Flexible Design for 21st Century Challenges

Balancing Competing Objectives and Optimizing Return on Investments

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White Paper and Meeting Summary

Minnesota Department of Transportation

Contents

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Executive Summary

Increasingly, state departments of transportation are turning to flexible design as a solution to a number of transportation challenges. These challenges include improving safety and mobility, making the most of limited funding, designing projects appropriate to their surroundings, incorporating multimodal transportation needs in highway projects, increasing public engagement, and improving public satisfaction with the project development process.

The Federal Highway Administration (FHWA) supports the use of flexible design, though flexibility is somewhat limited on the interstate system. While most state DOTs and FHWA state division offices have not embraced applying greater flexibility in design, some states—including Missouri, Washington, Massachusetts, Maryland, Kentucky and Pennsylvania—report initial success or a promising outlook for their implementation of flexible design, but these efforts were not without challenges. State approaches to flexible design vary widely, and are sometimes referred to as context sensitive solutions (CSS), smart transportation, practical design, or practical solutions.

There are barriers—both real and perceived—to flexible design. These barriers include institutional resistance, liability concerns, design speed misperceptions, concerns that flexibly designed projects compromise safety, and concerns about revising design guidance and standards to allow for flexibility. States that have implemented flexible design report that many of these barriers are only perceived, and can be overcome using strong top-down leadership, education, consensus building, and a well-documented flexible design process.

There are also many benefits—both real and perceived—to flexible design. The benefits include an increased ability to accommodate multimodal transportation when needed, a greater sensitivity to the design needs of the local community and surrounding environment, the ability to increase safety system-wide by considering return on investment and engineering projects to the point of diminishing return, and the opportunity to touch more miles of highway with limited transportation funding.

Minnesota is moving forward on its own flexible design initiative. The forum on Flexible Design for 21st Century Challenges brought together leaders in flexible design; engineers, executives, and interdisciplinary perspectives from the Minnesota Department of Transportation (Mn/DOT); and other Minnesota transportation leaders and decision makers. The forum was held to help inform Mn/DOT's next steps and action planning for implementing a flexibility in design initiative that balances competing objectives and optimizes return on investments. An action plan for implementation was developed following the forum.

White Paper: Forum Background

The Need for Change

Mn/DOT is faced with many challenges that must be addressed in new ways in the 21st Century. Transportation needs will continue to increase in response to the state's population growth and aging infrastructure. In the face of growing challenges and constraints, the public is still expecting a better transportation system that has less adverse impact on communities and the environment, that does a better job of supporting alternative choices and modes of transportation, that is less likely to encourage sprawling growth and misalignment between transportation and land use development, and that is more likely to enhance quality of life and economic competitiveness. At the same time, financial resources to address statewide transportation needs are limited. "We can't build our way out of congestion" has been a mantra in Minnesota for the last two decades but it is truer today than it has ever been. We know that we must find ways to squeeze more effectiveness and capacity out of our existing systems; we must use retrofit solutions as well as reconstruction; and we must find ways to extend the life of our infrastructure, both physically and functionally. We must make much greater use of new technologies. All of these things must be done while providing a safe environment for all types of transportation users.

In the past, our transportation policies, approaches, and design guidelines have given a high priority to addressing congestion and safety issues through added lane capacity and roadway/interchange reconstruction but without adequate attention to system level considerations and the "right-sizing" or scaling of project solutions to optimize return on investments for competing needs. We need to change transportation policies, planning approaches and design guidelines so that we will have and use greater flexibility to retrofit existing systems, to address community and environmental issues, to accommodate multiple modes of transportation on the same roadway, and to achieve safety improvements more cost-effectively and quickly. This will help us to optimize our return on investments by understanding the points of diminishing returns and by stretching our available dollars to provide the most service to the most people (in the best public interests) while ensuring the safety of our transportation system. It will also help us to design projects that are more acceptable to our constituents in meeting their needs and the needs of local communities.

Related Initiatives

Context Sensitive Solutions - Mn/DOT has undertaken a number of initiatives in the last decade that have attempted to address these challenges and introduce greater flexibility into design and decision-making processes. Mn/DOT was one of five pilot states selected by FHWA in 1999 to help introduce and advance the concept and implementation of Context Sensitive Design (CSD)—now referred to as Context Sensitive Solutions (CSS). Mn/DOT's selection, as a pilot state, recognized the Department for an exemplary highway project development process and many notable and award-winning projects and processes over the previous 30 years. By late 2000, Mn/DOT (in partnership with the FHWA Minnesota Division and the University of Minnesota's Center for Transportation Studies) had developed and deployed a Department approach to CSD&S with training, a new design policy (Tech Memo), six core principles (including emphasis on applying flexibility in design), a marketing brochure, and a website. Since that time, Mn/DOT has continued to assess CSD&S implementation challenges while continuing to further develop and deploy periodic training and initiatives in applying CSD&S philosophy and principles inclusive of hosting a 2005 Midwest Region CSD&S Workshop with over 200 participants representing more than 30 states.

Design Flexibility - The impetus for the CSD/CSS national initiative (that was coined and kicked-off at a 1998 national "Thinking Beyond the Pavement Workshop" in Maryland) followed on the heels of two initiatives that set the stage. First, enactment of the 1995 National Highway System Designation Act emphasized and broadened consideration of flexibility in design (for non-interstate new construction,

reconstruction, resurfacing, restoration or rehabilitation) more than had ever been stated before (taking into account the built and natural environment of the area; the environmental, scenic, aesthetic, historic, community, and preservation impacts of the activity; and access for other modes of transportation). Additionally, for federal-aid projects off the National Highway System, Congress provided that states have the flexibility to develop and apply design criteria that they deem appropriate. Second, the FHWA development and publication of *Flexibility in Highway Design* (in 1997 as a national guidance document) built upon and highlighted the flexibility that already existed in current laws, regulations, guidance, and the AASHTO "Green Book." *Flexibility in Highway Design* illustrated opportunities and successful approaches for using flexibility in design to tailor solutions that fully consider and address the often conflicting objectives of environmental, scenic, aesthetic, historic, cultural, community, safety, and mobility needs along our highway system. The challenge laid out for the highway design community was to use more innovative thinking and creativity to find and tailor design solutions and operational options that balanced these sometimes conflicting objectives. While the Transportation Research Board (TRB), the Institute of Transportation Engineers (ITE) and AASHTO all published documents recommending greater flexibility in design and application of standards in the early 2000s, most FHWA state division offices and most state DOTs have not yet embraced or met this flexibility in design challenge.

Innovative Contracting Methods – Mn/DOT has used several innovative contracting methods to create more flexibility in the delivery of projects, which enables projects to be delivered more quickly. The *Design-build* approach can significantly deliver projects faster than traditional methods. The *Cost plus time (A+B) bidding* approach factors cost and time to determine the low bid. The *Lane rental* approach encourages contractors to minimize road-user impacts. Using *incentives or liquidated savings* approaches can accelerate contract completion times. Mn/DOT's *Indefinite Delivery / Indefinite Quantity Contract* pilot project involves the demolition of buildings on highway construction projects. Contractors provide a lump sum bid for each property; Mn/DOT awards the contract to the lowest bidder for the whole project. When a structure is ready for demolition, Mn/DOT notifies the contractor and pays for that bid item. The *Warranties* approach guarantees quality and durability for selected work items for a specific time period after construction. The *Pay for Performance* specifications approach relies on final outcomes measured against performance criteria in the contract. Application of *Technology Advances in the Field* is another approach that is helping Mn/DOT to reduce construction time.

Current Activities - Recently, Mn/DOT developed and began implementation of a new and comprehensive statewide scoping model; a new cost management model; a new cost risk assessment and value engineering model; and is in the beginning stages of leading a multi-jurisdictional study to examine the feasibility and cost/benefits of adopting "Complete Streets" policy in Minnesota. Additionally, Mn/DOT recently conducted a self-assessment of CSS understanding and implementation across the organization and has begun work on executive level CSS action planning. In the spring of 2009, Mn/DOT will re-deploy a revamped core CSS training class and a new pilot class in applying advanced flexibility in design. Despite these many initiatives and a number of documented, highly successful, and nationally recognized MN project case studies in applying CSS and flexibility in design, Mn/DOT has not yet adopted specific flexibility in design objectives, criteria, or guidelines and does not yet consistently consider and apply sufficient innovation and flexibility in planning, design, and operations to balance competing objectives and optimize return on investments for the majority of the Department's projects.

Project Examples

Representative examples of Minnesota projects (there are other examples in all districts), which have used design flexibility in a variety of ways, are described below. All of these projects had unique circumstances or special situations that influenced the chosen solutions and required a more creative approach to design than is usually employed in the typical project delivery process. All of these projects encountered significant procedural and design challenges which had to be overcome in order to implement flexible design solutions. The design flexibility used in these projects has shown staff that it is possible to effectively

balance competing objectives by using a more flexible approach to design. However, staff is also aware that there currently are major process hurdles to applying greater design flexibility on typical projects. The purpose of this design forum is to identify and remove the hurdles that are encountered when proposing flexible approaches to problem solving and design so more creative and right-sized solutions can be readily implemented when they are appropriate to the circumstances.

Reconstruction Projects
The following are examples of reconstruction projects where design flexibility was used to resolve competing objectives.

Minnesota TH 61 (North Shore Scenic Highway All-American Road) – This roadway design and reconstruction approach was cited as one of nine case studies featured in the 2002 National Cooperative Highway Research Program (NCHRP) Report 480 "A Guide to Best Practices for Achieving Context Sensitive Solutions." Selection of a lower design speed (55 mph rather than 70 mph) and maintaining an upgraded two-lane facility, appropriate to the unique circumstances, allowed maximum flexibility to find the best roadway alignment to balance the competing safety, mobility, social, economic and environmental needs while saving costs and optimizing return on investments. Forensic post-reconstruction analysis later documented that annual crash rates had also been reduced by 45% to more than 70% in the various segments.

MN TH 38 (Edge of the Wilderness National Scenic Byway) – This roadway design and reconstruction project was cited as the best CSS project in the inaugural 2005 AASHTO national Best Practices in CSS competition. Reconstruction of TH 38 segments utilized the lowest appropriate design speeds (50-55 mph), and appropriate design exceptions, to maximize flexibility in design to balance unique competing needs and objectives while trying to maximize return on investments and value-added. The substandard highway was reconstructed as a 10-ton road maintaining much of the existing two-lane horizontal and vertical alignments balanced with strategic spot and intersection improvements where accidents were documented as frequent. The typical reconstruction cross-section includes two 12-foot lanes with 4-foot paved shoulders and 2 feet of additional reinforced gravel shoulder and rumble stripes to mitigate for substandard alignment and the use of steeper back slopes and variable ditch cross-sections to minimize adverse environmental impacts. Forensic post-reconstruction analysis documented typical cost savings of more than 40% and annual crash reductions exceeding 55%.

TH 23 Spicer from TH 71 to CSAH 31 (through Spicer and New London) – The reconstruction and expansion of this two-lane roadway to a divided four-lane highway passes through the environmentally sensitive Green Lake Watershed. To reduce runoff impacts, 39 ponds of various configurations (single, double, multicell & grit chamber) were constructed to capture and treat roadway runoff before entering Nest & Green Lakes. In addition, the impervious roadway surface was reduced by designing 6-foot shoulders throughout the raised median urban section. A number of retaining walls were constructed to minimize impacts to vegetated slopes and to also minimize the surface areas of urban ponds and ditches within right of way constraints. The architectural details for the retaining walls and bridge abutments utilized a multicolored concrete field stone pattern to reflect the historical and prominent use of natural stone construction found throughout the community of Spicer.

TH 1 Near Ely – TH 1 connects the North Shore of Lake Superior with the community of Ely in the northeast corner of the state while traversing wild and remote woodlands. The highway also serves as one of the gateways into the vast and famous Boundary Waters Canoe Area (BWCA) wilderness. The 15-mile section between Lake County Highway 2 and the Kawishiwi River Bridge was an experience loved by residents and tourists alike for its winding alignment and trees right up to—and even growing in—the roadway shoulder. Reconstructing this segment of highway was a difficult and sensitive undertaking to strike a balance between modernizing the highway and preserving its character, charm and historical integrity. Selection of the design speed was the key decision to enable a flexible and context sensitive design. After several trial investigations, the design speed was set at 40 mph—a design exception 10 mph

below the standard range and 10 mph below the existing posted speed. Additionally, design exceptions for horizontal alignment below 40 mph were used in a few sensitive and constrained areas. This flexibility allowed the vast majority of the highway's length to fall within a few feet of the alignment of the original road—itself designated as a historic property. The highway's other elements were designed using Minnesota's Natural Preservation Route standards as borrowed from the Minnesota State Aid Rules. The successful application of CSS vision and flexible design execution produced a project that gained public acceptance during development and has received very positive feedback upon completion.

TH 10 Access Management through Detroit Lakes - The realignment and reconstruction of Highway 10 through the heart of the City of Detroit Lakes, Minnesota, improved safety and mobility along this segment of an important interregional corridor while improving access and mobility for local traffic as well. Collaborative solutions were identified during public input and included reducing crossings with the railroad and providing an opportunity for urban redevelopment in Detroit Lakes. The design addressed many factors including railroad needs, coordination with local business and civic groups, historic buildings and properties, impacts to adjacent property owners, water quality, and staging criteria controlled by fish migrations. The project's staging plan was considered a critical input in the early stages of design. Traffic impacts were reduced and the construction contract used several innovative contracting methods. A + B bidding was used and the successful bidder took a three-year project and built it in two years. A locked incentive date was used within the project for timely completion of work on an important bridge. The contractor not only achieved the date but completed the bridge work in one construction season rather than two. Detour rentals were utilized throughout the project to reduce the length of time in which important city streets were detoured. The above, coupled with effective use of a communication and public relations expert (pay item), resulted in a very successful and cost-effective project that was delivered quickly and with well informed and engaged public and business stakeholders.

CSAH 3 Excelsior Boulevard (St. Louis Park) – This roadway design and reconstruction approach was cited as one of five case studies in the Institute of Transportation Engineer's 2006 proposed recommended practice publication *Context Sensitive Solutions in Designing Major Urban Thoroughfares for Walkable Communities*. Design speed was reduced and flexibility in design was applied to reallocate cross-section space to balance competing stakeholder needs and objectives while also improving safety for all modes. Community needs, in this built urban environment, were addressed along this roadway by using a design speed of 35 mph (consistent with desired operating speed) and 11-foot travel lanes, adding landscaped medians, eliminating shoulders, adding off-street parking facilities, adding on-street parking lanes that incorporated reaction distances, adding protected but shortened left turn lanes and tapers, adding access controls and consolidations, adding near-side and far-side transit stops, providing for convenient off-route bicycle mode accommodation (parallel streets), widening sidewalks, adding streetscape elements and a hierarchy of roadway and pedestrian level lighting that all combined to support a "complete street" and revitalized suburban town center. Forensic post-reconstruction analysis documented more than a 60% annual crash reduction in the first reconstruction segment.

CSAH 13 (Radio Drive) Safety & Mobility Project - The County and City worked with the public to develop a safety and mobility project that was consistent with the community's vision. The project included critical technical improvements such as expansion into a four-lane divided roadway with turn lanes; multi-use paths on both sides of the roadway; signalization; and a multilane roundabout. The Radio Drive/Bailey Road roundabout was one of the first full multilane roundabouts in the state and the first full multilane roundabout on a high-speed arterial roadway. It currently carries over 20,000 ADT and is expandable to carry over 60,000 ADT in the future. Preliminary construction cost estimates for this three mile long project were up to $14 million. A value engineering approach was used during final design and it led to a context-sensitive design solution and construction cost of $9.6 million. Cost savings were realized through use of a full closure during construction, profile adjustments to minimize earthwork and adverse project impacts, minimization of right of way acquisition, and use of MSE walls. The staging eliminated a full year of construction and allowed the project to open on schedule after a yearlong delay due to lack of funding.

Retrofit Projects
The following projects are examples of projects where design flexibility was used to resolve an existing problem without complete reconstruction. In some cases, actions were taken to address emergency situations; in other cases, actions were taken to gain benefits early by providing immediate solutions to existing problems.

TH 65 in Columbia Heights – This is a four-lane divided roadway in an urban environment with many driveways, median openings, cross-streets and signalized intersections. The numerous access points resulted in one-way and do not enter signs being installed in the median over many years which resulted in a "sea of posts and signing." Mn/DOT and the city systematically evaluated access points to determine which, if any, were "over-signed." Using the flexibility allowed in the MUTCD, many signs were removed. The reduction in signs resulted in improved aesthetics for the city, lower maintenance cost for Mn/DOT and a safer and less distracting environment for the traveling public.

TH 61 through Hastings – This roadway was a four-lane undivided roadway with a very high crash rate and a high frequency of rear-end, left-turn crashes. To address the specific crash problem with the introduction of raised medians and protected left turn lanes, every other cross street intersection movement would have been closed to meet Mn/DOT standards for left-turn lane and taper lengths, and this was an unacceptable proposition for the city. Significantly shortened left-turn lanes and tapers were proposed such that all public street intersections could remain open. This flexibility in design solution was acceptable to the city and community stakeholders and enabled a project to move forward, resulting in a significant safety improvement by reducing annual post reconstruction crashes by approximately 44%.

TH 7 from Hutchinson to St. Bonifacius - Roundabouts and passing lanes were constructed on the eastern portion of this project to handle safety issues and projected traffic volumes instead of the more typical rural divided highway with interchanges and stoplights. Retaining walls in Hutchinson were constructed to minimize right-of-way takings and reduce cost. Controlled access management in certain areas was implemented to establish proper placement of entrances to the highway.

TH 100 from 36th Street to I-394, St. Louis Park – This is a four-lane segment of freeway between two six-lane segments. It was built in 1937 and has substandard ramps. The Metro District narrowed the existing shoulders and lanes on this road segment to add a third lane in each direction. Congestion has decreased, throughput has increased, and speed has increased. There has been a marked reduction in crashes, and the benefit-cost ratio is 13:1 based on congestion savings over a seven-year service life.

TH 100 northbound from France Avenue to I-694 – This project was undertaken to relieve congestion caused by the I-35W bridge collapse. The shoulders of this ramp segment were converted to provide a two lane entry on to I-694. Traffic throughput increased, congestion decreased, and speed increased. There has been a modest reduction in crashes, and the benefit-cost ratio is 17:1 based on congestion savings over a 20-year service life.

I-94 from I-35W to Hwy. 280 – This project was undertaken to relieve congestion caused by the I-35W bridge collapse. The Metro District narrowed the existing shoulders and lanes to provide four lanes of capacity. Access to Hwy. 280 was improved by having the southbound Hwy. 280 to westbound I-94 ramp start a new lane (instead of merging in on the left) and converting the eastbound I-94 exit (to northbound Hwy. 280) to a two lane exit. The improvements resulted in a 24 hour increase in traffic volumes and decreases in both a.m. and p.m. peak period congestion.

Key Questions

Some of the key questions (and no doubt there are many others) that need to be addressed during the forum include:

- What changes need to be made in Mn/DOT's philosophy and approaches to allow greater understanding and broader flexibility in planning, scoping, design development, operations and decision-making overall?
- What institutional roadblocks need to be addressed?
- How should links between funding and design approaches and standards be changed?
- How can data and assumptions be re-examined to frame different and better solutions?
- How should we evaluate return on investments and points of diminishing returns?
- What changes need to be made in Mn/DOT's planning, scoping, design and operational approaches and guidelines? Should we recommend value ranges or specifically graduated values in our flexibility guidance?
- Should we change our design exception and variance philosophy and processes?
- Should we change our criteria for level of service, capacity/congestion, and functional classifications?
- How can we advance broader and more balanced multimodal considerations and solutions with more flexibility in our approaches and guidance?
- Should design speed be the same as targeted operating speed?
- How do we introduce greater flexibility without compromising safety?
- Are there liability and risk management issues that need to be addressed?
- What training, research, and innovation are needed?
- What performance measures or indicators of success are needed?

Meeting Summary

Welcome and Forum Objectives

Robert Johns, Director, Center for Transportation Studies

Robert Johns

The goals of this conference are ambitious and important. It will take the idea of flexible design even further by exploring cutting-edge ideas and helping Minnesota plan its next steps into the realm of flexible design.

The University of Minnesota Center for Transportation Studies has a long history of research and leadership in the area of flexible design. Projects include a 1997 study on transportation and regional growth, and our *Moving Communities Forward* research studying how well-designed transportation projects positively influence communities. We're currently working on a study of accessibility to destinations by mode of transportation, and a study on reducing greenhouse gases. These projects, along with many others, fit under the larger umbrella of context sensitive solutions and flexible design.

More information at www.cts.umn.edu.

Tom Sorel, Commissioner, Mn/DOT

Tom Sorel

Flexible design is an important issue, and we need partners to make it work. Together, we can move our commitment to flexible design forward and take it to the next level.

As we discuss flexible design, we must keep our strategic vision in mind. Three elements will be especially important to this discussion. The first is an understanding of public values and how this ties to risk management. The second is how flexible design fits our investment principles of safety, preservation, mobility and regional and community development. The third is the toolbox that will help us implement flexible design and develop 21st century solutions for 21st century challenges.

I encourage you to think about how flexible design fits into Mn/DOT's larger vision. If we can pull context sensitive solutions together in a comprehensive approach, it can be transformational for both the transportation community as a whole and for our organization.

More information at www.dot.state.mn.us.

Mike Barnes, Engineering Services Division Director, Mn/DOT

Mike Barnes

Our goal for this conference is taking flexible design to the next level at Mn/DOT. The background documentation for this forum describes the purpose and need for change, as well as some other Mn/DOT initiatives and projects that relate to flexibility in design. The background document also contains key questions that must be addressed in our approach to flexible design. During this forum we are also using a collaboration technology enabling remote viewers to participate online via a web link. After the forum, we will be developing an action plan for flexible design. What we learn and discuss here will be an important part of the change effort, and get us all moving in the same direction.

Assessing Minnesota's Status and Perceptions Related to Flexibility in Design

Speaker: Dwight Horne, Director of Program Administration, FHWA

(Horne served as the moderator for the two-day forum)

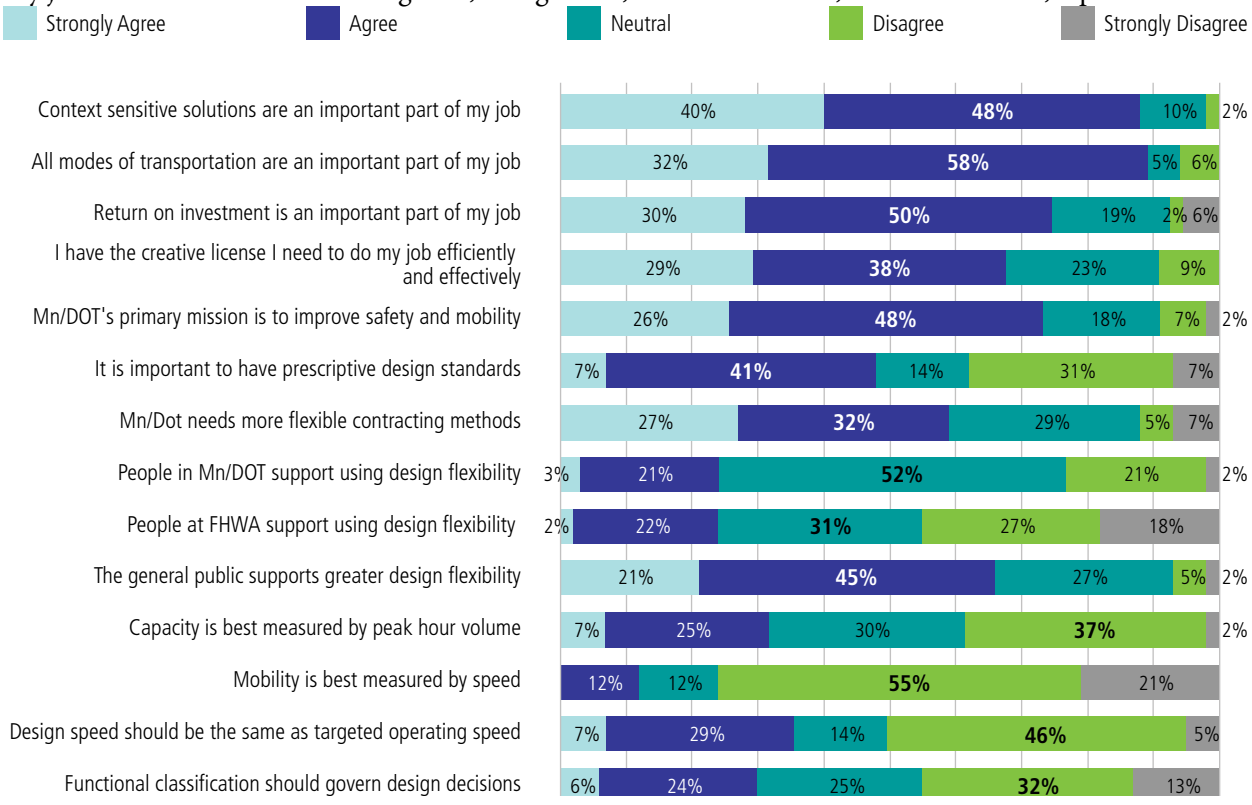
For flexible design to work, we need to understand what flexibility we have, and what standards and guidelines apply. We also need to understand the context of CSS. It is confined not only to projects—the principles of flexibility can be used in the entire arena of what we do—it has a role in all functions.

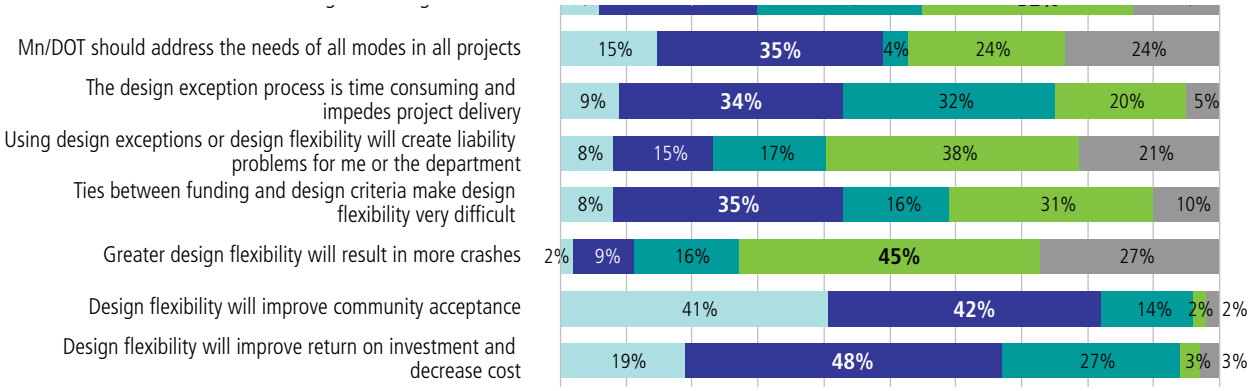
Remember, CSS is interdependent in function. To get beyond that interdependence, you must think as part of a team. With CSS, the best results come from a collaborative effort. You must have conversations about the design and know where you have the ability to be flexible. National guidelines are pretty flexible, but each state has a varying degree of rigidity. If you're interested in making CSS work, everyone on the team must be receptive to the idea of flexibility.

Group Polling Using iClicker Technology

More than 20 group polling questions were developed to help assess Minnesota's status and perceptions related to flexibility in design from the opinions of the forum participants. Electronic polling (using iClicker technology) was conducted on the morning of the first day of the forum prior to the featured presentations by transportation representatives from FHWA and six states regarding their approaches and advocacy toward applying flexibility in design. All respondents in the room used electronic voting to answer the following questions. Each question had between 65 and 52 respondents. The neutral response can also indicate "don't know."

My job is most related to: Planning 25%; Design 59%; Construction 8%; Maintenance 0%; Operation 8%





Some of the most significant or unexpected perceptions indicated by the group polling data include:

- 90% of the participants believed all modes of transportation were an important part of their job.
- 80% of the participants believed return on investment was an important part of their job.
- Nearly 90% of the participants believed CSS was an important part of their job.
- About 75% believed Mn/DOT's primary mission was to improve safety and mobility.
- About 50% of the participants believed it was important to have prescriptive design standards.
- Fewer than 25% of the participants believed FHWA supports using design flexibility.
- Fewer than 25% of the participants believed Mn/DOT supports using design flexibility.
- More than 65% of the participants believed the public supports using design flexibility.
- More than 40% of the participants believed the design exception process was time consuming and impeded project delivery.
- About 10% of the participants believed applying greater design flexibility will result in more crashes.
- More than 80% of the participants believed design flexibility will improve community acceptance.
- Nearly 70% of the participants believed that design flexibility will improve return on investment and will decrease costs.

FHWA Approach to Design Flexibility

Mark Taylor, Safety/Geometric Design Engineer, FHWA

Mark Taylor

Flexible design helps with program delivery and achieving environmental stewardship goals. It also promotes the CSS philosophy (a priority of FHWA), allows consideration of a wider range of design options and alternatives, and helps create cost-effective designs.

The degree of flexibility you have with design depends on the roadway's function. There is less room for flexibility on major arterials, and a greater degree of flexibility with collector roadways and the local level. However, we do have some degree of flexibility even with the interstate.

The FHWA has a long history of promoting flexibility. This is most notable in our 1997 document *Flexibility in Highway Design*. We are also cosponsors of the Web site www.contextsenstivesolutions.org. More recently, we've had a diverse outreach effort, including training and peer research.

Achieving flexibility requires the balance of many factors. There are always tradeoffs to consider in flexible design, including economic, stakeholder preferences, environmental impacts, social impacts, capacity, speed, and ease of maintenance.

The key concepts in flexible design embody the principles of risk assessment and require a balance of information, evaluation, risk assessment, and a structured decision-making process. To determine the level of risk, you must think about the severity of the consequence and the number of people exposed to the consequence. Evaluation and analysis in flexible design should consider the scope of the effects and not just the scope of the project, and should also consider both technical and non-technical factors.

The philosophy of design flexibility is a desired part of the design process. In flexible design, we take the concept across a system level, down to a corridor level, and then apply it to each project. This involves applying not only conditional measures, but also actual performance measures. Flexible design typically requires more information and a higher level of analysis than simply applying criteria "by the book."

Flexible design focuses on applying the inherent design flexibility within the guidelines. It emphasizes the use of the community context. It also uses design exceptions to examine what appropriate standards are for a corridor—this may or may not be what is normally prescribed for the situation. Instead, it should be the most appropriate design value for a particular location.

In assessing the risk of your design, keep an attitude of not being risk-adverse, but risk-aware. Understand the risks and the level of uncertainty, and study more than what is readily apparent on the surface. Maintain focus on the project's purpose and need to define performance goals and criteria—setting up evaluation criteria is often a missing step in design. Look at performance prediction tools and use good engineering judgment to assess the severity of adverse consequences and evaluate design tradeoffs. Mitigate risks to the extent it is practical, and ensure that risks outside of the norm have the endorsement of upper management.

The FHWA recommends applying a consistent national approach to flexible design, such as the AASHTO flexibility guide. We advise states to use a corridor approach for establishing design criteria and then be consistent with that approach throughout the corridor. It's also important to understand there is an appropriate, professional way and an inappropriate, cavalier way to approach flexible design. Flexible design requires a clear process for approving and documenting the rationale for important design decisions.

Implementing flexible design requires all stakeholders to be involved in setting design guidelines and criteria. You should address and institutionalize these processes through manuals, guidelines, education and training. Finally, you should support statewide programs to collect and analyze the performance data necessary for flexible design and use the latest tools to evaluate safety and operational design decisions.

More information at www.fhwa.dot.gov/design and www.fhwa.dot.gov/context.

State DOT Perspectives

Sally Anderson, Roadside and Site Development Manager, Washington Department of Transportation

Sally Anderson

In Washington, our mission hasn't changed to include CSS because a lot of the CSS principles are ingrained in our department already. These principles are being inclusive, environmentally responsible, focusing on multimodal transportation, and being cost-effective. We are also constantly working to reduce emissions and accommodate people with disabilities through compliance with the Americans with Disabilities Act.

Our funding structure relies primarily on gas tax, which is designated for transportation. Our projects are decided on by a legislative committee.

The goals for our design process and program emphasize comprehensiveness, planning, safety, sustainability, multiple modes, and public involvement. Our safety goal is zero fatal and serious crashes, and we have a separate safety program. When it comes to safety, we aren't flexible—this is something we never compromise.

In the past, projects were programmed based on high-crash locations. Over the past 13 years, we've had a 25-percent reduction in fatal crashes as a result. Because we've made most of the corrections at high-severity crash locations, we now use collision analysis. This analyzes the cause of the crashes and focuses on finding solutions.

The goals for our design process is a program that is comprehensive, planned, safe, sustainable, inclusive of multimodal transportation, and emphasizes public involvement. The design factors are project-specific, and many of our design processes fit CSS—including NEPA, safety improvement, public involvement, value engineering, cost/risk assessment, resource analysis, mitigation, and permitting. When it comes to flexibility in our design standards, there is a range available. Designers must recognize the tradeoffs within the range, and when they go outside the range there is an approval procedure.

Flexibility is often needed when balancing the requests of local interests. For example, we helped support the goals of one community to have trees in its median by developing an in-service agreement requiring them to mitigate if there were reoccurring crashes. This type of partnership creates a win-win for both groups.

Tom Dipaolo, Assistant Chief Engineer, Massachusetts Highway Department

Tom Dipaolo

Massachusetts has extremely varied types of transportation environments. These include historic town centers, the Cape Cod area, rural areas, and big-city Boston. Each of these environments has very specific transportation needs, and in the past many communities felt the designs we produced were not appropriate for their settings. As a result, projects were delayed and our processes were attacked.

In 1999, we created a design guide task force to work on a new guidebook. We brought in outside constituents including cities and towns, organizations for walking and biking, disability groups, and FHWA. In all, there were only six people from MassHighway on the task force, and a minority of engineers. Our aim was not to revise the current guideline, but to develop an entirely new document.

The guidebook was drafted using AASHTO guidelines as the basic design controls with an emphasis on safety and mobility, the need for a clear project development process, incorporating CSS principles, and multimodal transportation. A consultant selected by the task force managed the writing of the new, flexible 2006 edition of the MassHighway Project Development and Design Guidebook.

Our new guidebook takes a different approach to design control. We moved away from functional classification and instead identified nine area types within three categories: suburban, urban, or rural. The designer can chose from these nine area types. The guidebook also places a much stronger emphasis on multimodal. The first user in the guidebook is the pedestrian; this was done on purpose to refocus the designer on working from the outside of the cross-section in.

Examples of flexibility in the new guidebook include a broader range of design speeds, no prescribed level of service, a bigger range of lane and shoulder widths, and a clear process for design exceptions.

The new guidebook has been very well-received. We've had no negative press, experience fewer design delays, and issues are addressed earlier on in the design process. We are creating designs appropriate for their settings and giving designers the tools they need to think and be creative. It's not necessarily and easier process, but it is a better process.

Dennis German, Chief, Community Design Division, Maryland State Highway Administration

Dennis German

When it comes to design flexibility, you don't have to worry about compromising safety. In Maryland, we've never had to compromise safety in using flexible design. Our state does not have a design standard manual; our design guideline is mainly taken from AASHTO.

A big challenge we face today is addressing changes in land use and sprawl. The use of roadways built 40 years ago has changed, and we need to retrofit older systems to the type of transportation going on today. Many previously rural communities in Maryland have grown into the Washington D.C. metropolis, and now we need to recognize which of these roadways are safe and who they are safe for.

Multimodal transportation is important to our state. We are required to find a way to accommodate bicycles and pedestrians where it is reasonable—but we don't have the ability to expand beyond the physical borders, which are typically buildings. Pedestrians are the most vulnerable persons on the roadway, so sometimes we must sacrifice capacity to accommodate them. To do this, we'll use narrower lanes when it is appropriate.

We have achieved success with design flexibility by deciding that instead of looking just at a few projects, every project should be CSS-oriented. Part of this is considering a wide range of factors, including snow removal, utilities, storm water management, historical preservation, and wetland preservation.

We've also used CSS to help us improve pedestrian safety. Our state has a high pedestrian accident rate, so we've worked to improve on pedestrian safety on the design side and through education. Finally, we work to achieve measurable results and ADA compliance. More details on our ADA policies can be found at http://www.sha.state.md.us/businessWithSHA/opr/ada/ada_sitemap.asp.

Brian Hare, Design Services Division Chief, Pennsylvania Department of Transportation

Brian Hare

Pennsylvania is addressing changes in transportation with our Smart Transportation initiative. The changes it seeks to address are new modes of transportation, increased sprawl, limited development patterns, a deteriorating bridge infrastructure, climate change, decreased revenue, and the inflation of construction costs.

Smart Transportation's goal is linking transportation investments with land use planning and decision-making. It seeks to maximize value to price ratio, enhance the local network, look beyond level of service, place a strong emphasis on safety, accommodate all modes, leverage existing investment,

avoid sprawl, develop local governments as land use partners, and plan designs within their context. Key tenants of this approach are communication, flexibility, choice and safety.

In smart transportation, context must be determined in planning by considering land use, community, environment, transportation needs, and financial limitations. From there, we'll scale solutions to the problem with right-sizing—establishing the right program to address the most urgent problems and the right projects to focus on those problems.

Our new *Smart Transportation Guidebook* was published in March 2008 and is fully compatible with AASHTO. The guidebook contains some significant shifts from our old design manuals: it goes beyond functional classifications and defines more specific roadway typologies, expands bridge width criteria, and shifts design speed to match target operating speed.

The new guidebook also emphasizes multimodal transportation. The needs of bicycles are considered early on, before projects are programmed. Intersections are designed for all users, including bikes and pedestrians. Sidewalks must be provided along both sides of roadways in commercial areas and along arterials and collectors in residential areas. Public transit is also accommodated in Smart Transportation.

More information on Smart Transportation is available at www.smart-transportation.com.

Kathryn Harvey, State Design Engineer, Missouri Department of Transportation

Missouri's approach to flexible design, which we call practical design, was created out of necessity. Our costs were going up, our revenue was going down, and we needed a way to control costs without compromising safety. We were having spots of perfection, but fatalities on our entire system were rising.

Practical design is an approach that considers projects based on their contribution to the entire system rather than individual perfection. It's a radical cost control method to spread money around further—we want to build good projects, not great projects.

Rigid design standards can be dangerous. When we had no flexibility in the manuals, we were doing things without thinking about the context of the project. In many cases, the standards we were adhering to made no difference in the type or number of crashes.

In 2004, practical design was implemented in a top-down directive. Our designers were told to put their design manuals on the shelf for a year and use their engineering knowledge and the AASHTO Green Book as a guide. There were only three principles designers had to adhere to: every project must get safer, communication among stakeholders was critical, and the project must be practical and function properly. After that year, flexible engineering policies were developed and published on the Web.

The practical design movement in Missouri has been a success. Our state had the largest drop in fatalities of any state in the nation in 2006, with a continued downward trend. We have spread our money, touched more miles of highway, and improved the safety of our overall system. Our image has improved with customers and the media, and Missouri's pavement condition has gone from 3rd worst to 9th best.

Missouri has learned lessons about how to implement a practical design program. Practical design must begin with top-down leadership using an open and transparent process, the organization must be open to change, and these changes should come by working hand-in-hand with state and federal officials. It also requires a focus on the system—this means a shift from delivering perfect projects somewhere to good projects everywhere. Finally, states must honor their commitments by delivering projects that have been promised to the public.

Nick Stamatiadis, Professor of Civil Engineering/Transportation, University of Kentucky Transportation Center

Nick Stamatiadis

The reality for Kentucky is the reality of most states: limited funding, the need for roadway improvements, and more projects than funds. Kentucky's goal is using limited funds as efficiently as possible, knowing that safety is the one area we cannot sacrifice. We need to explore opportunities for balancing priorities system-wide.

When we think about different options for improving a roadway, we need to take a practical approach. Our goal must be to maximize the design to the point of diminishing return.

For example, a two-lane roadway with 10-foot lanes and 2-foot shoulders has 5.4 crashes a year and a travel speed of 41 mph. Widening the roadway to a two-lane facility with 12-foot lanes and 8-foot shoulders decreases crashes to 2.9 per year and increases travel speed to 47 mph at a cost of $7.2 million per mile. However, building that same road out to a four-lane roadway reduces crashes to 2.4 per year and increases travel speed to 56 mph at $21.5 million per mile—triple the cost of the improved two-lane facility. By choosing the improved two-lane roadway over the four-lane highway, we're able to triple the number of miles of highway we can improve—preventing more crashes for the same cost.

Currently, Kentucky is applying this thinking to its entire program using five principles: target the objectives of the purpose and need statement, meet anticipated capacity needs, evaluate safety concerns compared to existing conditions, evaluate design options, and maximize design to the point of diminishing return.

By re-evaluating all projects and reconsidering project size and budget, we'll realize cost savings, shorten our project backlog, and improve safety and mobility. Other states that want to implement this approach should remember to establish safety and mobility targets in project purpose and need statements and not exceed them. They should also identify true problems, think beyond design standards, and provide proper project documentation for design decisions.

Question and Answer Session

Q: Was there pushback against the changes?

Brian: Yes, the key to our success was creating ownership at each district office and gaining district buy-in with trainings and education.

Q: How can you overcome institutional barriers to flexible design?

Mark: Acting independently and accepting risk decisions is hard, that is why an interdisciplinary strategy works best.

Q: Do you use a centralized or decentralized organizational structure?

Dennis: We're pretty much centralized because we have a small state.

Tom: We're fairly centralized, but project development is more localized.

Sally: In Washington, our headquarters sets policy, and the regions mostly deliver projects that are assigned to them.

Kathryn: We are decentralized, Central Office sets policy and decisions are made at the districts. Design also occurs at the districts.

Brian: Pennsylvania is decentralized. Projects are designed in the districts with some oversight from Central Office.

Q: How did you formally manage the change management aspect of flexible design?

Brian: First we developed the guidebook. Once it was out, we formed a statewide steering committee, and I led the roll-out with consultant support and the management team. For us, it was all about creating ownership in the district offices.

Kathryn: When our chief threw out the guidebook, we took the staff that was in charge of updating the guidebook and used them to get the process moving.

Tom: Ours was different, because it was driven by external forces.

Dennis: Our entire department was involved. Every senior manager was part of the project, and implementing it was a two-year process.

Sally: We didn't use an organizational approach. A few of us realized it was important and approached executive management. The manual was in part a community effort.

Q: What culture changes did you experience when you implemented flexible design?
Kathryn: We went through culture shock. We got through the rough times by dangling a carrot—any money you saved in your district stayed in your district.

Tom: We had to go through that same type of push. You also need pressure from the outside, and it helped that the governor was the one telling us to come up with a new design manual.

Nick: Kentucky is only 10 months into the process, and there has been a lot resistance. It's important to make it a top-down initiative.

Dennis: At first, there was the feeling that this was just creating more work. We had to help people understand that this can actually be a benefit.

Brian: We were already incorporating this on a lot of projects, so now the challenge is to make it part of our best practices.

Q: How involved were the municipal planning organizations in establishing the new functional classifications?
Tom: The decisions were made by the group that drafted the guidebook, and each member was expected to gather input from their constituency group.

Dennis: We looked at historical context, available space, environmental issues, and crash rates to determine how we would classify a roadway.

Brian: Tom captured our approach. Functional classification is probably one of the more complicated issues we're dealing with.

Q: How do we make early planning a priority to start dealing with issues and concerns earlier in the project?
Dennis: Document all decisions and how you're making them, and keep the process as seamless as possible.

Kathryn: We heavily utilize the scoping phase to look at the appropriate scope, so planning and thought must go into it before it goes to construction, because then the budget is locked in.

Tom: The largest portion of our guidebook is the development section. We use a two-phase project initiation process. First, we identify the needs. Then, we work to establish the range of possible solutions.

Brian: Create a project development process to focus on upfront planning.

Q: How can we focus more on the purpose and need?
Kathryn: That's the point of scoping the project. The project's purpose and need statement are used for the project's description in the STIP.

Brian: Make defining the problem a major focus, and train the consultant community.

Nick: Develop a manual.

Q: How is value determined and how does the value tradeoff happen?
Dennis: Never trade safety, but maybe look at capacity. The real key is looking at what the problem is and figuring out how to best address it. Pinpoint that one issue and don't look beyond it.

Kathryn: It's as simple as getting the most bang for the buck. Maximize the value by spreading the dollars to more places, and don't go overboard.

Q: Does anyone have good measures for non-pavement performance metrics?

Nick: There is a study we're doing that is nearly finished on applying performance measures to CSS.

Dennis: We do a questionnaire at each of our project meetings, which is helpful from a narrative standpoint.

Q: Where does multimodal fit into this picture?

Brian: It's about choices and maximizing the options for all users.

Kathryn: We need to do it because it is the right thing to do, but we also need to make sure there is a need.

Tom: You have to construct the facilities for people who are going to be using them, and it goes beyond the motor vehicle.

Dennis: We simply can't keep building more and more 12-foot lanes. It's not sustainable.

Sally: There is also the global need to reduce greenhouse gases.

Q: In practical design, how do we address multimodal transportation?

Kathryn: Our approach to practical design looks at everything, including multimodal.

Nick: This is an example of how we need to balance issues and design to the point of diminishing return.

Q: Have local partners adopted your design guidelines at the local level?

Kathryn: Our local folks loved it when we changed our standards. They couldn't afford to do projects in the days of rigid design standards, so they were on board before we were.

Dennis: Overall they liked it, but they weren't happy when we really started to hold them to our ADA standards.

Tom: We do almost everything for the locals, so our guideline is their guideline. We basically rewrote it for them, so they loved it.

Q: How do we address land use problems at the local level?

Brian: Conduct outreach with municipalities, and involve them upfront earlier in the process.

Sally: We have a growth management act, and each community has to develop comprehensive growth plans. The environmental review process is also a good place to look at cumulative impacts.

Q: What happens when you have a land use conflict between the statewide interest and the local interest?

Brian: While we can't control land use at the local level, we can at least be involved in the planning.

Tom: We formally involve the MPOs and LPAs in the planning process. It's hard to influence land use when it is controlled by external forces.

Kathryn: We make the locals compete. When a locality needs a major project, they present their project to the rest of the state's MPOs and have to prove it's an important project with a statewide impact.

Q: Did you have problems when you decided to make design speed the same as target operating speed?

Brian: Our designers have been supportive of projects designed to the behaviors we're trying to drive.

Nick: I'm a strong advocate that design speeds should be the same as the speeds we want the roadway to operate at.

Q: By lowering design speeds, are we accepting a deficient design?

Brian: It really depends on the problem. If pedestrian safety is the problem, how is a faster roadway safer?

Tom: The whole issue of design speed is tough, that's why we morphed it into target speed—how fast do you expect someone to drive on this road?

Q: How do urban design speeds relate to statutory speeds?

Tom: Our guidance doesn't pin the design speed to the posted speed.

Q: Design speeds set a number of other things, such as safety devices. How do you deal with these issues?
Tom: I can't think of any issues that have come up because of this.

Sally: We had a lot of discussion about this; we tried to figure out if there were tools we can use if we're putting fixed objects in a clear zone.

Mark: It is primarily to ensure consistency of the design elements to one another. At any given speed, there are elements that are compatible and others that are not.

Q: When it comes to flexibility's effect on safety, do we have a good understanding of where we can cut back?
Brian: We look at the needs, and if there's a safety problem we're not going to walk away without addressing the factor that contributed to the crashes.

Tom: There is a lot more to standards than a safety component. The standard is there to provide some uniformity. If you can preserve safety by going outside the standards, that's okay.

Mark: The relationship between safety and standards is very tenuous. You have to look more carefully at each situation to see what's really going on.

Sally: We're also realizing the need to go beyond vehicle safety and address bike and pedestrian safety.

Q: How do you use data to drive safety improvements?
Dennis: We look at both crash types and crash rates.

Mark: To design any type of countermeasure, you need to know the crash types as well as the crash rates.

Q: Is it possible to go too far when creating cost-saving practical designs?
Kathryn: We haven't had that problem, because professionals are still designing the projects.

Dennis: This question comes up a lot when we look at how far to go in improving storm drains.

Brian: It just gets back to looking at the needs and determining if the solution can function safely.

Mark: Design for your users. If you're meeting the needs of users, then that is quality.

Q: How do you plan for forecasted volumes when right-sizing?
Tom: We didn't venture outside the traditional traffic forecasting models. We did discuss the problem of designing to peak hour, and addressed this by not specifying a required level of service.

Brian: We do a reality check to make sure there is actual infrastructure for growth. Always question and verify assumptions.

Q: Have you encountered any legal issues as a result of flexible design?
Kathy: There was concern about this, and we had to bring in our lawyers to talk to our designers many times to help them understand we would back them in court if needed.

Brain: We conducted liability training and included a representative from our state's engineering licensing board to put them more at ease.

Tom: With the exception of the interstate, flexibility has always been there. It's permission that has already been granted to us.

Q: We're giving engineers less training. When you throw away the book, do you feel confident in your staff?
Dennis: Absolutely. We give courses, encourage mentoring, and work in teams.

Mark: That's why your design manuals are important, to give them things to consider. In some situations, there should be a senior designer to help coach less experienced designers through the decision-making process.

Sally: We have an extensive mentoring program and staff trainers.

Tom: There should be a link between what we're talking about and what's happening in academia; students should be coming out of schools with the right knowledge.

Q: What are your perceptions of value engineering as it relates to flexibility and right-sizing?

Brian: We conduct value engineering as a two-day process on every project over $10 million.

Mark: Value engineering looks at the technical aspects of the project, whereas value analysis also looks at the non-technical issues. Value analysis is really where we're going with a more inclusive evaluation of the purpose and need.

Tom: I think value engineering and CSS can sometimes conflict. I get concerned about the value engineering process when you have a strike force that comes in and changes a two-year process.

Sally: I think it really depends on who is the facilitator.

Dennis: The problem is value engineering tends to look for things that are strictly in the purpose and need of the scope. Many times CSS won't directly apply, but will have helped bring the project along.

Kathryn: We look at it differently. If a value engineering proposal is rejected, it must go through the director.

Q: Bridges have a design life of 75 to 100 years, so how did you address the expansion of bridge widths to accommodate possible future need?

Brian: We made the 3R roadway width the minimum bridge width.

Kathy: We split our system into two parts, major and minor. We said we're never going to expand our minor system, so we simply put the bridge back to match existing criteria. We typically do not build a bridge wider than we need to. If we believe there is going to be growth, we build a bridge we can expand in the future.

Tom: When we replace bridges, we replace them to the roadway width.

Q: How strongly do you encourage or discourage design exceptions?

Brian: We use them when it is appropriate, and when you do, it must be documented.

Kathryn: I think they're a good thing. We encourage them and require documentation if the design falls below or above the standard. It's not permission to do something wrong, it's just laying out the reasons for deviating from the standard.

Tom: I don't like the name, but I do like them. I think it should be called design justification.

Dennis: We are neutral, if you do them for the right reasons.

Sally: We use them quite a bit, and call them design deviations.

Mark: We should be looking to elevate the decision-making process to a higher level so the upper management is aware of differences from standard practices, and why they're appropriate in this case.

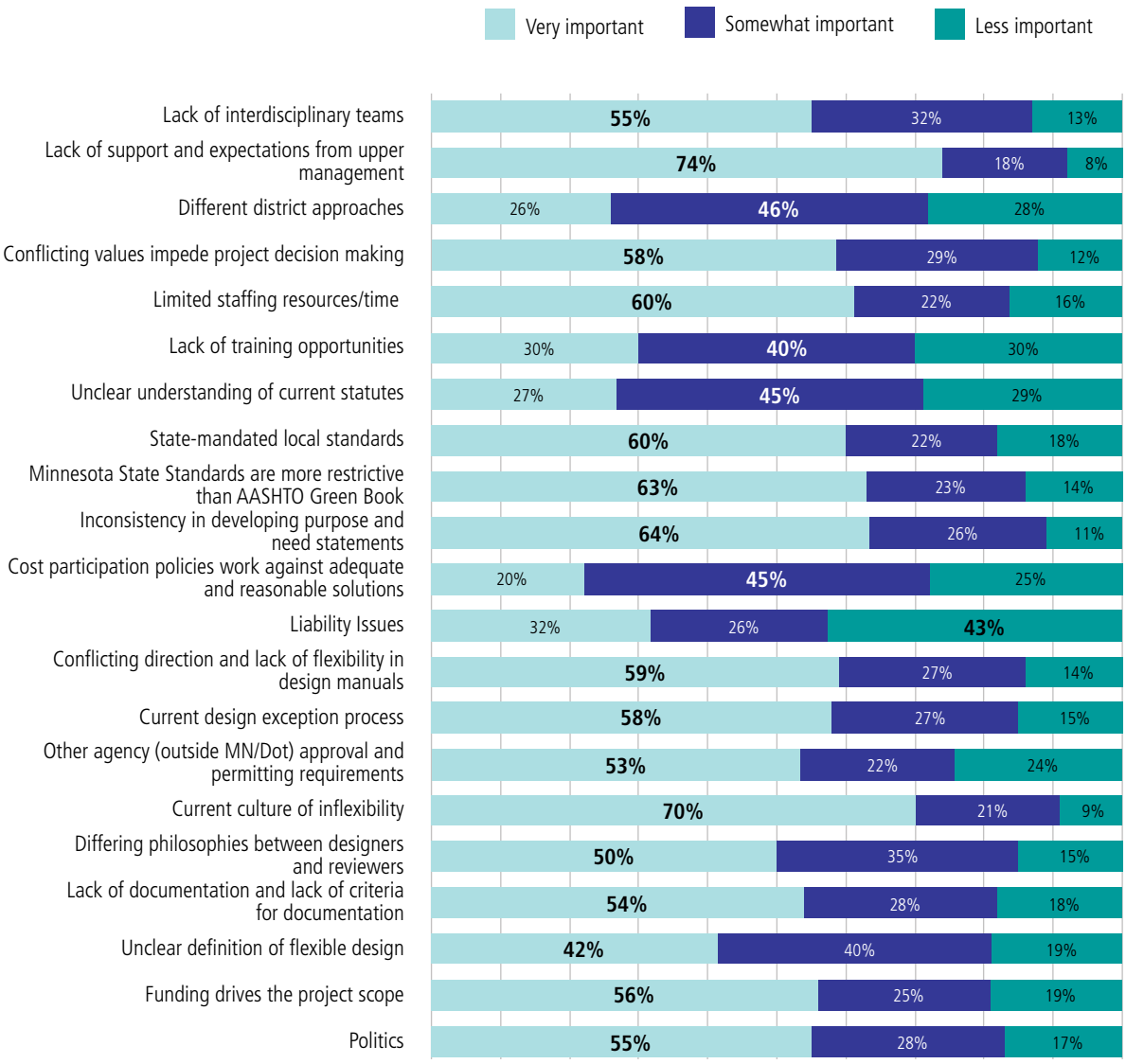
Group Polling Using iClicker Technology

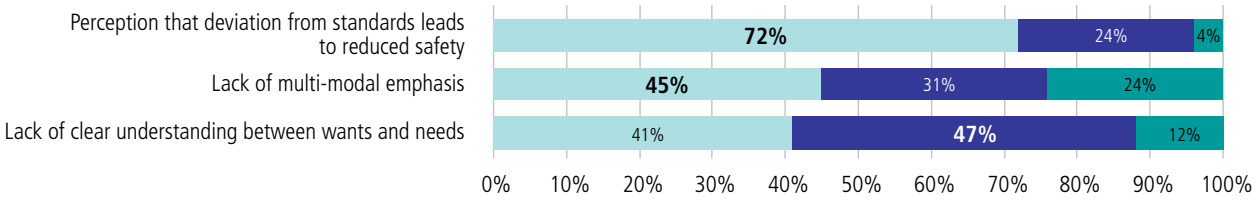
On the second morning of the forum, participants were divided into five breakout groups. A facilitator led each group through a brainstorming session to identify challenges of applying flexibility in design in Minnesota across three broad areas: institutional, performance criteria, and design standards. During a break, members of the forum planning team worked to combine, simplify, and restate similar breakout group statements into a smaller number of more generalized statements. These statements were then used for electronic polling among all participants when they reconvened in the general session.

The following 61 challenge statements and electronic polling response were the outcome. However, a number of participants felt combining and restating the breakout group work adversely affected the clarity and context of the original statements, thereby affecting the value of some of the large group electronic polling responses. The original challenge statements identified by the five breakout groups are included in Appendix B.

Institutional challenges

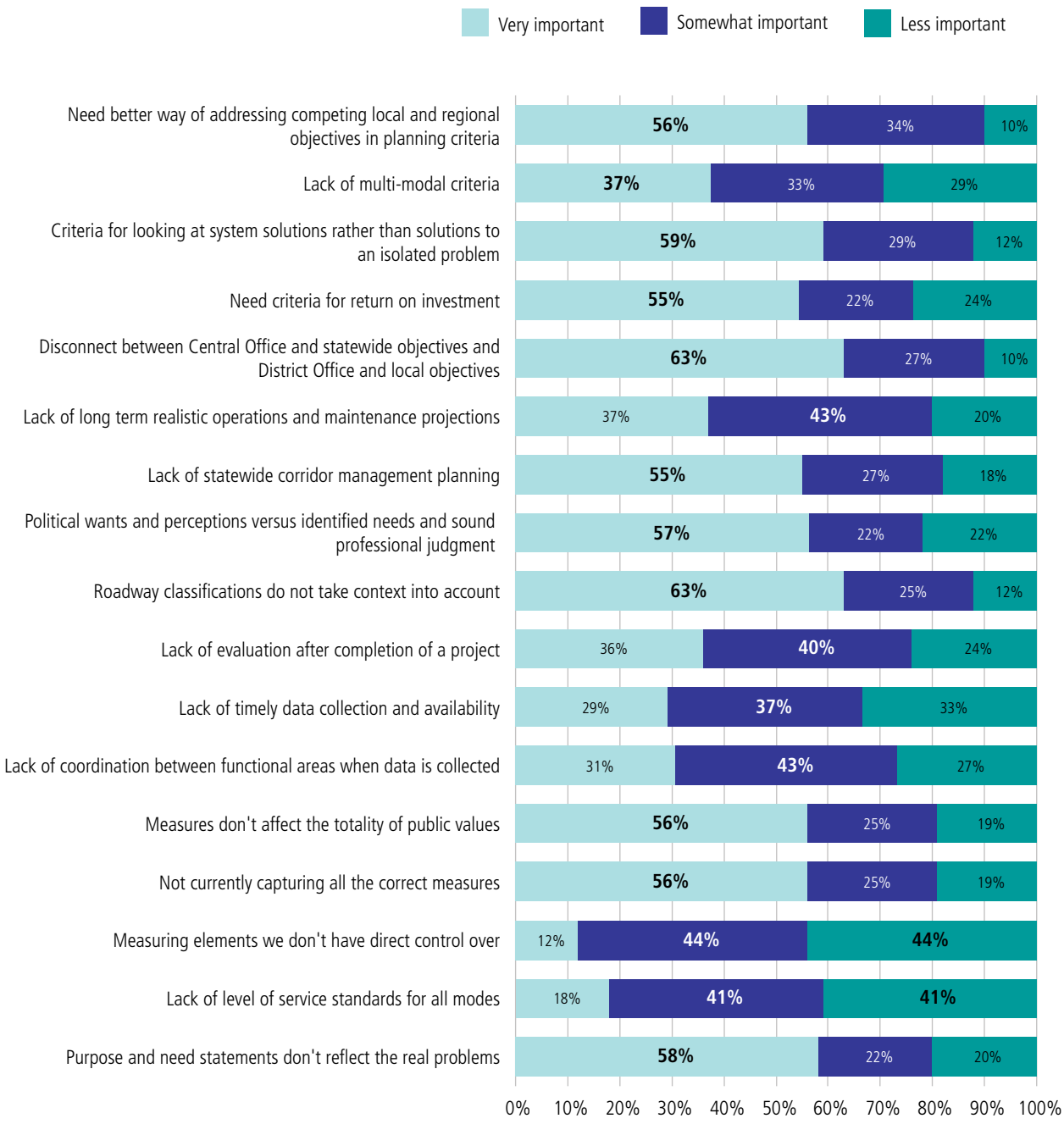
Question: What do you think are roadblocks or challenges to implementing more flexibility?





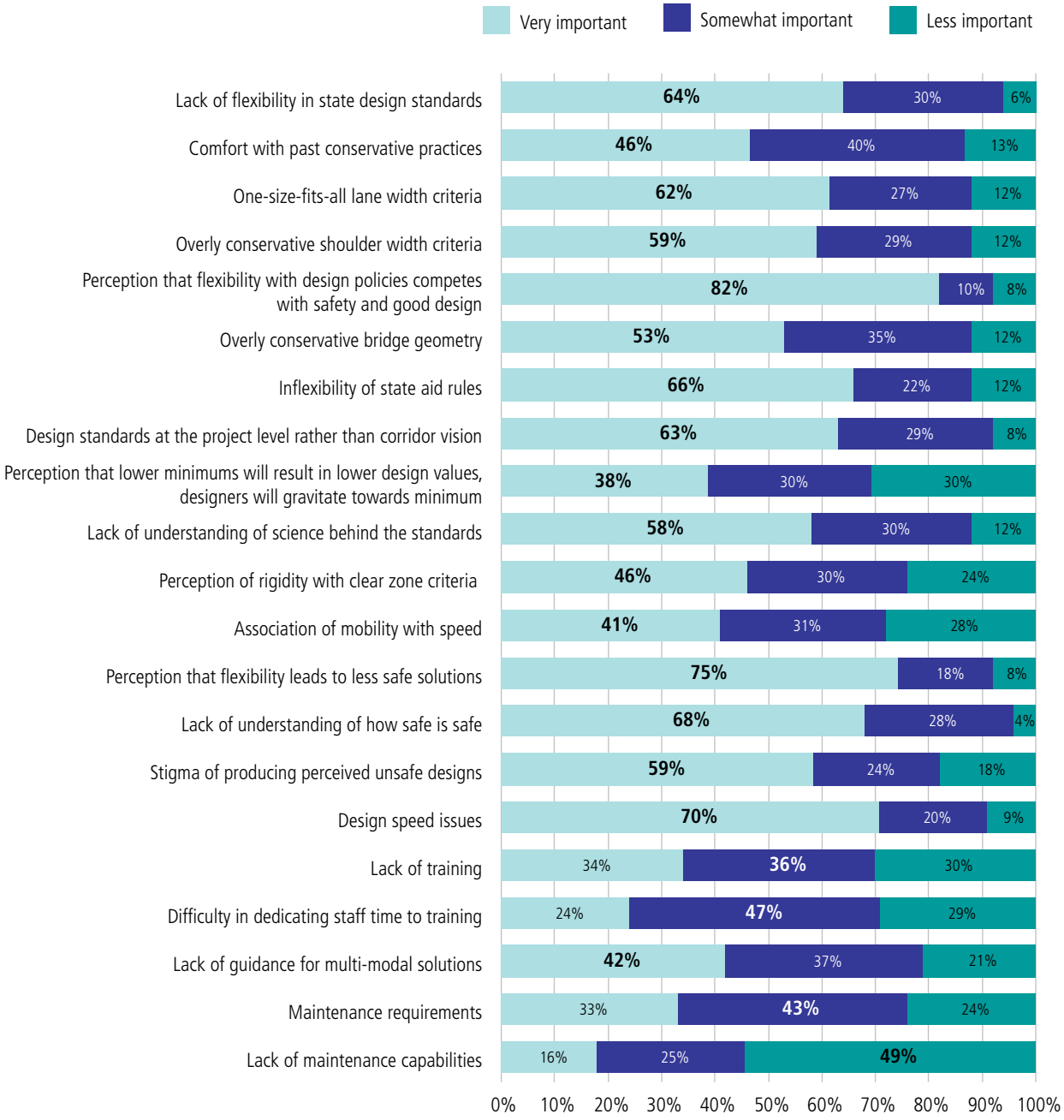
Performance Objectives

Question: What are the limits, roadblocks or hurdles to implementing flexible design?



Design Flexibility

Question: Where and how are current design standards getting in the way of good decision making?



Appendices

Appendix A: Speaker Biographies

Sally Anderson - Roadside and Site Development Manager

Sally Anderson is representing Washington State Department of Transportation.

Sally attended Washington State University and graduated in 1977 with her degree in Landscape Architecture. She became licensed as Landscape Architect in Washington State in 1983. Sally has worked for WSDOT since 1978.

Prior to her current position working in the Headquarters office, Sally was the manager of the Landscape Architecture & Roadside Management Office in the Northwest Region, an area encompassing the Seattle metropolitan area, where she was actively involved in planning, design, construction and management of roadside elements. Her work included many aspects of project design pertaining to roadside functions, environmental analysis and mitigation, and the integration of the CSS process. In her role with the region, Sally was involved in CSS from the ground up and has worked on many teams to assure the success of the program.

Sally currently works as the manager of the Roadside and Site Development Section in the Environmental and Engineering Programs Division of WSDOT headquarters in Olympia. Her office provides leadership and policy for effective and responsible statewide roadside management. She is involved in issues dealing with sustainable roadside and site development, storm water and water quality using low impact development, visual quality, environmental mitigation including wetlands, streams and steep slopes, and pedestrian and bicycle design including ADA compliance. As an emerging issue, her office is also involved in response to climate change through adaptation and mitigation. Sally advocates for livable communities and a sustainable environment through management of the roadside as a resource, and the integration of transportation facilities in context with the surrounding landscape.

Thomas A. DiPaolo - Assistant Chief Engineer

DiPaolo has worked for the Massachusetts Highway Department for more than 22 years. He spent his first six years as a design engineer in one of the department's district offices before relocating to the Boston headquarters in 1992. In the Boston office he worked as a Project Manager overseeing consultant designs and in the Highway Engineering office prior to becoming the Assistant Chief Engineer in 1998. Specific duties include serving as Chairman of the department's Architects and Engineers Review Board, working with the local chapter of the American Council of Engineering Companies on project design and contracting issues, and assisting in the development of various department policies and initiatives, especially those related to design standards and design issues.

Tom received his Bachelor's Degree in Civil Engineering from Lafayette College in 1986 and is a registered Professional Engineer in Massachusetts.

Dennis German - Chief, Community Design Division

Dennis German is Chief of Maryland State Highway's Community Design Division. Dennis's 30-plus year career in engineering highway improvements in Maryland includes managing the design of the I-68 Freeway in Western Maryland, I-270 corridor linking western commuters to the District of Columbia, the I-95 Fort McHenry Tunnel under Baltimore's Harbor and numerous urban roadway projects in

Baltimore City. For the last 13 years he has led the effort at State Highway to establish the Neighborhood Conservation Program/Community Safety and Enhancement Program, a key effort in Maryland's nationally recognized Smart Growth Program. This rewarding endeavor is a major contributor to SHA's Thinking Beyond the Pavement effort and is helping bring important changes to over 140 communities in Maryland.

Brian Hare - Division Chief

Brian Hare is the Division Chief of the Design Services Division of the Pennsylvania Department of Transportation. The Design Services Division provides a wide range of services in the project delivery process. We offer photogrammetric services including aerial photography and digital mapping; acquire consultant services; write engineering agreements; manage right-of-way acquisition, railroad grade crossing liaison and utility coordination for transportation projects; issue right-of-way and utility clearances; review and develop bidding packages for contractors; and perform low bid justifications and construction contract award activities. The Division is comprised of the Consultant Agreement Section, Contract Development and Award Section, Utilities and Right-of-Way Section, and the Photogrammetry and Surveys Section.

Additional activities include operational guidance, technical assistance, and the development of engineering policy for statewide design services activities.

We strive to maintain close working relationships with our Engineering District partners, as well as our engineering consultants and contractors.

Kathy P. Harvey - State Design Engineer

Harvey is a 1979 graduate of the University of Missouri at Rolla and a registered professional engineer in the state of Missouri. Harvey spent 12 years in private practice in Colorado and Missouri before joining the Missouri Department of Transportation in 1991. She has held numerous positions during her time at MoDOT, all in design, and was promoted to State Design Engineer in 2005. As State Design Engineer for MoDOT, she has responsibility for MoDOT's Engineering Policy, the monthly construction lettings, environmental and historic preservation services, photogrammetry and surveying, CADD support and design expertise.

Kathy and her husband live outside of Jefferson City and have only one of their six children left at home.

Dwight Horne - Director of Program Administration

Dwight Horne is the Director of the Office of Program Administration in the Federal Highway Administration's (FHWA) Headquarters in Washington, D.C. and is responsible for providing leadership, direction, coordination, and guidance in development of national policy and procedures to assure conformance of a variety of specialized activities with provisions of Federal-aid legislation and regulations. He has a Bachelor of Science (B.S.) degree in Civil Engineering from the University of Florida. He joined the FHWA in January 1971 and has had division office assignments in Arkansas, Connecticut, Florida, Georgia, Mississippi, New Jersey, and Texas. Also, he worked in the FHWA's former Region 1 office in Albany, New York and the former Region 4 office in Atlanta, Georgia. Mr. Horne served as Director of the Office of Highway Safety Infrastructure, Chief of the Federal-Aid and Design Division, Region 1 Deputy Regional Administrator, and Connecticut Division Administrator. He has more than 30 years of experience with highway programs and technologies.

Nikiforos Stamatiadis - Professor of CE/Transportation

Dr. Stamatiadis is a Professor of Civil Engineering at the University of Kentucky. He has completed three NCHRP and several state-funded research grants dealing with Context Sensitive Solutions. He has published several articles in journals and has authored and co-authored several reports. He was involved in establishing Kentucky's CSS training program in 1998 and has been involved in CSS since the beginning of the concept. He is currently serving as the Chair of the TRB Subcommittee on Self-Explaining Contextual Geometrics and he is the new chair of TRB Task Force on Context Sensitive Design and Solutions.

Mark Taylor - Safety/Geometric Design Engineer

Joined FHWA in 1974

Education: Bachelor of Science, Civil Engineering, Virginia Tech

Expertise/Specialty

- Geometric Design
- Preparation of Plans, Specifications, and Estimates
- Context Sensitive Solutions
- Project Management
- Safety Design
- Roadside Safety
- Safety and Operational Effects of Geometric Design

Professional Associations

- Member, TRB Committee on Geometric Design (AFB10)
- Member, TRB Committee on Visualization (ABJ95)
- FHWA Liaison for the NCHRP Project 25-29A, Guidelines for Design and Management of Historic Road Corridors
- FHWA Liaison for NCHRP Synthesis 40-08, Traffic/Speed Calming for High- to Low-Speed Transitions

Professional Highlights

- Design Functional Discipline Leader, Federal Lands Highway, Lakewood, CO
- Project Development Engineer, Central Federal Lands Highway Division, Lakewood, CO
- Highway Design Manager, Central Federal Lands Highway Division, Lakewood, CO
- Project Manager, Central Federal Lands Highway Division, Lakewood, CO
- Area Design Engineer, Central Federal Lands Highway Division, Lakewood, CO
- Preliminary Design Engineer, Central Federal Lands Highway Division, Lakewood, CO
- Assistant Area Engineer, Arkansas Division Office, Little Rock, AR
- Graduate, Highway Engineer Training Program (HETP)

Appendix B: Breakout Group Session Notes

On the morning of Tuesday, February 23, the larger group split into five separate breakout groups to identify design flexibility challenges in Minnesota. Notetakers documented the issues each group identified; what follows is the compilation of those notes.

Breakout Session One: Institutional Challenges

Question: What do you think are roadblocks or challenges to implementing more flexibility?

Gold Room

- Staff moves around and promises are not always met. Construction might not be aware of promises that the planners or designers might have made.
- Define the difference between needs and wants. Not promising on the wants at the beginning of the project. Can't deliver everything.
- Not enough public involvement in the front end (before the STIP). Not enough time to get input.
- Inconsistent on developing the purpose and need statements for projects.
- Not a clear definition for flexible design and right-sizing and figuring out the right size fix for the problem.
- Getting a comfort level from the employee.
- Not enough training in Highway Design, Highway Capacity Manual, Roadside Design Manual. Flexibility Training for Engineers.
- Not enough knowledge of the standards.
- Confusion between guidelines and standards.
- What is the difference between guidelines and standards?
- Defining context.
- Need long-term commitment and strong support from upper management.
- When leadership changes you might get new ideas.
- Who has the authority for decision making?
- Definitions of roles and responsibilities on the project.
- Variations in Districts, Divisions and Offices.
- No consistency from office to office or person to person.
- Who is doing the design (engineers or technicians)?
- Political projects versus non-political projects.
- Encouragement to go with the safest route.
- FHWA approvals and standards.
- Review and approval time frames.
- Permitting Process is lengthy and changes from agency to agency and may be too prescriptive.
- Municipal Consent Rule inhibits flexibility but pushes toward compromise because of competing needs from other stakeholders.
- MnDOT Standards. Definitions between guidelines and standards. Better documentation of deviations from these and a better understanding of the design exception process.
- State Aid Rules
  - Some are less stringent and some are more stringent
  - Variance process is to long
  - Authority (Commissioner or Committee)
  - Differences between MSA-CSAH and TH Design Standards
- Design Exception Process
- Liability.
  - Obstacle in seeking variance.
  - Is the liability issue real or perceived?

  - How to document changes, who does it, who wants the responsibility?
- Design to overcompensate.
- Education, enforcement, emergency response—we forget the value of these.
- Need more emphasis on multiple modes.
- Emphasis on preserve but pressure to expand.

AI Johnson Room

- Culture of inflexibility (just following the book) and fear of being sued or opposed.
- Comfort level with deviation from standards/signing off on deviation.
- Perception or assumption that deviation leads to reduced safety/quality.
- Lack of understanding of what modifications mean.
- Lack of clarity about which standards are eligible for deviation versus what's not negotiable.
- Need clear understanding of what is in statutes / definitions.
- Ideal solutions take longer to implement, thereby delaying benefits.
- State aid standards/rules based on solutions versus law
- Need allowance for "gray area" decisions—what can and cannot be negotiable. Design exceptions.
- Rigid standards—overdesign on rural roads.
- Differing philosophies between designers and reviewers. Reviewers always win. Designers are closest to customers. Designers have little discretion in conflicts with reviewers. Design engineers make key design and plan decisions, but no discretion on project elements.
- Reviewers too remote for meaningful dialogue / collaboration on deviation. "Process is backwards."
- Criteria viewed as "silos" as opposed to how they interact with each others.
- Lack of interactive design tool/model.
- Need local/regional flexibility. E.g., regional driving behavior is a factor, as is percent of trucks.
- Some missing factors (or silos), such as truck traffic and parking lane width.
- Forced into recreation/political standards. Worry about potential lawsuit. Public fervor/politics can override sound engineering without good documentation.
- Bias against non-motorized. Design standards conflict with multimodal. "Can't plow it." Too much bike lane in rural.

Ski-U-Mah Room

- How to make multidisciplinary into interdisciplinary?
- Lack of mentorship/leadership for project managers to identify roles and responsibilities.
- Breaking down the silos of Mn/DOT's organization.
- Different district approaches to the same projects.
- Top-down approach requires upper level participation.
- Conflicting values. How do we trade one project value for another? Who makes the decision?
- Limited staffing resources and training to deliver programs.
- Purpose and need not closely linked to public need/value and other internal needs.
- Not a clear direction on mode priorities.
- Cost participation.
- Funding drives the project scope.
- Conflicting design direction between manuals.
- Hard time incorporating public value.
- Operating in crisis mode.
- Misunderstanding of liability issues.
- Having a common understanding and acceptance of design exception.
- FHWA or other agency approvals.

Minnesota Room

- Buy-in of employees requires a top-down approach.
- Design expectations, top-down to the central office, what is the central office role? Districts more willing to be flexible.
- Different culture between central and district office. Local perspective.
- Within a district, you develop a plan, fear of liability.
- MN manual is prescriptive in allowing flexibility.
- Culture is treated like a "bible." Design exception mode causes delays, not clear.
- People do not like change or choose not to change. Accepting other ways to do things.
- Misconceptions on what the "other" person wants. Maintain control.
- Starting something new causes "fear." People don't want to start something new.
- Local state aid is a separate issue. Loosen control on state aid standards.
- Term design exception not clear.
- Managers unwilling to change.
- Municipal consent
- Told what to do, but not explained why.
- MN State conservative compared to Green Book.
- State law prescribes standards at local level.
- Is design exception the only flexibility allowed? Barrier? If MN adopted a more expected design standard, then more flexibility.
- Criteria limits the designer, design exception approval.
- Need more data regarding design so person signing for approval understands what they are signing.
- Politics can be a barrier. Promises made.
- Meeting schedules and getting projects out the door as fast as possible can cause barriers, fear of spending too much time on something new.
- Lack of diversity around the table, look at it more as a project team, multi-disciplinary. Constantly revisiting issues is a barrier.
- People changing jobs, so records are difficult to find. How is documentation stored? Promises made earlier, what happens to the promise when someone leaves their position?
- Electronic filing system used, but not everyone uses it. Project Wise might need to be utilized better. Assign someone specific to a specific project file.
- Overall staffing. Too many projects, lack of staff an issue.
- More project management.
- More exchange needs to take place from central office. People can understand each other better. Rotation or job exchange needed.

Maroon Room

- FHWA Standards Enforcement.
- Reluctance of Designers to consider design exceptions.
  - Liability, thinking out of the box, tradition, culture.
- Limited time for design to craft solution.
- Technical driven design.
- History with design exceptions.
- Perception/Reality of likelihood of design exception approval.
  - Consequences
- Time factor of design exception approval.
- Performance measures.
- Resistance to only "good" vs. best/standard solution.
- Incremental cost of "better" or standard solution.
- Not seeing the big picture.

  - Divided organizations.
- Functional groups with absolute authority.
- Systemic perspective (or lack thereof), by various parties.
- Design Standards.
  - Some not all, safety, specific issues, special cases/scenarios, institutional experience, qualifications.
- Design standards hindering not helping.
  - Not just design, permits, access, developers, cuts across everything done with public, programming around standards.
- Need for training.
- Risk-adverse organization.
  - Failures tend to be catastrophic, fear of liability, legal issues, career advancement.
- Funding for CSS solutions.
- Cost participation policies.
- Using design standards across spectrum of working with public, etc.
- If we are going to jeopardize our standards why don't they? One size doesn't fit all.
- Public perception/acceptance of "inadequate" solutions, unsafe solutions.
  - Education, flexible and reasonable.
- Education barriers with public.
- External partners
  - Ex. Metro transit
- Maintenance needs
- Corridor or district consistency.
- Corridor prioritization (or lack).
  - Politics
- Municipal consent.
  - Flexibility.
- Environmental law and agencies.
  - Using standards to negotiate.
- State aid rules.
  - Liability, some like, some dislike.
- Lack of system wide goals and measures.
- Tradeoffs, interpretation, climate and economy (impact and expectations), leadership, acceptance and awareness.

Breakout Session Two: Performance Objectives

Question: What limits, roadblocks, or hurdles are created by the criteria we currently use for making planning and design decisions?

Gold Room

- Performance measures in statewide plan
  - Travel time in inter-regional corridor plans
  - Interpretation that applies too broadly
  - The context is not always considered
- Planning process should reflect objectives of local MPO's, cities, counties
- Municipal consent—needed even when reducing lanes
- 20-year forecasts
  - Assumptions
  - Need validation
  - Not reflecting current or future change
- Multimodal criteria needed.
- Consider all modes in safety analysis.
- Preservation versus expansion.
- Tie funding to all modes—if you want all modes, then you should be open to paying for all modes.
- Functional classification serves different functions in different context.
  - Multiple needs and objectives
- Early connection with all involved.
- Do we understand public expectations?
- Understand what the real problem is.
- Look at whole system and not just the project.
- Public perception is different from reality.
- People adjust routes based on travel times and experiences.
- Has Level of Service considered flex-time, transit, bike/pedestrian?
- Criteria when to look at the isolated problem and look at the entire system solution
  - Look at all alternatives
  - Look at how people travel
  - Use of complementary systems (local roads)
  - Short trips using freeways
  - Look at network/operational solutions
- Multimodal cost-benefit analysis.
- Criteria for Return on Investment
  - travel time
  - crash reduction
  - system benefit versus project benefit
- Look at network (including local roads) solutions.
- A specific group to look at system-wide solutions. Project Managers cannot do this.

AI Johnson Room

- Lack of district discretion and autonomy. Discretion and autonomy impeded by investment and management goals/criteria.
- Some corridor opportunities will never reach fruition due to current situation—investment management criteria.
- Lack of long-term realistic operation and maintenance cost projections. Build things that cannot be maintained. Asset management/preservation is not balanced with planning and project development

… investment sustainability. There is no definition of specific elements needed as support infrastructure (e.g., truck stations, snow plows).
- Minnesota needs a "1 perfect project vs. 20 good projects" debate.
- Purpose and need in performance goals are more flexible versus our mindsets.
- Statewide 20-year plan (which really is a program) framework goals and measures do not address regional needs well.
- Lack of statewide corridor management plan. Lack of corridor-wide goals (or plan).
- Align design decisions with project goals as opposed to functional class standards.
- Roadway classifications do not take context (beyond urban versus rural) into account. For example, Minnesota, compared to other states, has a cumbersome array of tables of standards that provide little flexibility. "Typing" a road brings better flexibility.
- With multimode, unsure where to give priority. Seems to always be given to personal vehicles.
- Difficult to address level of service issues for "other" modes and to model demand.

Ski-U-Mah Room
- Measuring for measurements sake.
- Need someone to declare key measures for decision purposes.
- Measuring elements we don't have direct control over.
- Measures don't reflect the totality of public values.
- Lack of coordination between measurements.
- Measures don't include other modes into decision making process.
- Reluctance to measure elements that may have an impact on other measures.
- How is the data collected? Data collection seems to be subjective.
- How do we ensure measures align with public and internal values?
- How to do what the majority wants without infringing on the rest?
- How do we measure different mode priorities?
- How future operations influence decision making.
- Level of service drives us to the more costly solution.

Minnesota Room
- Political versus identified needs.
- Things not evaluated on a state-wide system. Spread equally across the state.
- Gap of knowing what state priorities are—these need to be clear. Taking away from preservation priority to use in other areas. Top priority depends on district.
- Big change to proactive versus reactive. Big shift.
- Decision on solutions made prior to reviewing alternatives. Lack of consistency.
- After the project is complete, do we evaluation the situation? Did the project work? Analysis might not happen because of limited costs. Money needs to be set aside for evaluation after the project is complete. Operation side. Emphasis on front-end. Did we solve purpose of the need? Not a priority to find out why. Identify in scoping documents, upfront.
- Project development process need to include performance measures.
- Designers should consider coming back to the community and discussing the project with community members. Need to "close the loop" on the project.
- There doesn't seem to be a closure in projects. Public side.
- Other modes are not considered in projects. Need to address this more.
- Continuous training on addressing other modes is needed.
- No formal process in addressing other modes of transportation. Designers not always thinking about these other modes, or choose not to think about. Should be at the forefront of project. Multi-function. No formal process of pedestrian review. More discussion needed for designers.

- Required to implement pedestrian specifications in projects that might not make sense. Hard sell. Who do you listen to?
- Lack of specific process
- Life-cycle cost analysis, usefulness?
- Strategic direction can be used to bring focus.
- Is preferred alternative the barrier? The criteria development is very engineering but not holistic. Engineers might not need to be driving the issue. Barrier is the organizational structure. Not involving multidisciplinary.
- Too one-sided, need the balanced approach.
- Not embracing value engineering.
- Functional classifications not defined.
- Those setting decisions and needs can be a barrier.
- Communication barrier.

Maroon Room

- Hourly and seasonal peak traffic.
- We keep building to receive peak hour traffic level of service "E."
  - Can't build our way out of congestion, plan for failure, educate public.
- FHWA planning requirements (MPO and municipal consent), institutional barrier.
- Performance criterion doesn't capture project value.
  - Keep performance objective in mind when making decisions at all levels, inconsistent performance goals, rigid goals (unreasonable).
- No specific safety goals.
  - Predictability.
- Lack of higher-level goals and objectives statewide and on corridors.
- No measure of cost effectiveness for tradeoffs.
- Decisions made on spot basis, rather than from system basis.
  - Systematic fixes, low cost compared to adding more lanes (buying more time), not easy increments.
- How do you define corridors?
- Functional class can be conflict with reasonable design approach or CSS.
- Design of elements (e.g., shoulder width) based on ADT is a moving target.
- Speculative design-to greater than 20 year needs.
  - Past is not good forecast for the future.
- Planning difficult between different regions and rural/urban.
  - Weighing urban/rural mobility versus capacity, political.
- Inconsistent measures from administration to administration.
  - Feast or famine, preservation mode.
- Lack of quantifiable safety measure.
  - How do you get there (difference in opinion), what impact are you having?
- We say we're not going to chase fatal crashes, but we do.
  - You can demonstrate they are low cost, how can you demonstrate they are effective, spot-fixing problem intersections, individuals design preferences?
- Competing standards that can inhibit things like rumble strips.
- One-size-fits-all lane-width criteria.
- Design speed versus posted speed versus operational speed conundrum.
- Horizontal sight distance criterion can be unreasonable to achieve.
  - What is the risk? Glare, sight distance or object in road the issue.
- Questionable value of clear roadside concept.

Breakout Session Three: Design Flexibility

Question: Where and how are current design standards getting in the way of good decision making?

Gold Room

- Public doesn't understand functional classification and context.
- Guidance needed for setting multimodal priorities.
- Lower design speed than posted speed equals safety issues.
- Posted speed is a political issue.
- Fit design speed to design rather than other way around.
- Start with old plans or existing conditions.
- Set design speed in scoping discussion and rely on old plans and existing conditions.
- Who and how do we decide design speed.
- Desired operating speed versus design and/or posted speed.
- We should consider guidance from other states.
- Lane widths on principal and minor arterials.
- Shoulder width—in slope, usable shoulder, paved versus gravel.
- Clear zones have flexibility (community desires regarding what an obstacle is, what are the safety implications?).
- Preference for open clear zone and not much guardrail.
- Maintenance expectations are very high.
- Need connection between designers, LAs, contractors, and maintenance.
- Designer needs to understand basis of standard vs. guideline.
- Taper standards.
- Appropriate access requirements.
- ADA requirements.
- Bridge shoulder standards.
- Other agency standards and/or requirements.
- Build bridge to future volume need.
- Bridge maintenance requirements.

AI Johnson Room

- Perception that flexibility with design policies competes with safety and good design.
- State aid standards and law.
- Difficult to make "common sense" improvements without red tape.
- Slow receipt of crash data negatively impacts implementation of safety improvements.
- Design standards viewed at the project level, as opposed to corridor system level, particularly upstream and downstream of the project limits.
- Crash data not analyzed enough in the vicinity of areas in question.
- Lack of understanding of crash triggers, which are independent of standards.
- Culture of "what we always do" (e.g., no time spent deciding on a 70 mph design standard) leads to not thinking through some decisions.
- We tend to segregate standards when they are connected.
- Design standard exception process very difficult.
- Lack of understanding of when lane width of less than 12 is acceptable.
- Perception that flexibility leads to inconsistency. Connected is the question of how important consistency is.
- Speed limits are all over the board (as is signage). This is the case even though that all speed limit decisions go to one person (State Traffic Engineer).

Ski-U-Mah Room

- Design guidance is taking away flexibility.
- We continue to build to higher standard.
- We associate mobility with speed. Is that the right association?
- Public perception of solutions. Lack of communication with internal and external parties about the benefits of innovative design concerning safety issues.
- Does staff have the technical knowledge or understanding of how various design elements impact safety and operations?
- What is the right level of design documentation
- Need a process that allows for good decision-making.
- Funding has been driving the decisions whether they are right or wrong.
- The standards can create unachievable outcomes.
- Standard operational practices need to evolve to be more multimodal.

Minnesota Room

- Design standards more restrictive than the green book. Allows flexibility to the designer in different circumstances.
- It takes a long time to get changes in the design manual. Get design manual updated.
- Misunderstood for satisfying purpose and need. Confusion between standard and the need. Standard becomes the obstacle.
- Speeds are misused.
- Origin of standard causes misunderstanding. Origin gets lost along the way.
- Standard might not be the problem. Perception that standard is the problem. Flexibility needs to be in the design or process. Term might be guideline with ranges.
- Tougher to get design exceptions under state aid rules. Liability concern. Culture engrained.
- Standard can't include a technology, too restrictive. Gate-keeping technologies.
- Project type definition can prohibit the "right" fix because they require certain standards.
- FHWA division office barrier to flexibility and design. Inconsistent.
- Need a process to define standards.
- Need mindset to be flexible in accommodating pedestrians, bikes, transit. There should be a need present. Approach and how you think. Opportunities for mode shift.

Maroon Room

- One-size-fits-all lane-width criteria.
- Design speed versus posted speed versus operational speed conundrum.
- In some cases, we are making programming decisions to avoid design exceptions.
  - Resource allocation issues, streamlining effort.
- Lack of knowledge of design standards and what is reasonable.
- Design flexibility training, no curriculum, no expertise to build on, have training and get people to attend.
- Different delivery method for training, having a hard time getting training out.
  - Productivity (initial lack), frustration level, justification on a system wide basis instead of case-by-case.
- Bridge geometry may be overly conservative criteria.
- Perception/belief that design will always gravitate to minimum.
  - Depends on training
  - Setting a single number (min/max) gives no information on how to choose a design value.
  - Regional variability.
- Safety: How safe do we need to make it? (e.g., clear zone application)

  - Is that the goal and objective of the project?
- What will the safety Nazis say?
  - Aren't you in favor of safety? Flexibility dependent upon the objective/goal of project, direction has to come from higher-up (backing from upper management), obligation to make the road reasonably safe.
- Misspent safety money works against safety.
- Design standards imply that a standard design is safe.
- Snow removal/snow accumulation issue adds to costs.
- Bridge inspections on high volume roadways.
- Maintainability of certain feature.
  - Budget and allow for it, designers must be part of the conversation (may make transitions/ tradeoffs easier for everyone).

Appendix C: List of Meeting Attendees

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