHWA, and other stakeholders. In addition, however, MoDOT also made some significant, unilateral structural changes, including mandating divisional reorganization and a single engineering policy group to handle standards for the entire agency.⁴⁷

The results of MoDOT's changes were impressive. The department estimates that, in the first two years of its implementation, practical design saved Missouri taxpayers \$400 million (across a \$3.1 billion program).⁴⁸ Not only did the changes save money, they are credited with improvements in safety and performance as well. Six years ago, only 44% of Missouri's highways were rated in good condition. Today, 83% of the state's highways are rated as good.⁴⁹ MoDOT also realized a 24 percent reduction in fatal crashes between 2005 and 2008; with no open container or primary seatbelt law passed in the state during that period, MoDOT leaders believe that the system-wide safety approach must factor into that trend.

46 Jones, J. (2010, February) "Practical Design." *Public Roads*. (Publication Number FHWA-HRT-10-002)(Volume 73, Issue 4). Federal Highway Administration. Retrieved 8/3/12 from <http://www.fhwa.dot.gov/publications/publicroads/10janfeb/06.cfm>.

47 *Ibid.*

48 Allen, T. & Brendel, B. (2006). "Practical Design at MoDOT." *Achieving Value*. Value Engineering. Retrieved 8/3/12 from http://www.value-eng.org/knowledge_bank/attachments/Practical%20Design%20at%20MDOT.pdf.

49 "America's highway infrastructure needs money, manpower—and a new vision: How We Can Save Our Roads." (2009, March). *Parade*. Retrieved from <http://www.parade.com/news/2009/03/how-we-can-save-our-roads.html?index=1>.

Tennessee DOT: Expedited Project Delivery

Tennessee DOT (TDOT) began incorporating context sensitive solutions (CSS) principles in 2003 and, in 2006, adopted a formal commitment to CSS all projects.⁵⁰ Since then, the department has offered CSS training to its staff, consultants, and partners and made its training modules available online.⁵¹ In recent years, under leadership from Commissioner John Schroer, CSS has played a key role in efforts to use agency resources more wisely. A report released by TDOT and Smart Growth America in 2012 recognized that the agency's existing project load was nine times greater than its available funding would cover.⁵² TDOT has since begun to audit projects already underway and evaluate planned projects in order to achieve expedited project delivery solutions, favoring operational improvements and return-on-investment over additional lane capacity. This approach, which TDOT has labeled "Expedited Project Delivery," has led to numerous project revisions, including some in which the planning process was already far along. It is also expected to reduce highway project costs by more than 95% of their original estimates, resulting in total savings of \$170 million for five projects under consideration.

Tennessee's State Route 126 is one notable example of a project that has been revised considerably during the audit process. TDOT was in the process of planning improvements along the dangerous eight-mile highway corridor for more than ten years and had arrived at two design alternatives. After seeking extensive public input and reviewing the project alternatives, TDOT decided upon a third, new option. This smaller-scale option adds fewer new lane miles and reduces impacts to adjacent properties, while meeting its performance objectives.⁵³

Resources

The American Association of State Highway and Transportation Engineers. (2004). A Guide to Achieving Flexibility in Highway Design. *Not available online.*

AASHTO's guide to CSS is a useful overview of the topic and touches on a wide range of design issues, from project development to specific roadway design elements. It is intended as a complement to the AASHTO Green Book.

The Federal Highway Administration's Context Sensitive Solutions Website.

<http://contextsensitivesolutions.org/>.

The FHWA's CSS website provides a wide range of information and links about CSS projects, case studies, background, and additional information.

Michigan Environmental Council. (2005). Michigan Environmental Council research findings: Ten state case studies of CSS implementation. <http://www.environmentalcouncil.org/mecReports/tenstates.pdf>.

This report provides short profiles of ten state CSS implementation efforts, based on personal interviews with each, and offers a good summary of a range of approaches.

50 US Department of Transportation (Last Modified 2012, September 17) "Tennessee | Context Sensitive Solutions.org." webpage. Retrieved 11/12/2013 from <http://contextsensitivesolutions.org/content/gen/state-profiles/TN>.

51 Tennessee Department of Transportation (2011) "2-Day Basic Training on Context Sensitive Solutions" Context Sensitive Solutions webpage. Retrieved on 11/12/2013 from <http://www.tdot.state.tn.us/environment/planning/training.htm>.

52 Tennessee Department of Transportation (2012 August 20). *Removing Barriers to Smarter Transportation Investments Final Report*. Retrieved on 11/12/2013 from <http://www.tdot.state.tn.us/documents/RemovingBarriersToSmarterTransportationInvestments.pdf>.

53 Tennessee.gov (Updated 2013 May 30) "Decision Made for State Route 126 Project." TN.gov Newsroom & Media Center webpage. Retrieved 11/12/2013 from <https://news.tn.gov/node/10790>.

Minnesota DOT. (1999). Hear Every Voice: A Guide to Public Involvement at Mn/DOT. Available at <http://contextsensitivesolutions.org/content/reading/hear-every/resources/hear-every/>; see also update at <http://www.dot.state.mn.us/publicinvolvement/pdf/HEVII.pdf>.

This report is a thorough guide to soliciting and incorporating public and community involvement at every stage of the planning process, from project development through construction and operation, from a state DOT considered a leader in that area. It includes extensive descriptions of a wide range of techniques, from small group meetings and open houses to civic advisory committees to media strategy, as well as case studies.

Missouri DOT. Practical Design Implementation Manual. <http://www.modot.org/business/documents/PracticalDesignImplementation.pdf>.

This is the guidebook for Missouri's program.

National Coordinated Highway Research Program. (2002). NCHRP Report 480: A Guide to Best Practices for Achieving Context Sensitive Solutions. http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_480a.pdf.

This guidebook comprehensively covers how state DOTs and other transportation agencies can incorporate context sensitivity into their project development work. It was primarily written for transportation agency personnel who develop transportation projects.

State Smart Transportation Initiative. (2011). SSTI Review of PennDOT's Smart Transportation Initiative. http://ssti.us/wp/wp-content/uploads/2011/02/SSTI_Review_of_PennDOT_Smart_Transportation.pdf.

This report is one of the most comprehensive evaluations of PennDOT's reform program, exploring both internal PennDOT operations and external outreach and connections to partner agencies. Chapter 9 of this study focuses on new approaches to project delivery and features the U.S. 202 project as a particular example.

University of Kentucky, Kentucky Transportation Center. (2008). Practical Solution Concepts for Planning and Designing Roadways in Kentucky. http://www.ktc.uky.edu/files/2012/06/KTC_08_30_SPR_369_08.pdf.

Kentucky's program, based on practical design principles similar to Missouri's program, emphasizes project delivery based on reasonable, prudent design approaches over meeting maximum standards. This document describes principles communicated to agency project managers in pursuing lower-cost, efficient designs.

Washington State DOT. (2005). Understanding Flexibility in Transportation Design—Washington. <http://www.wsdot.wa.gov/publications/fulltext/design/CSD/UnderstandingFlexibility.pdf>.

One of the earlier and best state guides to CSS, this report provides a comprehensive set of agency approaches to project development, community involvement, and environmental and design considerations. It also includes an appendix with a dozen or so very useful case studies.

FOCUS AREA 4: INCREASING TRANSPORTATION SYSTEM EFFICIENCY

Improve Street Connectivity

The Opportunity

Approximately 50 percent of all trips made nation-wide are three miles or shorter, and 28 percent are one mile or shorter.⁵⁴ When road networks lack multiple routes designed to serve the same destinations, these short local trips must use major corridors designed for regional and freight traffic, exacerbating regional congestion.

The Victoria Transport Policy Institute defines street connectivity as the density of connections in a path or road network and the directness of links within the network.⁵⁵ Improving local street connectivity can be a relatively inexpensive alternative to traditional capacity expansion projects. Providing travelers with multiple routes from which to choose for short trips protects a state's investment in the existing transportation network by lowering maintenance costs and reducing or delaying the need for expensive, publically funded projects to widen major corridors. Better connectivity improves access to destinations, reduces emergency vehicle response times, and adds economic benefit by increasing development opportunities (and thus the tax base) on land that the connecting network serves. Dense, well-connected street networks also produce short block lengths that enable walking and biking, plus have higher safety ratings for all road users including drivers.^{56, 57} Studies have shown that these street characteristics are positively correlated with lower rates of obesity, diabetes, high blood pressure, heart disease, and asthma.⁵⁸

What Is It?

Congestion on state roadways, especially those serving as primary commercial streets, is often an indicator of the disconnect between land use and transportation systems. Local governments approve new development along these corridors, generating additional traffic volume beyond the roadway's intended capacity. Without a secondary network of functional, connected local streets, local development is dependent on—and limited by—capacity on state facilities. Meanwhile, any projects that expand the capacity of these streets are doomed to be of limited utility, as new development quickly follows new traffic capacity.

By expanding their scope to encompass the local street network, state transportation agencies gain access to a relatively low-cost means to break this cycle of capacity additions. Without expanding their legal jurisdiction, state agencies can partner with local governments to design complementary, integrated transportation networks that increase development capacity for local governments while protecting the state's investments by distributing traffic volume across a more complete network.

The most direct way for states to influence local decisions may be to invest directly in local roadways, creating a mechanism to ensure that local governments account more effectively for the impact of

54 Federal Highway Administration. (2010, January). "2009 National Household Travel Survey." Retrieved 9/12/2013 from <http://nhts.ornl.gov/publications.shtml>.

55 Victoria Transport Policy Institute. (Updated 2012, January 5). TDM Encyclopedia. *Roadway Connectivity: Creating More Connected Roadway and Pathway Networks*. Retrieved 8/6/12 from <http://www.vtpi.org/tdm/tdm116.htm>.

56 Marshall, W. E., & Garrick, N. W. (2010). "Effect of Street Network Design on Walking and Biking." *Transportation Research Record: Journal of the Transportation Research Board*, 2198: 103–115.

57 Marshall, W. E., & Garrick, N. W. (2011). "Evidence on Why Bike-Friendly Cities Are Safer for All Road Users." *Environmental Practice*, 13(1): 16–27.

58 Marshall, W.E., Piatkowski, D.P., & Garrick, N.W. (2014). "Community design, street networks, and public health." *Journal of Transport and Health*. <http://dx.doi.org/10.1016/j.jth.2014.06.002i>.

their decision making on state facilities. A more affordable, and potentially more effective, approach to partnerships with local governments is to work together to achieve greater regional connectivity by enhancing local networks alongside state facility projects. States can develop standards to create a complete local network that integrates well with state roadways; they can also define standards that allow them to accept a privately funded road into the state system if the state maintains control over an extensive portion of the road network. By doing this in concert with additions to the local network that are intended to support private development, states can develop a network that preserves the capacity and functional lifespan of all of their investments.

Implementation

A local street network must provide ample interface with the state roadway network in order to function as a local traffic distribution tool. Two primary means for achieving this are: 1) local government development standards that make local street requirements clear to development applicants, so that the private streets they provide as a “fair share” development contribution actually help support and complete the local network, and 2) state access rules and policies that take a more flexible approach to access points on state roadways when these access points are based on public streets (and not only private property driveways).

Specific policy mechanisms that states can use include the following:

1. **Consider a broader scope of project options for addressing traffic congestion problems by partnering with local governments.** Many states opt to widen their roadways or add capacity to the same roads they already have when roads suffer from congestion and inadequate capacity. They also sometimes pursue bypass projects, especially when the congested roadway they seek to address serves as a main street or other primary commercial street for a town or city. Instead, states can increase capacity on an overall corridor route by continuing to maintain the route on a main street and adding improvements on parallel and nearby streets that can increase service to the overall community and corridor area. This is often the least costly option.
2. **Revise state access management requirements to focus on public streets instead of private property driveways.** Many state agency access management standards seek to minimize the speed and turning conflicts presented by private driveways and cross streets by setting minimum distances for driveway and intersection spacing. One outcome of this approach is that it reduces the number of local streets that can feed into state roads along a given stretch. As a result, local travelers must use state roads more frequently for short trips, leading to higher traffic volumes, additional movements at intersections, and generally reduced capacity. Making access management standards more flexible, so that minimum distances are relaxed if the access points are cross streets rather than driveways, allows land development to access cross streets instead of the principal roadway and facilitates greater network connectivity. While this may result in overall reduced speeds along the state roadway, its application in strategically focused areas, such as major commercial centers or downtowns, can improve operations along an entire corridor by alleviating some of the corridor’s most acute pressure points.
3. **Adopt selected roadways into state jurisdiction.** State transportation agencies faced with fiscal challenges are typically not inclined to add roads to their maintenance responsibilities, but a focused, strategic addition of critical segments may help a DOT add capacity to the state system without undertaking a costly improvement project on an existing state roadway.

- 4. Take a more proactive role in development review.** States may also focus efforts on building partnerships with local governments to work toward a goal of development-added roads that provide true local circulation, not just access to and from a state roadway. This may include participation in development review discussions or incentives for local governments to adopt better zoning ordinances or subdivision regulations. In the short term, this is likely to include direct assistance to the local government to develop plans, amend local zoning and land development legislation, and generally educate agency and developer stakeholders on the benefits. In the long term, a state may need to take a more direct and proactive approach to development review, aligning its own priorities for project investment with those local governments that have revised their development controls so that new land development does not concentrate access and impact on state roads.

Because secondary roads are often not owned by the state, reorienting a state agency's attitude toward them frequently requires a high-level policy action. Such a directive should be issued by a DOT executive, though if it requires enabling legislation, the appeal for such legislation should be led jointly by the DOT executive and the governor. In either case, the DOT will want its staff and the staff of partner local agencies to be involved in writing new guidance to build buy-in and to ensure the guidance is workable. Two essential points to communicate in promoting this initiative are:

- The high resource and political costs of capacity-adding projects that have negative community impact will not be sustainable for the agency in the long run, and
- The DOT will need to partner with local government representatives so as to help manage expectations and ensure that affordable projects can be delivered according to community needs.

With this in mind, the following implementation steps represent different approaches to pursuing such a system. Note that they do not need to be taken in the order listed, and some states may find that only selected steps need to be followed in the short term.

1. Revise state access policies, including access management guidelines, to respond more flexibly to local street/state roadway connections. This may also require changing other design policies, such as intersection and traffic signal spacing requirements.
2. Develop local street connectivity guidance for local governments to use in guiding private development review.
3. As appropriate or necessary, tie state priorities and funding assistance to state roadway projects where local governments have followed this guidance. This helps to reward those communities that have taken steps to assist in the capacity and operations of the state system by prioritizing state investment there.
4. Create a designation for essential local streets and roads that have strategic importance to the state system and prioritize state funding assistance to local governments based on these roads.
5. Re-designate state roads (e.g., change the route on which a state highway designation is assigned, or add a duplicate route for business/local traffic to separate it from regional traffic) to take better advantage of the roadway network.
6. Work with local governments to improve zoning, development, and subdivision regulations so that development begins to shift its access and transportation impacts away from being exclusively on the state's roadway system.

Case Studies

Virginia

A few states maintain control over nearly their entire roadway network, including local streets and roads. Virginia is one such state, and it has sought to ensure that local networks contribute to the overall transportation system by defining standards for local streets that interact with the state system. In an effort led by then-Governor Tim Kaine, the Virginia General Assembly enacted legislation in 2007 that required the Commonwealth Transportation Board to develop Secondary Street Acceptance Requirements.⁵⁹ These requirements defined the conditions and standards that must be met before secondary streets constructed by developers, local governments, and entities other than the Virginia DOT (VDOT) will be accepted into the state secondary system for maintenance by VDOT. VDOT had long-established standards regulating roadway design and construction, but until this point, it had not regulated the form or spatial relationship of streets that weren't constructed under a VDOT-led project.

The Secondary Street Acceptance Requirements were based on a series of principles that recognized the value of a connected street network, including improvements in the flow of through-trips on collector and arterial streets, a reduction in vehicle miles traveled (VMT) and congestion, a reduction in emergency response times, the promotion of alternative transportation options (especially biking, walking, and transit), and improvements in access to community facilities and shopping areas. They defined quantitative standards under which certain thresholds must be met, such as a connectivity index, defined as the ratio of street network links to the nodes connecting them (or a basic formula of calculating network efficiency that returns higher values for street networks with few dead-end and disconnected streets).

The Secondary Streets Acceptance Requirements were modified substantially in 2011. The legislature directed the Commonwealth Transportation Board and the DOT to solicit public comments and consider revisions to the original requirements, resulting in the removal of some of the strongest provisions for promoting local street networks such as the connectivity index and the division of the state into tiers for different levels of compliance,⁶⁰ due to a perception that these measures were too rigid. Having stronger local support for the idea, developing it with VDOT staff and partners, and piloting applications to demonstrate network effectiveness could potentially have helped to sustain the regulations as a strong policy tool.

New Jersey

In the late 1990s, New Jersey inaugurated its Futures in Transportation initiative (NJFIT), a program administered by the New Jersey DOT (NJDOT) in partnership with the state's Office of Smart Growth and other state agencies.⁶¹ Faced with an increasing backlog of maintenance obligations and declining revenues from conventional transportation funding sources, NJDOT sought alternatives to the conventional transportation approaches to addressing growth. The goal of NJFIT was to move away from the capacity-adding projects the agency recognized were fiscally unsustainable and toward a cooperative approach to land use and transportation planning that emphasized lower-cost solutions that continued to meet community needs.

59 State of Virginia. Va. Code Ann. §33.1-70.3 (A). Retrieved 9/12/2013 from <http://leg1.state.va.us/cgi-bin/legp504.exe?000+cod+33.1-70.3>.

60 Virginia Department of Transportation. (2012, February 16). "Secondary Street Acceptance Requirements." Retrieved 8/2/12 from <http://www.virginiadot.org/projects/ssar/>.

61 New Jersey Department of Transportation. (2011, January 11). "NJFIT: Future in Transportation: Overview." Retrieved 8/20/12 from <http://www.nj.gov/transportation/works/njfit/>.

Implementation of NJFIT was initially based on a series of pilot transportation projects that featured a prominent land-use planning component. To alleviate long-standing congestion issues on Route 31 in Hunterdon County, NJDOT had initially proposed building a limited-access bypass around the town of Flemington, but the high cost of this project and community resistance drove NJDOT to consider a broader, more context sensitive series of alternatives.⁶² Assistance and resources from NJDOT and the Office of Smart Growth ultimately allowed the Flemington Township to design a plan for greater local street connectivity that would accommodate growth in the region over time and relieve some of the pressures on Route 31. This plan leaves the responsibility for the bulk of the local street network to private development, to be guided by a street master plan that outlines key network street alignments and identifies key connections that must be made. NJDOT's primary responsibility is the state roadway itself, although the revised plans from the joint planning exercise are estimated to cost approximately half of the amount estimated for the original proposed bypass.⁶³

New Jersey's approach offers several lessons. States can establish programs such as the Local Technical Assistance Program to provide technical assistance to local governments, but perhaps more importantly, they can use particular projects that have long been in planning but have never been constructed due to budgetary limitations as opportunities to begin discussions on how to reach resolution. The NJFIT Route 31 pilot project represents a case of a state agency moving forward on a project long-promised to a community, though with a revised approach and an introductory message that ongoing (and increasing) resource constraints have made it all but necessary to reevaluate the project.

Delaware

The Delaware Department of Transportation (DelDOT) is currently working to improve land use and transportation decision-making in the state, including road network connectivity, by demonstrating to local communities how coordination between transportation and land-use planning can both improve livability and reduce the need for costly capacity expansion projects. To this end, the agency recently developed the Land Use and Transportation Scenario Analysis and Microsimulation (LUTSAM) tool to evaluate and demonstrate the benefits of roadway connectivity, bicycle, and pedestrian investments and more efficient land use strategies.⁶⁴

LUTSAM integrates industry-standard geographic information systems, travel demand, and three-dimensional (3-D) microsimulation tools to dramatically reduce the time required for scenario analyses and ease the process of making 3-D simulations for public outreach. This enables a greater variety of scenarios to be tested and, because auto, bicycle, transit, and pedestrian travel can be modeled at a finer level of detail, demonstrates the benefits of greater street and sidewalk connectivity with detailed estimates of how it will impact the number of trips, VMT, emissions, and hours of delay in the area.⁶⁵

DelDOT has used the application for various analyses. In 2012, DelDOT sponsored a research project at the University of Delaware to examine the effects of new subdivisions built on the suburban cul-de-sac model versus those built on a grid system. Findings showed that the grid system, or smart growth form, outperformed the cul-de-sac model in several key areas considered fundamental elements of

62 New Jersey Department of Transportation. (2010, October). "NJFIT: Future in Transportation: Route 31 project Hunterdon County." Retrieved 8/1/12 from <http://www.state.nj.us/transportation/works/njfit/route31.shtm>.

63 Michaelson, J., Toth, G., and Espiau, R. (2008). "Route 31 in Flemington, New Jersey." *Great Corridors, Great Communities: the Quiet Revolution in Transportation Planning*, p. 30. Project for Public Spaces. Retrieved 9/12/2013 from http://www.pps.org/pdf/bookstore/Great_Corridors_Great_Communities.pdf.

64 Thompson-Graves, S., et al. (2012). "Development of the State Smart Transportation Initiative's DelDOT 3-D Micro Model Process—A scenario planning tool to evaluate urban form, land use, and multimodal investment impacts on mobility." State Smart Transportation Initiative. Retrieved 9/12/2013 from <http://www.ssti.us/2012/06/lutsam/>.

65 *Ibid.*

complete streets policies. These included an increase of over 10 percent in pedestrian trips inside and outside the subdivision, a 5 percent increase in bike mode share, 20 percent less VMT per unit, and a 12 percent decrease in mobile source ozone precursor emissions per unit.⁶⁶

Resources

Institute of Transportation Engineers. (2011). Planning Urban Roadway Systems.

This manual from ITE offers guidance in planning, modifying, and expanding roadway networks to develop an effective transportation system.

New Jersey Futures in Transportation Program Description. Online at: <http://www.nj.gov/transportation/works/njfit>.

This website provides a description of the NJFIT initiative.

Smart State Transportation Initiative. (2012, June). Land Use and Transportation Scenario Analysis and Microsimulation (LUTSAM) Tool. Online at: <http://www.ssti.us/2012/06/lutsam/>.

This page provides information and links to a recorded webinar, paper, and user's guide.

Victoria Transport Policy Institute. (Updated 2012, January 5) TDM Encyclopedia. Roadway Connectivity: Creating More Connected Roadway and Pathway Networks. Online at: <http://www.vtpi.org/tdm/tdm116.htm>.

This chapter of the Victoria Transport Policy Institute's TDM Encyclopedia provides additional information on the concept of connectivity, describes the benefits and costs of improving connectivity, and provides examples of indices for measuring connectivity.

Virginia DOT. Secondary Street Access Requirements. Online at: http://www.virginiadot.org/projects/resources/SSAR_Final_Registrar_Regulation.pdf.

Secondary Street Access Requirements is a result of legislation adopted by Virginia in 2007. These requirements determine the "conditions and standards" that have to be met by developers, localities, and entities other than VDOT before secondary streets can be constructed.

66 Thompson-Graves, S., et al. "Linking Land Form and Development Location to Multimodal Travel Demand: Case Studies of Transportation and Land Use Studies in Delaware. Transportation Research Board. Retrieved 11/23/2014 from <http://trid.trb.org/view.aspx?id=1289352>.

FOCUS AREA 4: INCREASING TRANSPORTATION SYSTEM EFFICIENCY

Modernize Access Management Standards

The Opportunity

Access management broadly defines a set of strategies that state DOTs and local governments can use to manage how and where vehicles are able to access a roadway. Since development clusters around available transportation, without an access management program a road can become a victim of its own desirability, as an ever-increasing number of private driveways and entrances to commercial/business establishments dot the highway. The increasing number of turning movements and vehicles entering a high-speed roadway leads to increases in crashes and congestion and premature calls for adding travel lanes to reduce traffic problems.

Effective access management not only saves road capacity (and therefore money), but it also can improve safety and access to transportation across modes at the same time. An effective way to manage access to a roadway while continuing to provide access to multiple modes is to develop a comprehensive access management plan. This approach allows political leaders to promise improvements for both private auto users and other users of the street such as freight, bicycles, pedestrians, public transportation, and emergency vehicles—all while expanding the useful life of the existing capacity. When done correctly, access management achieves a delicate balance that incorporates enough standards to make it effective, but also gives local governments sufficient access in communities where it is needed.

What Is It?

As defined by the Transportation Research Board, access management is the “systematic control of the location, spacing, design, and operation of driveways, median openings, interchanges, and street connections to a roadway.”⁶⁷ It also includes certain roadway design elements such as median treatments, auxiliary lanes, and traffic signal spacing. Access management limits the number of driveways and intersections on highways and arterial roadways, improving safety and reducing congestion. Limiting driveway access can be used to support Transportation Demand Management (TDM) outcomes, as development will cluster near access to transportation.⁶⁸

Without effective access management plans and policies, the function and character of major roadways can deteriorate quickly. An absence of access management plans and policies may result in the following negative scenarios:

- Increased crashes at access points due to vehicles entering and exiting the same road at different speeds;
- Increased impacts to property owners by a continuous cycle of widening roads;
- Increased fiscal and political costs of property takings and right-of-way acquisition; and
- Increased commute times, fuel consumption, and vehicular emissions, as numerous driveways and traffic signals intensify congestion and increase delays along major roads.

Since access management policies largely impact urban and suburban communities through which

67 Transportation Research Board of the National Academies, Committee on Access Management. (2003). *Access Management Manual*. Retrieved 9/12/2013 from http://www.accessmanagement.info/pdf/nchrp_rpt_548.pdf.

68 Victoria Transport Policy Institute. (2010, February 8). “Access Management: Coordination Between Roadway Design and Land Use Development to Improve Transportation.” *Transportation Demand Management Encyclopedia*. Retrieved 9/12/2013 from <http://www.vtpi.org/tdm/tdm1.htm>.

arterials and highways pass, successfully modernizing standards will typically involve working cooperatively with local governments to develop access management plans that coordinate subdivision and development rules with state access management policies.

It is important to note that strategies for controlling and limiting access points are only appropriate in cases where mobility is the primary function of a roadway. In cases where access is an important function, free-flowing traffic can be an impediment to non-motorized road users and can pose safety concerns. In high access areas, improved street connectivity and traffic calming strategies are important tools for providing the greatest system efficiency, while accommodating all road users and roadway functions. Achieving the most appropriate solution in these cases requires a careful evaluation of local project goals and possibly a reform of the level of service principle (also discussed in Focus Area 4). Access management strategies allow DOTs to distinguish between areas of access and areas of mobility, and prioritize those functions in each.

Implementation

When done well, a good access management plan and policy can improve the safety and efficiency of the roadway system for multiple travel modes. Effective asset management requires thinking flexibly about developing access management standards as a tool to identify and pursue a variety of transportation and land use outcomes.

Access management standards should focus on efforts to maximize efficiency for all users, and can help to achieve multiple traffic management goals. As noted above, it can encourage TDM projects, reduce congestion, improve accessibility for bikes and pedestrians, and improve transit operations. A high-quality access management plan may affect land use by increasing densities and reducing vehicular traffic.

Coordination within and among government agencies is critical at every stage of access management, from program development to permitting decisions. Moreover, agencies and landowners must communicate regularly and openly to understand the needs and interests of both sides.

Provide a structure for internal decision-making within the DOT

Access management decisions require input from several divisions within a state agency, including planning, environmental management, traffic operations, legal, right-of-way, design, construction, and maintenance. Strategies for internal coordination include:

- Creating cross-organizational task teams or working groups to clarify division responsibilities
- Developing viable coordination procedures or protocols between divisions
- Encouraging project management and permit review coordination
- Establishing a project manager and review team to improve coordination in the management of complex transportation and development projects
- Reviewing the work program for scheduled projects that could incorporate access management improvements

Coordinate with local governments

A successful effort will also involve close partnerships with local government agencies. Strategies for intergovernmental coordination include:

- Develop policies that ensure that standards for access management are compatible. This may involve developing a statewide map or other means to recognize different access

needs and where access standards may be applied differently (or, at least identifying key corridors and engaging local partners within them).

- Develop corridor access management plans to facilitate intergovernmental coordination and consistent decision-making along sections of state highways where extensive development is anticipated.
- Develop formal agreements or resolutions—either through resolution, memorandum of understanding, or intergovernmental agreement—on state and local roles and responsibilities for access management.
- Require advance notification for significant developments to take advantage of access management opportunities, and ensure that local development requirements create local networks for local traffic, rather than relying on state facilities for all local movements.
- Hold regular access permitting meetings to provide a forum for coordination between state and local governments.
- Build a tiered review process for coordinating development applications requiring access to state highways.

Case Studies

Maine

U.S. Route 1 in Maine’s coastal region varies in function throughout its approximately 100-mile length, serving as a small-town main street, a major truck route, and a scenic byway. It passes through small villages and towns and vacation destinations as well as significant regional employment centers.

The Maine DOT (MaineDOT) faces fiscal constraints and has also encountered opposition to conventional capacity projects due to their significant community and environmental impact.⁶⁹ MaineDOT realized the most effective way to address Route 1’s challenges was to prevent further degradation of the road.

In 2005, MaineDOT, the Maine State Planning Office, and 20 communities on the Route 1 corridor inaugurated a joint effort to address corridor-wide land use and transportation challenges. The primary goal was to preserve the rural character of Route 1. The resulting effort of the collaboration was the Gateway 1 Corridor Action Plan and a memorandum of understanding expressing corridor-wide commitment to develop a plan and implement its recommendations.⁷⁰ The goal of Gateway 1 is to minimize the impact of future development on Route 1, while supporting and connecting economic development and new housing as well as multimodal transit opportunities. Gateway 1 proposes strategic transportation investments along the corridor, and asks municipalities to make adjustments to their local comprehensive plans and zoning ordinances to support more densely built core growth areas, to protect specific view sheds and wildlife habitats, and to create a more defined level of roadway access management. As part of an interlocal agreement, communities will share unprecedented decision-making authority through a corridor management committee composed of representatives from the municipalities and MaineDOT.

Gateway 1 provides that local agencies will regulate access on state highways in core growth areas on roadways with posted speeds of 35 miles per hour or less. MaineDOT regulates access on other state

69 Maine Gateway 1 Coalition website. “A Brief History.” Retrieved 8/7/12 from <http://www.mainegateway1.com/history.html>.

70 Maine Gateway 1 Coalition Steering Committee. (2009, July). “Gateway 1 Corridor Action Plan: Brunswick to Stockton Springs.” Retrieved 8/20/12 from http://www.mainegateway1.com/Gateway_1_Action_Plan.pdf.

highways and, in some special examples, as in the communities of Damariscotta and Newcastle, has purchased access rights along sections of the Route 1 corridor. MaineDOT pursues the preservation of high speeds and mobility outside of these core growth areas, meaning that access management is stronger and land development intensity is limited. Per conventional access management practice, Gateway 1 greatly emphasizes driveway regulations and has been eliminating those driveways with safety issues, traffic hazards, or limited sight distance.⁷¹

North Carolina

The North Carolina Strategic Highway Corridors (SHC) initiative is a collaborative effort among the North Carolina DOT (NCDOT), the Department of Commerce, and the Department of Environment and Natural Resources to preserve and maximize mobility and connectivity on a core set of highway corridors throughout the state. Its central effort is to develop a long-range, consensus-based vision for each corridor to guide decisions related to funding, project planning, design, driveway permit approvals, and local land use. Adopted in September 2004, the primary purpose of the SHC initiative is to provide a network of high-speed, safe, and reliable roadways throughout the state. The initiative promotes both good environmental and fiscal stewardship by maximizing the use of existing facilities and moving people and goods quickly and efficiently. The initiative offers NCDOT, partnering agencies, and other stakeholders an opportunity to consider a long-term vision when making land use decisions as well as design and operational decisions on the highway system.

Implementation of the SHC initiative focuses on six areas: (1) Education, (2) Long-Range Planning, (3) Project Planning and Design, (4) Land Use, (5) Corridor Protection, and (6) Driveway Permits and Traffic Signals. Access management and the purchase of access rights are identified as key strategies under Corridor Protection. In addition, under Driveway Permits and Traffic Signals, alternative solutions to traffic signals and driveway consolidation and sharing are highly encouraged.

As part of the SHC initiative, four facility types—freeways, expressways, boulevards, and thoroughfares—and associated Control of Access Definitions were developed to create a set of understandable and consistent definitions for all roadways for NCDOT and its partners to use in planning, design, and operations. The definitions are based primarily on the function of the roadway, level of mobility and access, and whether the facility has traffic signals, driveways, or medians. These definitions were developed by a committee composed of members from FHWA and NCDOT's Traffic Engineering, Highway Design, Project Development, and Transportation Planning branches.⁷² Table 1 shows a comparison of NCDOT facility types.

71 Federal Highway Administration, Office of Operations. (2007, January). *Domestic Access Management Scan Tour Summary Report*. Retrieved from http://www.accessmanagement.info/2006SCAN/section_3.htm.

72 Gluck, J. S. & Lorenz, M. R. (2010). "State of the Practice in Highway Access Management: A Synthesis of Highway Practice," pp. 92-93. National Cooperative Highway Research Program. Transportation Research Board. Retrieved 8/20/12 from http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_syn_404.pdf.

Table 4.1: Comparison of NCDOT Facility Types

	Freeways	Expressways	Boulevards	Thoroughfares
Functional Purpose	High Mobility, Low Access	High Mobility, Low to Moderate Access	Moderate Mobility, Low to Moderate Access	Moderate to Low Mobility, High Access
AASHTO Design Classification	Interstate or Freeway	Arterial	Arterial or Collector	Collector or Local
Posted Speed Limit	55 mph or greater	45 mph to 60 mph	30 mph to 55 mph	25 mph to 55 mph
Control of Access	Full	Limited or Partial	Limited or Partial	None
Traffic Signals	Not Allowed	Not Allowed	Allowed	Allowed
Driveways	Not Allowed	Limited Control of Access	Limited Control of Access	Allowed with Full Movements; Consolidate or Share Connections, if Possible
Cross-Section	Minimum Four Lanes with Median	Not Allowed	Not Allowed	Minimum Two Lanes; No Median; Includes Facilities with Two-Way Left Turn Lane
Connections	Provided Only at Interchanges; All Cross Streets are Grade-Separated	Partial Control of Access—One Driveway Connection per Parcel; Consolidate and/or Share Driveways and Limit Access to Connecting Streets or Service Roads,	Partial Control of Access—One Driveway Connection per Parcel; Consolidate and/or Share Driveways and Limit Access to Connecting Streets or Service Roads;	Primarily At-Grade Intersections
Median Crossovers	Public-use Crossovers Not Allowed; U-turn Median Openings for Use by Authorized Vehicles Only When Need is Justified	Restrict to Right-in/ Right-out	Restrict to Right-in/ Right-out	<i>Not Applicable</i>

Source: North Carolina Department of Transportation, Strategic Highway Corridors.
<https://connect.ncdot.gov/projects/planning/TPB%20-%20Strategic%20Highway%20Corridors/NCDOT%20Facility%20Types%20-%20Control%20of%20Access%20Definitions.pdf>.

Resources

Gluck, J. S., & Lorenz, M. R. (2010) State of the Practice in Highway Access Management: A Synthesis of Highway Practice. National Cooperative Highway Research Program. Transportation Research Board: Washington, DC. http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_syn_404.pdf.

This report provides an overview of access management practices and specific case studies in states around the country.

Maine Gateway 1 Steering Committee. Gateway 1 Corridor Action Plan. <http://www.mainegateway1.com/Gateway%201%20Action%20Plan.pdf>.

This plan defines the vision developed by MaineDOT and the 20 communities along the Route 1 corridor, specifying commitments by local governments and the state.

Transportation Research Board of the National Academies, Access Management Committee (AHB70) homepage, www.accessmanagement.info.

This is an online resource for planning and engineering corridor access management. It includes animated reference material, links to research and presentations, and up-to-date tools and techniques.

Transportation Research Board of the National Academies. (2003). Access Management Manual. Committee on Access Management. Washington, DC. <http://www.trb.org/Main/Blurbs/152653.aspx>.

This manual has been a standard resource on access management for state and local DOTs, covering planning, design, and implementation of access management.

Victoria Transport Policy Institute. (2010, February 8). "Access Management: Coordination Between Roadway Design and Land Use Development to Improve Transportation." Transportation Demand Management Encyclopedia. <http://www.vtpi.org/tdm/tdm1.htm>.

This section of the Victoria Transport Policy Institute's TDM Encyclopedia describes the benefits, costs, and travel impacts of access management strategies.

FOCUS AREA 4: INCREASING TRANSPORTATION SYSTEM EFFICIENCY

Use Transportation Demand Management

The Opportunity

Transportation is a matter of supply and demand. If states can manage the demand, they will be less reliant on costly projects that increase the supply of transportation infrastructure. Managing how and when a state's transportation system is used can improve the effective capacity of the system at less cost than capital projects that add physical capacity. Reduced demand also translates into lower emissions, less congestion, and less personal cost to travelers.

What Is It?

TDM includes a broad array of strategies and tools intended to alleviate congestion without expanding highway and road capacity. It is normally focused on reducing the number of single-occupant vehicle trips to and from major employment and activity centers during peak travel periods. It is often undertaken at the local level, by cities, MPOs, transportation management associations (TMAs), or major employers. But state DOTs have a strong interest in managing demand as well, and TDM can be a demand-side tool along with pricing, land use strategies, intelligent transportation systems (ITS), and provision of non-auto mode choices. Some DOTs have launched their own TDM efforts that can serve as models, and innovation in this field is likely as economic and environmental pressures make traditional capacity-based solutions less attractive.

TDM strategies rely on such measures as:

- **Ridesharing.** Ridesharing includes carpools, vanpools, and any other form of arrangement in which two or more travelers occupy a single passenger-driven vehicle. Programs can provide ride-matching, routing service, or “premium” parking for carpools. They may also provide van service.
- **Bicycle use and walking.** Bicycle travel, in particular, is growing rapidly in cities that have invested in appropriate infrastructure. Programs can provide routing services, secure bike parking, or showers to facilitate bike commuting. In the longer term, TMAs and other larger programs can help provide cycle tracks and sidewalks to provide good bike-pedestrian connectivity.
- **Flexible work hours.** These arrangements allow workers to commute to their jobs during off-peak hours, or four days a week instead of five.
- **Telecommuting.** Similar to flexible work hours, telecommuting allows would-be commuters to work from a remote location, often from home, to avoid traveling. A recent poll published by online communications provider TeamViewer found that people value the ability to work from home, and many are willing to make sacrifices for that ability; 17 percent of those surveyed said they would give up a salary increase, and 15 percent said they would give up half of their vacation days if they were able to telecommute.⁷³
- **Transit assistance.** Commuters can reduce SOV travel by using transit, even occasionally. Programs can provide subsidies or full coverage for transit passes as well as transit information and routing service. Employers can also facilitate transit ridership by locating in sites where transit is readily available.
- **Emergency ride service.** Commuters will be more willing to arrive at their workplace without a car if they know they can get home readily to care for a sick child or take care

73 Mielach, D. (2012, February 9). “Employees would give up showers and spouses to work from home.” *Business News Daily*. Retrieved from <http://www.businessnewsdaily.com/2005-telecommuting-reasons.html>.

of another emergency. This service may take the form of a free or reduced-price taxi ride available a handful of times of year.

In addition to these overarching TDM measures, emerging technologies have enabled a wider range of Active Demand Management strategies. These strategies, which require real-time monitoring and responses, include the following:

- Dynamic pricing of roads, parking and transit,
- Dynamic managed lanes,
- Dynamic routing and way-finding, and
- On-demand transit and ridesharing.

Active travel and parking demand management strategies respond to daily travel patterns in order to redistribute traffic and encourage mode shifts, thereby reducing total traffic volumes, particularly on congested routes during peak periods. Washington State DOT launched a dynamic ridesharing pilot program in 2010, recruiting close to 1,000 participants. That program allowed Seattle-area commuters to request a nearby carpool using mobile applications. CalTrans also initiated a dynamic rideshare program that is now being implemented in the San Francisco Bay area by a private vendor. The San Francisco Municipal Transportation Authority launched a federally-funded pilot, known as SF Park, in 2011 to test dynamic parking management. The project incorporated real-time parking availability information, demand-responsive pricing, and pay-by-phone technology to manage parking demand and mitigate traffic impacts from parking searches. A recent evaluation of SF Park confirmed that it had reduced average parking rates, improved the availability of parking spaces, made it easier to pay and avoid parking citations, and reduced greenhouse gas emissions.⁷⁴ Active travel and parking demand management strategies can also be used in conjunction with Active Traffic Management strategies (outlined in the following section) to further reduce overall delay.

Implementation

TDM programs are relatively inexpensive strategies state DOTs can use to reduce congestion on their existing networks. They may choose to operate programs or provide assistance to MPOs and local governments who operate them. Many states' TDM programs focus on ridesharing and car- and vanpools. Larger programs typically receive special funding through a transportation agency (or another state agency) and have staff dedicated to program management and administration.

But DOTs have a bigger role to play as well. When considering mitigation for new development or when conducting project EIS or corridor plans, they can consider TDM in lieu of roadway capacity. Similarly, they can encourage local governments to require that TDM be included in new development applications. These strategies allow for needed economic development while simultaneously addressing the increased transportation demand triggered by that development. TDM can also be a cost-effective tool for developers, reducing mitigation costs and potentially on-site parking costs.

Models for assessing the impact of TDM measures to reduce demand include U.S. EPA's COMMUTER, and Florida DOT's Worksite Trip Reduction Model. See the link in Resources below.⁷⁵ Additionally, big data tools can be used to understand the movement of commuters to better meet the demands during peak hours and offer incentives for commuters to travel at different times. For more information see the discussion of big data in Focus Area 2.

74 San Francisco Municipal Transportation Agency. (2014). *SF Park Pilot Evaluation*. Retrieved 11/23/14 from <http://sfpark.org/about-the-project/pilot-evaluation/>.

75 University of South Florida. (2010). "Models to assess the efficacy of TDM measures in reducing demand." Retrieved 9/12/2013 from <http://www.nctr.usf.edu/clearinghouse/software.htm>.

Where is TDM already being applied?

New Jersey, Massachusetts, Washington, and Vermont have central, statewide TDM programs and management, but their approaches differ. New Jersey focuses its efforts on technical assistance to local and district-specific TMAs that perform the day-to-day tasks of identifying demand management opportunities and coordinating various stakeholders and participants.⁷⁶ Washington uses more formal and direct cooperation with employers and local governments in its efforts to reduce traffic and energy use, and provides financial assistance to enact local TDM plans.⁷⁷

Massachusetts allows TDM in lieu of highway capacity expansion in development cases where mitigation is required,⁷⁸ and the Washington and Colorado DOTs have included TDM strategies as part of corridor work in the Puget Sound and Denver areas, respectively.⁷⁹

Case Studies

Washington

The Washington Legislature passed the Commute Trip Reduction (CTR) Law⁸⁰ in 1991 because of growing traffic congestion, especially in the Seattle metro region.⁸¹ The 1991 law was intended to improve air quality, reduce traffic congestion, and decrease VMT with employer-based programs that encourage the use of alternatives to driving alone. At the same time, proponents argued that the legislation offered strategic advantages for businesses, as reduced employee travel time (and especially time driving alone) and a transportation system with overall greater reliability could improve employee productivity and business performance. Identifying shared goals between the state and employers was a critical component of the legislation's successful passage.

Increasing local involvement

The CTR law's first major overhaul, the 2006 CTR Efficiency Act, took advantage of sunset clauses in the original 1991 legislation as mechanisms for reorganizing the way the state pursued TDM.⁸² The 2006 Act more explicitly targeted a reduction of drive-alone trips and vehicle miles traveled per capita (seeking reductions of ten percent in single-occupant vehicle trips and 13 percent in VMT); it also built upon employers' roles and expanded responsibility for the program's success to local governments that work with employers.⁸³ Focusing on local governments responded to a general need to tie the management of travel demand on the state roadway system to local land use planning. Instead of working exclusively through employers, local CTR plans and programs are now integrated with local land use and transportation plans to align policies and investments.

76 National Cooperative Highway Research Program. (2010). "Research Results Digest 348: State Department of Transportation Role in the Implementation of Transportation Demand Management Programs." Retrieved 9/12/2013 from http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rrd_348.pdf.

77 Washington State Legislature. (1991). "Transportation demand management—Findings." RCW 70.94.521. Retrieved 9/12/2013 from <http://apps.leg.wa.gov/rcw/default.aspx?cite=70.94.521>.

78 National Cooperative Highway Research Program. (2010). "Research Results Digest 348: State Department of Transportation Role in the Implementation of Transportation Demand Management Programs." Retrieved 9/12/2013 from http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rrd_348.pdf.

79 Victoria Transportation Policy Institute. (2012). "Success Stories: Examples of TDM Programs that Work." Retrieved 9/12/2013 from <http://www.vtppi.org/tdm/tdm71.htm>.

80 Washington State Legislature. (1991). RCW 70.94.521, Transportation Demand Management – Findings. Retrieved 8/21/12 from <http://apps.leg.wa.gov/rcw/default.aspx?cite=70.94.521>.

81 *Ibid.* The law encompasses Sections 521 through 551 of Title 70, Chapter 94 of the Revised Code of Washington.

82 Washington Substitute SB 6566. (2006). 2006 Commute Trip Reduction Efficiency Act. Retrieved 9/12/2013 from <http://www.wsdot.wa.gov/NR/rdonlyres/01C32E8B-4273-482A-9F09-86083556AFF/0/6566SPL.pdf>.

83 *Ibid.*

Growth and Transportation Efficiency Centers (GTECs) also became a part of the CTR program through the 2006 legislation. GTECs effectively give responsibility for the implementation of the CTR program to local governments.⁸⁴ This allows CTRs to respond to the needs of local communities, particularly in urban centers (an established concept under Washington’s growth management legislation). The CTR program utilizes state resources to expand a community’s pool of participants and, with the law’s new provisions, CTR programs can now go beyond employers and look for ways to address non-work-related trips. The GTEC model has enhanced the CTR program because it provides additional resources from WSDOT, and implementation is more flexible.

In the 2011-13 legislative session, the legislature funded the CTR program at approximately \$5.5 million. Of this, \$3.9 million is distributed to local governments, based on allocation decisions by the CTR board.⁸⁵ Local governments use this funding to assist employers in the development and implementation of their worksite programs. The balance of the state investment primarily gives direct assistance to employers to help establish TDM programs. WSDOT has also used this funding to provide technical support and program tools to local governments, and to measure, evaluate, and report on the program’s performance. A small portion of the balance funds program administration, monitoring, and reporting.

Impact

A 2005 report to the Washington state legislature analyzing the impacts of the program found that it resulted in:⁸⁶

- A significant decrease in the number of people driving alone to CTR worksites in the state—from 70.8% in 2003 to 65.7% in 2005—leading to nearly 20,000 fewer vehicle trips each morning statewide,
- \$24 million in reduced cost of delay in the Puget Sound region (calculated using 2003 data),
- Savings of \$13.7 million in fuel costs for employees commuting to CTR worksites, and
- Reduction of the equivalent of 74,200 tons of carbon dioxide.

As of 2010, approximately 574,000 employees at roughly 1,100 worksites in nine counties had access to employer CTR programs. An additional 535,000 commuters had access to services and programs offered through seven designated GTECs. In 2006, the latest year for which data is available, employers invested \$45 million in their CTR programs, more than \$16 for each dollar invested by the state.⁸⁷

The Washington CTR program reflects a joint effort by WSDOT and legislators to use resources to reduce overall demand and distribute travel more evenly across the day, delaying the need for costly new capacity projects. The coordinated response to growing vehicle travel demand has built a broad base of supporters (made up of both local government agencies and private employers) who recognize its economic and social value and continue to benefit from the program over 20 years after its inception.

84 *Ibid.*

85 Washington State Commute Trip Reduction Board. (2011). CTR Report to the Washington State Legislature. Retrieved 9/12/2013 from http://www.wsdot.wa.gov/NR/rdonlyres/05054197-8764-4026-A011-C480E686BBF5/81137/CTRBoard_Report_2011Web.pdf.

86 Washington Commute Trip Reduction Task Force. (2005). Report to the Washington State Legislature. Retrieved 8/16/12 from http://www.wsdot.wa.gov/NR/rdonlyres/172087A9-85D1-416B-86C4-33281C7BDE68/0/CTR_Report_05.pdf.

87 Washington State Commute Trip Reduction Board. (2011). Report to the Washington State Legislature. Retrieved 9/12/2013 from http://www.wsdot.wa.gov/NR/rdonlyres/05054197-8764-4026-A011-C480E686BBF5/81137/CTRBoard_Report_2011Web.pdf.

Bay Area California

In March 2014 the Bay Area Air Quality Management District and the Metropolitan Transportation Commission (MTC) launched a joint pilot program requiring employers with more than 50 full-time employees in the District's nine-county area to offer commuter benefits to their employees to promote their use of transit and vanpools and reduce highway congestion.⁸⁸ The program was started in response to Senate Bill 1339, which was signed into law by Governor Brown in September 2012 and authorizes the Air District and MTC to adopt and implement the Commuter Benefits Program on a pilot basis through the end of 2016. Employers must select at least one commuter benefit, register via the program website, and implement their program by September 30, 2014. The program's goal is to reduce greenhouse gas emissions and traffic congestion by incentivizing commuters to choose transportation modes other than the single-occupancy vehicle. The four commuter benefits programs that employers can choose from are:

- Option 1: Pre-tax Benefit, which allows employees to exclude up to \$130 of their transit or vanpooling expenses each month from taxable income
- Option 2: Employer-Provided Subsidy, which provides a subsidy to reduce or cover up to \$75 per month of employees' monthly transit or vanpool costs
- Option 3: Employer-Provided Transit, which provides a free or low-cost transit service for employees, such as bus, shuttle, or vanpool service
- Option 4: Alternative Commuter Benefit, which provides an alternative commuter benefit that is as effective in reducing single-occupancy commute trips as Options 1, 2 or 3

By having employees choose the pre-tax option employers can reduce their Social Security and Medicare payroll taxes as a result of the reduction in taxable income. Employees can save up to 40 percent on monthly transit or vanpool costs by excluding these costs from taxable income.

Resources

National Cooperative Highway Research Program. (2010). Research Results Digest 348: State Department of Transportation Role in the Implementation of Transportation Demand Management Programs. http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rrd_348.pdf.

This report provides survey results and case studies from state DOTs regarding their involvement in TDM programs.

University of South Florida Software to assist TDM programs. (n.d.) <http://www.nctr.usf.edu/clearinghouse/software.htm>.

This website gives summaries and links to demand-reduction models, a business-benefits calculator, and other software.

Victoria Transportation Policy Institute Online TDM Encyclopedia. <http://www.vtppi.org/tdm/index.php>.

This encyclopedia is "[T]he world's most comprehensive information resource concerning innovative transportation management strategies," and contains cases and analysis from around the world, with links to papers and other materials.

⁸⁸ Metropolitan Transportation Commission (2014 March 26) "Air District and MTC Approve Commuter Benefits Program." Retrieved 11/7/2014 from http://www.mtc.ca.gov/news/current_topics/3-14/commuter_benefits.htm.

Washington State Commute Trip Reduction Board. (2011). CTR 2011 Report to the Washington State Legislature. http://www.wsdot.wa.gov/NR/rdonlyres/05054197-8764-4026-A011-C480E686BBF5/81137/CTRBoard_Report_2011Web.pdf.

This report details activity and success of the WSDOT CTR program, with recommendations for expansion.

FOCUS AREA 4: INCREASING TRANSPORTATION SYSTEM EFFICIENCY

Invest in System Management

The Opportunity

Compared to highway capacity projects, system management offers a low cost way to improve transportation network performance. A large segment of the public believes transportation infrastructure investments can be more productive. A recent survey found that 64 percent of voters say that how the government currently spends money on building and maintaining our transportation infrastructure is inefficient and unwise, including one in four (26%) who say it is very inefficient.⁸⁹

State DOTs can respond to public concerns through the use of Transportation System Operations and Management (TSO&M) programs. These strategies can help alleviate traffic congestion and travel delay, thereby improving the performance of our existing transportation networks and helping to improve air quality, reduce energy consumption, and grow the economy. TSO&M has also become a formalized focus of federal, state, and regional funds through MAP-21.

Many states are already using (or are in the process of developing) transportation system management approaches to achieve the benefits of capacity expansion at a fraction of the cost. By one measure, operational improvements in 2011 resulted in a savings of more than 370 million annual hours of delay nationwide.⁹⁰ A report for the Minnesota DOT concludes that the return on investment for active traffic management (ATM) is anywhere from 700 to 1,000 percent.

What Is It?

TSO&M encompasses a range of practices and technologies used to maximize the safety, reliability, and efficiency of existing transportation systems. Used alone or in conjunction with traffic demand management (TDM) strategies, discussed in the previous section, these methods can greatly reduce congestion and improve travel times. Common TSO&M tools include coordinated traffic signals, variable signage advising motorists of delays or detours, telephone- or internet-based resources with information on real-time traffic and roadway conditions, and the use of managed lanes and mobile toll collection methods like EZ Pass. These strategies depend on facilities and staff equipped to collect, process, and redistribute real-time travel data.

Many common TSO&M approaches are designed primarily to address recurring or routine congestion associated with capacity constraints and daily fluctuation in demand. However, transportation agencies are increasingly turning their attention to addressing nonrecurring congestion (NRC). Nearly 50 percent of traffic congestion on the U.S. highway system is due to traffic incidents, road work zones, weather events, special events, and other exceptional circumstances.⁹¹ TSO&M programs are also evolving to overcome barriers to coordinating activities across geographic, jurisdictional, and modal boundaries.

89 Transportation for America. (2010 March 2). *Future of Transportation National Survey*. Retrieved 11/22/2013 from <http://t4america.org/wp-content/uploads/2010/03/031010-Future-of-Transportation-Poll-Summary.pdf>.

90 Schrank, D. & Lomax, T. (2012). *Urban Mobility Report 2009*. Texas Transportation Institute. Retrieved from <http://tti.tamu.edu/documents/mobility-report-2012.pdf>.

91 Parsons Brinckerhoff Consulting (2011). *Guide to Improving Capability for Systems Operations and Management*. SHRP 2 Report S2-L06-RR-2 Prepared for Transportation Research Board. Retrieved on 10/25/2013 from http://onlinepubs.trb.org/onlinepubs/shrp2/SHRP2_S2-L06-RR-2.pdf.

Transportation Systems Management Technologies at a Glance

- **Coordinated traffic signals** dynamically adjust the timing of signals along a corridor depending on traffic flow to mitigate recurring or nonrecurring congestion.
- **Traffic signal sensors and cameras** detect vehicles waiting at intersections and adjust signals in response.
- **Parking space sensors** can be used to provide real-time information about parking availability to travelers in congested areas.
- **Dynamic message signs** display real-time traffic, weather, and road condition information to travelers.
- **Websites and mobile phone applications** for travelers provide real-time travel information on traffic delays and detours, transit service timing, and parking availability.
- **Ramp meters** manage traffic by controlling the rate of vehicle entry onto highways via on-ramps during peak travel periods.
- **Electronic toll collection** uses sensors at toll plazas and electronic transponders in cars to maintain traffic flow.
- **Weigh-in-motion truck inspection systems** automatically weigh and validate trucks, potentially eliminating the need to stop at inspection stations.

Implementation

Key partners include the usual agencies responsible for other transportation modes and transportation system components, such as transit authorities, MPOs, and local governments. Effective TSO&M strategies should include the entire transportation system, so that public transportation, for example, can help reduce pressure on the roadway system. MPOs are also an important partner because they can identify opportunities for the regional application of TSO&M strategies. Local governments, especially in larger metropolitan regions where travel demand and traffic extend beyond local jurisdictional boundaries, can work more closely with local employers and residents to develop policies on TDM, a companion strategy to TSO&M that can make state-level TSO&M approaches more successful.

Specific transportation projects allow state DOTs to test different TSO&M tools such as the signalization of expressway ramps or the use of dynamic message signs. Because TSO&M solutions typically have a smaller environmental impact than traditional capacity expansion projects, they can often pass quickly through the environmental review process and be completed much faster than solutions requiring large-scale construction.

Generally speaking, TSO&M programs are more complex and varied in urban environments because there is more congestion and a greater variety of transportation facilities. The following programs and policies, some broad and some more focused, can help state DOTs implement TSO&M strategies and integrate them into existing programs:

- **Active traffic management (ATM)**, which encompasses many real-time TSO&M strategies, can reduce congestion and improve travel time reliability using variable speed limits, temporary shoulder use, ramp metering, dynamic signage and other tools outlined above.
- **Traffic incident management** programs improve emergency response to traffic accidents and reduce the time needed to clear lane closures through the use of safety service patrols, surveillance, and improved emergency communication and coordination.
- **Work zone management** can reduce delays in work zones through the use of temporary traffic controls, variable speed limit signs, dynamic lane merge systems, and other tools.

- **Special event planning** can mitigate and manage traffic impacts of large-scale events such as sporting events. Examples include Michigan’s Palace of Auburn Hills and the Kansas Speedway.
- **Road weather management** involves coordinated weather monitoring, road clearing operations, road closures, and dissemination of relevant weather-related information to road users.
- **Transportation management centers (TMCs)** are central hubs for collecting, analyzing, and redistributing data to optimize transportation system performance.
- **Multi-agency operations planning** involves the coordination of two or more agencies to implement TSO&M approaches at a scale appropriate for the transportation corridor or system; this can include MPOs, local governments, or multiple state agencies. Examples are given below.
- **Least cost planning** (or “value and cost informed planning”), though not system management strategy itself, improves efficiency by ensuring the TSO&M solutions are considered as an alternative to infrastructure expansion projects. One example is Oregon DOT’s MOSAIC – a least cost planning tool for evaluating the costs and benefits of various transportation strategies, including TSO&M.
- **Identify and track meaningful metrics**, such as crash clearance for incidents that cause lengthy delays, rather than trying to assess all cases or the median case. One example is the Washington State DOT (WSDOT) joint operations policy agreement with the State Patrol and the Washington fire chiefs, established in 1999, which focuses partly on tracking incident response times on major crashes and has reduced the average time required to clear disabled vehicles from 17 to 10 minutes.

To successfully integrate TSO&M programs, state DOTs may benefit by reviewing their internal organizational structure and improving their general business practices. The Strategic Highway Research Program (SHRP2) has identified four key traits common to mature TSO&M programs, including a cultural commitment to providing customer mobility, the integration of TSO&M as a core program at all levels of staff, dedicated sources of funding, and the consolidation of TSO&M functions through TMCs.⁹²

Multi-State Initiatives

TSO&M strategies, especially ITS applications, are in use in many states and benefit from national and interstate coordination among agencies. Examples of voluntary multi-state initiatives include the I-95 Corridor Coalition, the I-80 Winter Operations Coalition, and the North/West Passage Corridor.

Some states have also taken important steps in making their respective highway tolling systems interoperable. To a large extent, the thirteen Northeast and Great Lake states are already interoperable through their common use of EZ Pass. North Carolina DOT has led further efforts by pushing for interoperability among its own Quick Pass system, the EZ Pass system, and, more recently, Florida’s Sun Pass system. Georgia’s Peach Pass is the next system expected to join this network.⁹³ MAP-21 provides further impetus by setting a 2016 deadline for nationwide tolling interoperability.

In addition, the U.S. DOT is in the process of developing a national system for data collection and system monitoring in real time. The program uses information provided by states and is being designed

⁹² *Ibid.*

⁹³ Atlanta Regional Commission (2012 December 22) “North Carolina and Florida Announce Toll Interoperability Agreement; Georgia to Follow.” Transportation Spotlight webpage. Retrieved 11/20/2013 from <http://transportationspotlight.wordpress.com/2012/12/22/north-carolina-and-florida-announce-toll-interoperability-agreement-georgia-to-follow/>.

to incorporate data from existing systems such as the Highway Performance Monitoring System. The system is expected to cover the interstate highway system by 2014 and expand to include regionally significant highways in metropolitan areas by 2016.

Case Studies

California

Due to dramatic increases in population growth and vehicle traffic in the last half-century, California has been one of the early leaders in advanced traffic control methods on its state highway system, especially its expressways. With nearly 2,500 ramp meter signals (more than 60 percent of the U.S. total), California leads the way in expressway ramp metering.⁹⁴

Ramp meters help control the flow of traffic entering expressways, especially during peak periods of travel. They preserve the overall flow of the expressway and manage the spot congestion that occurs when entering traffic attempts to merge with higher-speed mainline traffic.

The California Department of Transportation has conducted multiple studies of various M&O strategies to measure their impact on performance and overall roadway efficiency. For example, the total cost of a proposed series of M&O capital enhancements (including additional ramp meters, monitoring and information display technology, and the professional technical services associated with data collection, reporting, and distribution) for nearly 20 miles on the Interstate 15 corridor in San Diego is estimated at \$12 million over the ten-year lifespan of these investments.⁹⁵ In contrast, adding one lane in each direction to the expressway could cost ten times as much.⁹⁶ A pilot project to develop, implement, and operate an Integrated Corridor Management (ICM) system on Interstate 15—which will allow freeways, arterial, and transit networks to be managed together to improve mobility and maximize system efficiency—received the Operation Efficiency Program of the Year award from the California Transportation Foundation in May 2014.⁹⁷ A study by the Metropolitan Transportation Commission (the MPO for the San Francisco Bay area) found that use of ramp meters and other M&O technology reduced travel times by up to 20 minutes on some expressway corridors, up to a 60 percent reduction in delay in some locations.⁹⁸

Minnesota

In an unusual case in 2000, the Minnesota state legislature mandated that the Minneapolis-St. Paul metropolitan area temporarily deactivate the region's 400 ramp meters to allow the MnDOT to perform a before-and-after evaluation of their effectiveness. This study concluded that the expressway system generally provided lower levels of performance without the meters in place. Without the ramp meters, the expressways carried nine percent less traffic volume, expressway travel times were 22 percent greater, and crashes increased by 26 percent.⁹⁹

94 California Department of Transportation. (2011, December). *Ramp Metering Development Plan*. Retrieved from 9/12/2013 http://www.dot.ca.gov/hq/traffops/systemops/ramp_meter/RMDP.pdf.

95 U.S. Department of Transportation, Research and Innovative Technology Administration, Intelligent Transportation Systems Joint Program Office. "Integrated Corridor Management Pioneer Sites – San Diego, California." Retrieved from http://www.its.dot.gov/icms/pioneer_sdiego.htm. Cost estimate retrieved 8/2/12 from <http://www.itscosts.its.dot.gov/its/benecost.nsf/SummlD/SC2011-00219?OpenDocument&Query=Home>.

96 Victoria Transport Policy Institute. *Transportation Cost and Benefit Analysis II – Roadway Costs*. Retrieved 9/12/2013 from <http://www.vtpi.org/tca/tca0506.pdf>.

97 San Diego Association of Governments. *Comprehensive Transportation Projects: I-15 Integrated Corridor Management*. Retrieved 11/8/14 from <http://www.sandag.org/index.asp?projectid=429&fuseaction=projects.detail>.

98 Metropolitan Transportation Commission. (2011, May). "Freeway Performance Initiative: Regional System Efficiency and Integration in the Works." Retrieved 9/12/2013 from http://apps.mtc.ca.gov/meeting_packet_documents/agenda_1666/05d_1_FPI_Fact_Sheet_Final_5.2.11.pdf.

99 Minnesota Department of Transportation. (2001, February 1). *Twin Cities Ramp Meter Evaluation: Final Report*. Retrieved from <http://www.dot.state.mn.us/rampmeter/pdf/finalreport.pdf>.

Georgia

TMCs that are developed for a specific purpose can be used for system management in “normal” conditions and, in fact, can make it easier to add TSO&M infrastructure and facilities later. The Georgia DOT’s (GDOT) NaviGator management system was originally developed for the 1996 Olympic Games in Atlanta to facilitate incident management, monitor traffic congestion, and dispatch assistance to drivers. Since the Olympics, it has been used as a centralized place to collect and distribute information from the Atlanta metropolitan area. The TMC has been the foundation for several other TSO&M strategies, such as recent ramp metering on Atlanta expressways, the development of high-occupancy vehicle lanes, and the conversion of one of these lanes to a high-occupancy toll lane (as well as the variable pricing on this lane in response to real-time travel conditions).¹⁰⁰

In the late 1990s, GDOT estimated that five incidents per hour—including accidents, breakdowns, or other exceptional circumstances—occurred on the Atlanta expressway system, causing significant congestion and reducing the system’s reliability.¹⁰¹ The TMC provided a central location to monitor travel conditions and used technology such as variable signage to alert motorists of incidents well in advance, allowing them to select alternative routes or adjust time expectations accordingly. Because of other simultaneous changes to the expressway system, GDOT has been unable to isolate the impact of the TMC.

In conjunction with its TMC, GDOT also operates a Highway Emergency Response Operators (HERO) program. This program is offered in the Atlanta metropolitan area and is funded through a private-public partnership with a major insurance company. The HERO program offers basic motorist assistance in the event of breakdowns and manages incidents that interrupt traffic operations on expressways and major highways, allowing GDOT to monitor and distribute information on traffic congestion as well as alleviate congestion when caused by non-recurring incidents.¹⁰² According to TMC Operations Manager, Ron Boodhoo, the HERO program has made a “tremendous difference [in] reducing response times and incident clearance times.”¹⁰³

Resources

The Federal Highway Administration. (2010). Best Practices in Traffic Incident Management. Available online at: <http://ops.fhwa.dot.gov/publications/fhwahop10050/fhwahop10050.pdf>.

This study provides a review and assessment of various transportation incident management policies, procedures, and technologies in use in the United States to identify best practices.

Minnesota DOT. (2001). Twin Cities Ramp Meter Evaluation Final Report. <http://www.dot.state.mn.us/rampmeter/pdf/finalreport.pdf>.

In this study, Mn/DOT details the changes in effectiveness of the overall freeway system during a six-week shutdown period mandated by the Minnesota state legislature.

Parsons Brinckerhoff. (2011). Guide to Improving Capability for Systems Operations and Management, SHRP Report S2-L06-RR-2. Available online at: http://onlinepubs.trb.org/onlinepubs/shrp2/SHRP2_S2-L06-RR-2.pdf.

100 Metropolitan Transportation Management Center. (1999). *A Case Study: Georgia NaviGator- Accurate and Timely Information to Navigate Georgia Roads*. Retrieved 9/12/2013 from http://tmcps.ops.fhwa.dot.gov/cfprojects/uploaded_files/11124.pdf.

101 *Ibid.*

102 Georgia Department of Transportation. “HERO Units Overview.” Retrieved 9/12/2013 from <http://www.511ga.org/hero-overview.html>.

103 Personal communication. (2012, June 15).

This report offers guidance for implementing TSO&M strategies through improved business practices and organizational architecture at state DOTs.

U.S. DOT. (2009). Investment Opportunities for Managing Transportation Performance Through Technology. Available online at: http://www.its.dot.gov/press/pdf/transportation_tech.pdf.

This report provides potential benefits, costs, and ranges of benefit/cost ratios for 15 different categories of system management activities, such as traffic incident management, road weather information systems, and transit signal prioritization.

Victoria Transport Policy Institute. (updated 2010). Least-Cost Transportation Planning: Creating an Unbiased Framework for Transportation Planning, TDM Encyclopedia. <http://www.vtpi.org/tdm/tdm21.htm>.

This chapter of VTPI's TDM encyclopedia describes least cost planning, how it can be implemented in the realm of transportation, and its benefits, costs, and equity impacts. It also provides case studies and examples of places that use least cost planning for transportation.

U.S. DOT (2012). The Role of Transportation Systems Management & Operations in Supporting Livability and Sustainability. Available online at: <http://ops.fhwa.dot.gov/publications/fhwahop12004/index.htm>.

This report, directed at transportation planners and transportation system operators at the State, regional, and local levels, describes how transportation systems M&O can support livable and sustainable communities.