

STATES' PRACTICES ON ROUNABOUT SELECTION, DESIGN, AND PERFORMANCE ANALYSIS

September 19, 2016

Lee Rodegerdts
Alek Pochowski
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Today's Presenters

- **Moderator**
Lee Rodegerdts, Kittelson & Associates, Inc.
- **Overview of Synthesis Results**
Alek Pochowski, Kittelson & Associates, Inc.
- **Case Studies and State DOT Perspective**
Andrew Paul, Massachusetts Department of Transportation

NCHRP is...

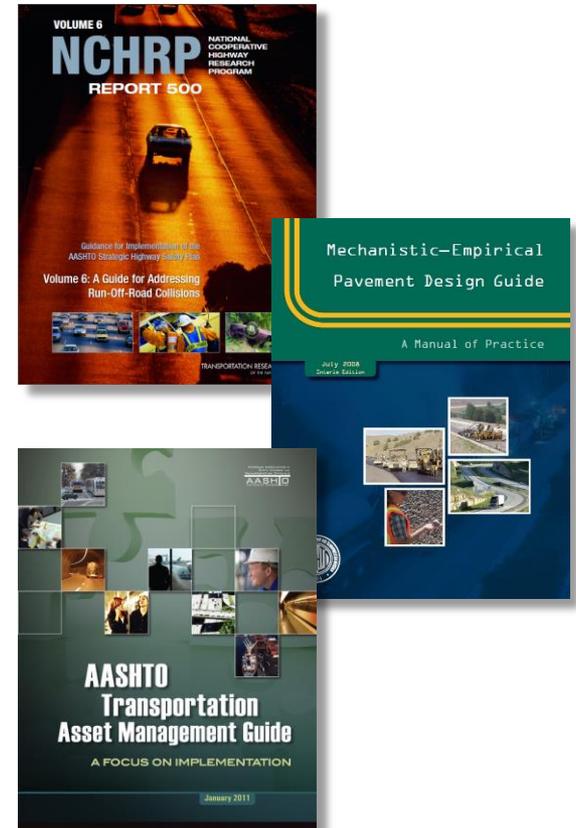
A state-driven national program

- The state DOTs, through AASHTO's Standing Committee on Research...
 - Are core sponsors of NCHRP
 - Suggest research topics and select final projects
 - Help select investigators and guide their work through oversight panels

NCHRP delivers...

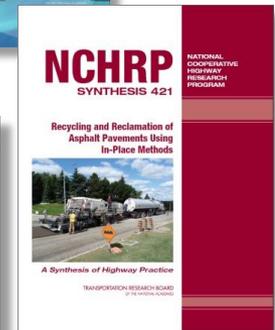
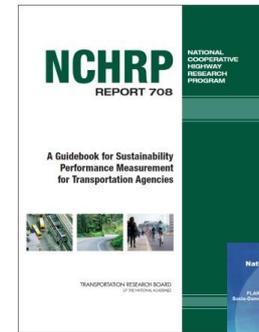
Practical, ready-to-use results

- Applied research aimed at state DOT practitioners
- Often become AASHTO standards, specifications, guides, manuals
- Can be directly applied across the spectrum of highway concerns: planning, design, construction, operation, maintenance, safety



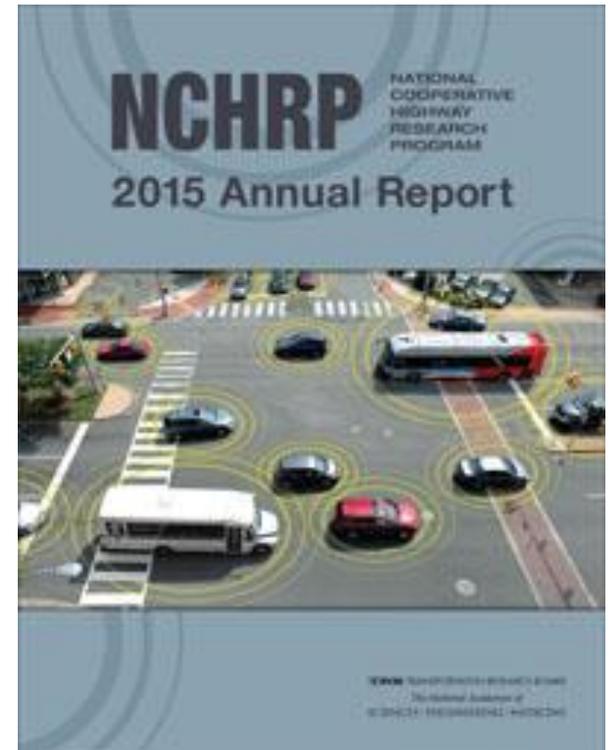
A range of approaches and products

- Traditional NCHRP reports
- Syntheses of highway practice
- IDEA Program
- Domestic Scan Program
- Quick-Response Research for AASHTO
- Other products to foster implementation:
 - *Research Results Digests*
 - *Legal Research Digests*
 - *Web-Only Documents and CD-ROMs*



NCHRP Webinar Series

- Part of TRB's larger webinar program
- Opportunity to interact with investigators and apply research findings.



Sponsoring Standing Committee

- TRB Committee on Roundabouts (ANB75)
- Upcoming webinar:
 - “The Marriage of Roundabouts and Access Management”
 - Monday, September 26, 2016
 - 2:00p-3:30p Eastern/11:00a-12:30p Pacific

Today's First Presenter

- **Overview of Synthesis Results**
Alek Pochowski, Kittelson & Associates, Inc.



OVERVIEW OF SYNTHESIS RESULTS

September 19, 2016

Alek Pochowski

Synthesis Contents

1. SUMMARY

2. INTRODUCTION (Alek)

- Objectives of Study
- Study Approach
- Synthesis Organization

3. LITERATURE REVIEW (Alek)

- Roundabouts in the United States
- Roundabout Policies
- State Statutes, Codes, and Laws
- Public Outreach Efforts
- Roundabout Performance
- Roundabout Design

4. SURVEY RESULTS (Alek)

- Roundabout Selection
- Roundabout Costs
- Public Outreach
- Roundabout Performance Analysis
- Roundabout Design

5. CASE EXAMPLES OF ROUNDABOUT PRACTICES (Andy)

- Roundabout Selection
- Modifications to Existing Roundabouts
- Phased Roundabout Implementation
- Design Vehicle Accommodation
- Accelerated, Low-Cost Roundabouts
- Effective Practices

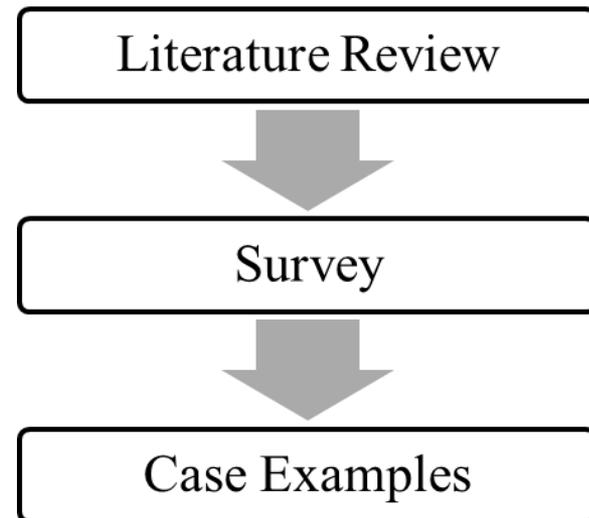
6. CONCLUSIONS (Alek)

- Suggestions for Further Research

Introduction

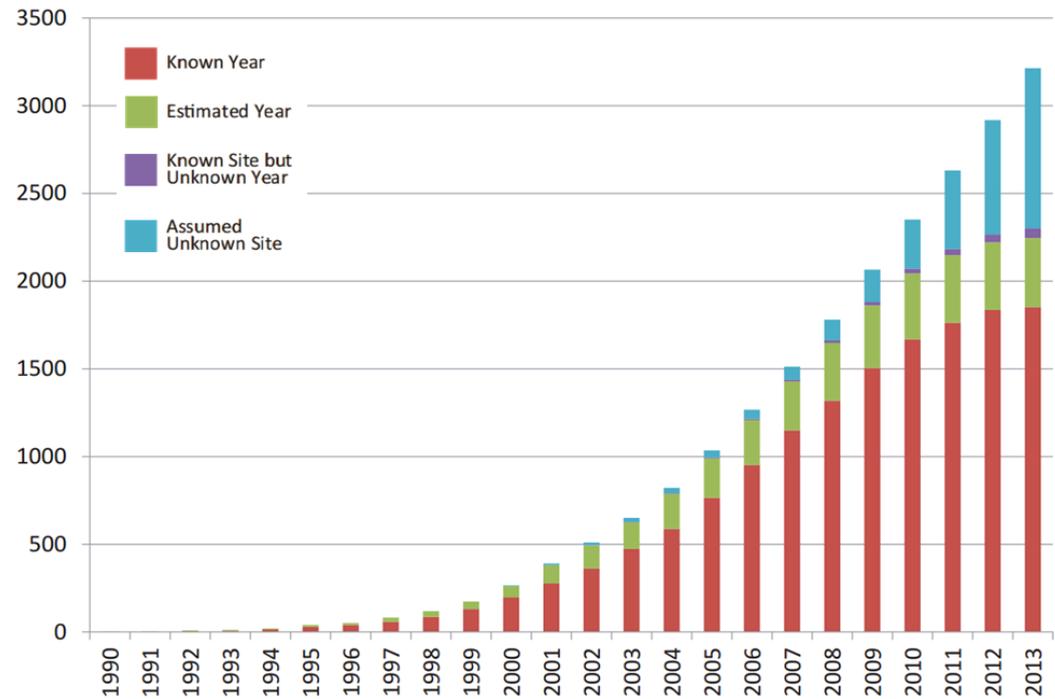
- The intent of the synthesis is:
 - Be a useful reference to agencies that are creating or updating roundabout and/or intersection control policies
 - Provide updated information about current roundabout practices

Approach



Literature Review

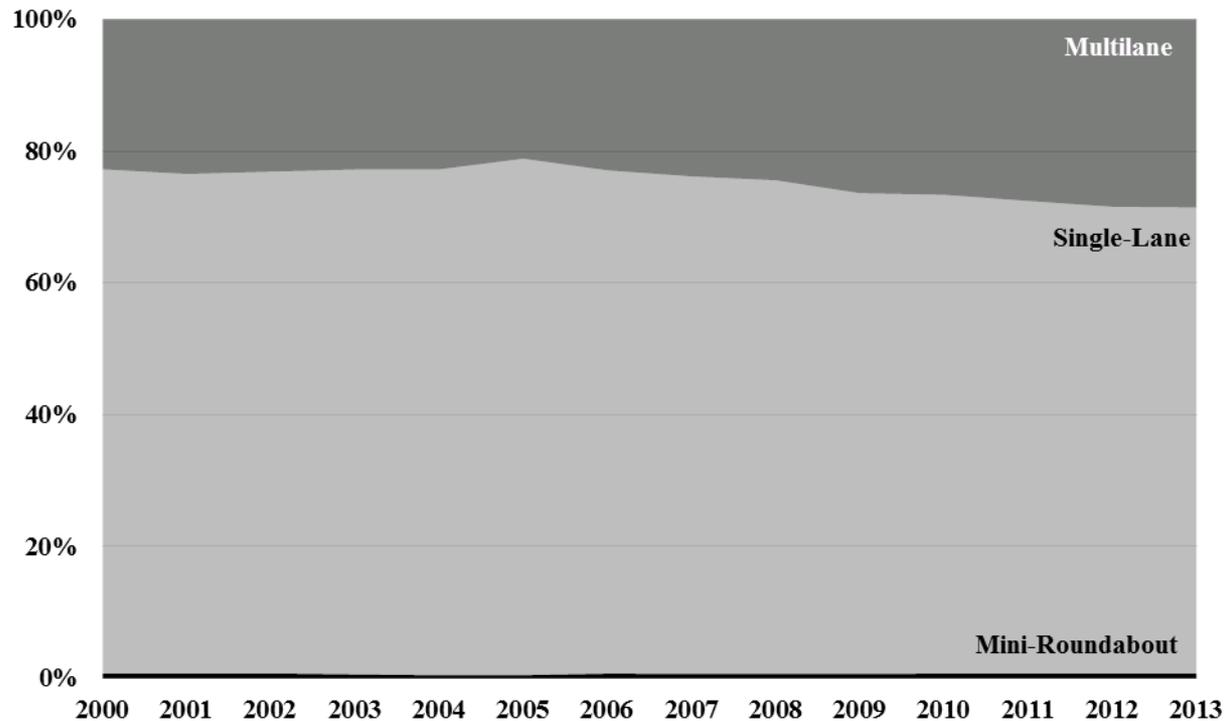
- Approximately 3,200 roundabouts in the United States by 2013
- Compares to approximately 50 roundabouts as of mid-1997 identified in *Synthesis of Highway Practice 264: Modern Roundabout Practice in the United States*
- Roundabouts are now found in every State and the District of Columbia
- In general, roundabouts have been constructed at an increasing rate per year



Estimated Cumulative Roundabouts in the United States

Literature Review

- Single-lane roundabouts have consistently been the most prominent type of roundabout constructed
- The ratio of multilane roundabouts to single-lane roundabouts has increased slightly over the last decade



Cumulative Percent of Known Roundabouts by Type in the United States

Literature Review

- Roundabout policy information updated from 2010 study
- Agency policies, guidance, and practices regarding the selection and design of roundabouts vary across the United States
- Several states have adopted ICE (Intersection Control Evaluation) policies allowing a more proactive method for evaluation

Summary of Statewide Roundabout Policies

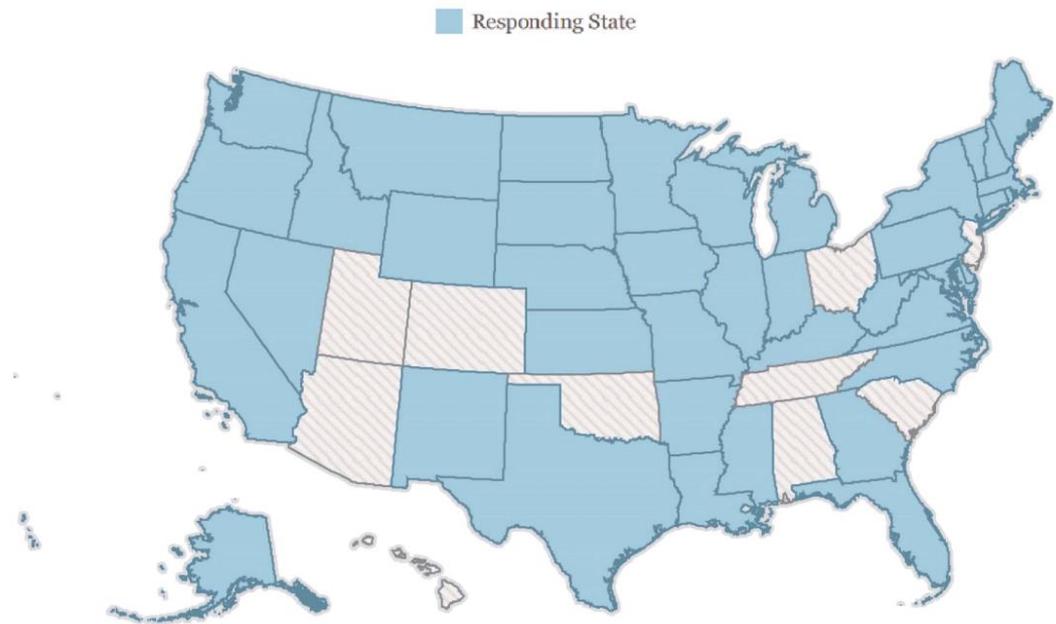
Policy Type	No. of States	%
None	7	14
Allow	13	25
Encourage	18	35
Evaluate	8	16
Preferred	5	10
Total	51	100

Types of Roundabout Policies

Category	Description
None	No policy or mention of roundabouts from the state DOT. Consequently, the state neither encourages nor discourages roundabouts.
Allow	The state allows the consideration of roundabouts.
Encourage	The state encourages the consideration of roundabouts.
Evaluate	The state requires the evaluation of a roundabout alternative.
Preferred	The state requires the evaluation of a roundabout, and justification when a roundabout is not the preferred alternative.

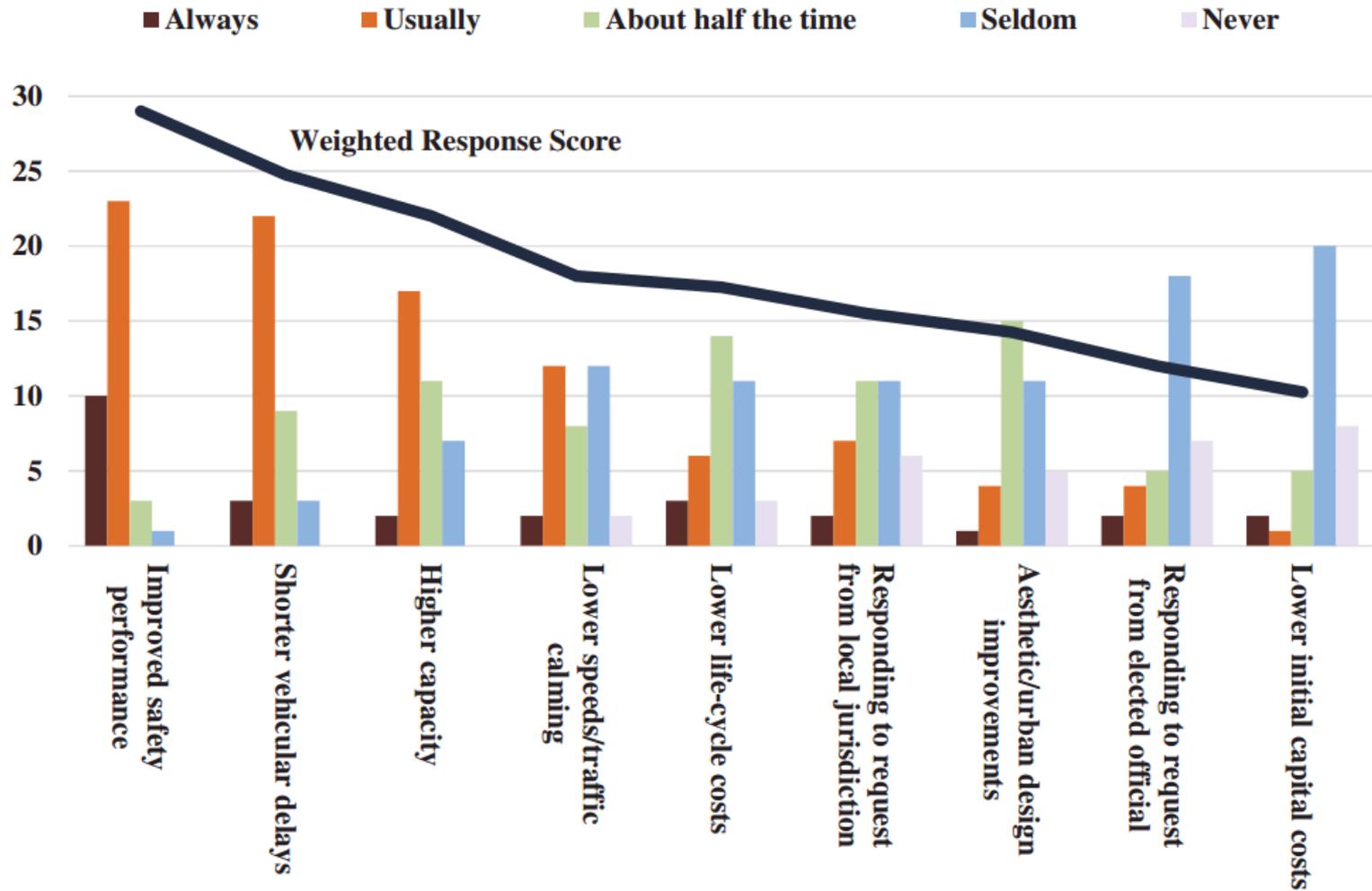
Survey Results

- A questionnaire was sent to the 52 AASHTO member departments
- Responses were received from 40 States
- Of the 40 States who responded to the questionnaire for this effort, **38 States** have a roundabout in operation on the state highway network
- By comparison, the 1998 *Synthesis*, identified only **nine** State agencies with a roundabout in operation, under construction, or in design as of 1997



States Responding to Questionnaire

Survey Results



Number of Responses Indicating the Frequency of the Use of Primary Reasons for the Selection of Roundabouts

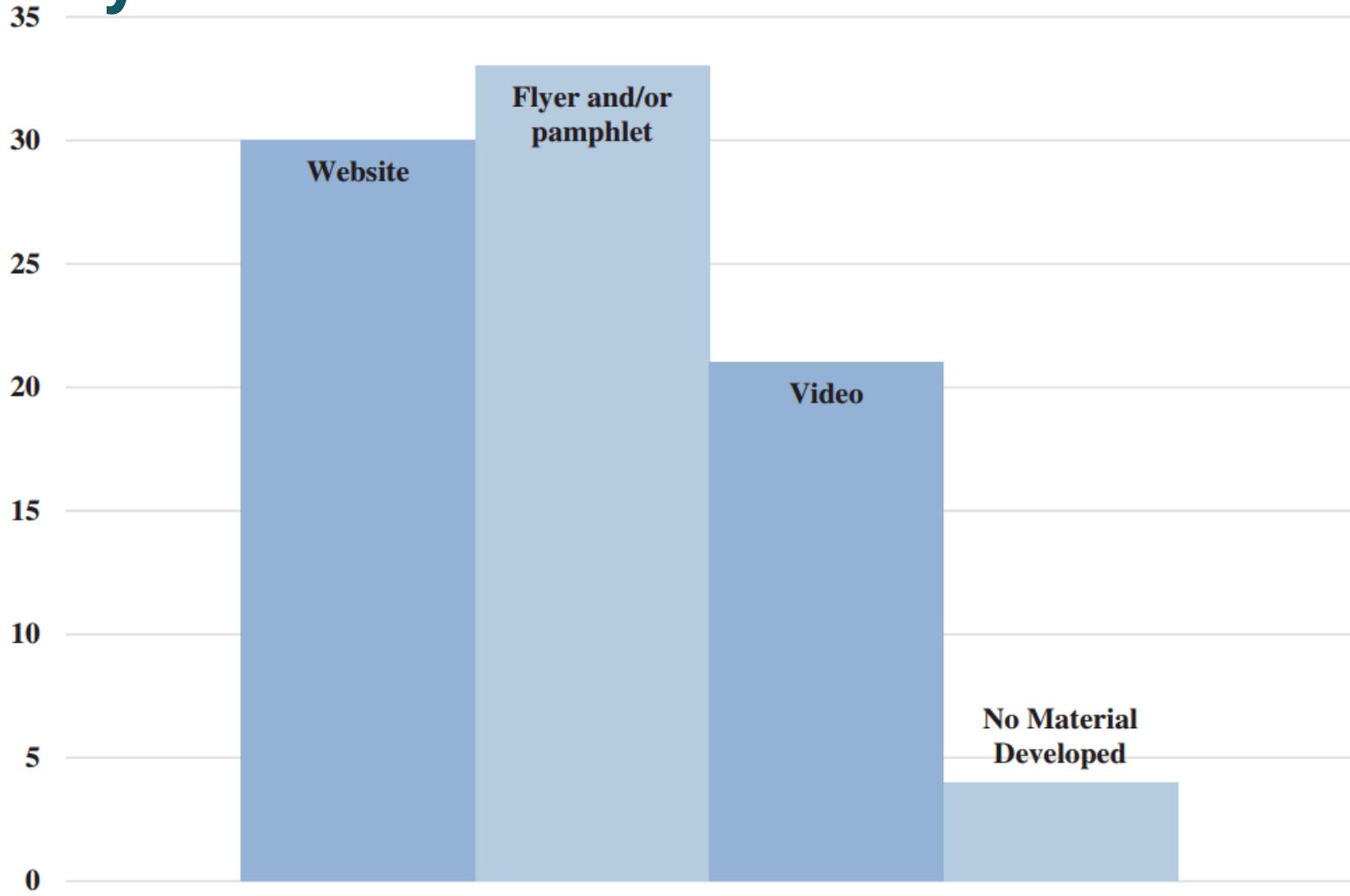
Survey Results

- States provided planning-level cost estimates (screening or feasibility level estimates) for mini-, single-lane, and multilane roundabouts

Planning Level Cost Estimate (screening or feasibility level estimate) by Roundabout Type as Reported by State Agency

	Roundabout Type		
	Mini-roundabout	Single-lane roundabout	Multilane roundabout
Number of Responses	10	29	25
Minimum	\$50,000	\$100,000	\$200,000
Average	\$249,000	\$1,296,034	\$2,048,000
Maximum	\$1,000,000	\$5,000,000	\$6,000,000

Survey Results



Number of State Agencies Developing Types of Public Outreach Material as Reported by State Agency

Survey Results

Operational Performance Models Reported by State Agencies

Model	Reporting State Agencies Using Model	%
<i>HCM 2010 Model</i>	26	72
Base HCM 2010 Model	22	61
HCM 2010 Model calibrated to local conditions	12	33
HCM 2010 Model calibrated to non-local conditions	2	6
<i>SIDRA Standard Model</i>	27	75
SIDRA Standard Model with Environment Factor	20	56
SIDRA Standard Model without Environment Factor	13	36
<i>UK Equations</i>	8	22
UK Equations uncalibrated	4	11
UK Equations calibrated	4	11
<i>Microsimulation</i>	22	61
<i>Other</i>	0	0

- Because States were allowed to select more than one operational performance model, there is some overlap in the number of States using each type of performance model.

Survey Results

Safety Analysis Procedures Reported as Used by State Agencies

Safety Analysis Procedure	Reporting State Agencies Using Safety Analysis Procedure	%
Our state does not typically estimate or predict safety at roundabouts	5	13
<i>Highway Safety Manual</i> predictive methodology	17	45
Crash modification factors or crash reduction factors (uncalibrated)	19	50
Crash modification factors or crash reduction factors (calibrated to local conditions)	9	24
Other Responses	7	18
Insurance Institute for Highway Safety	2	5
State agency-specific procedure	5	13

Survey Results

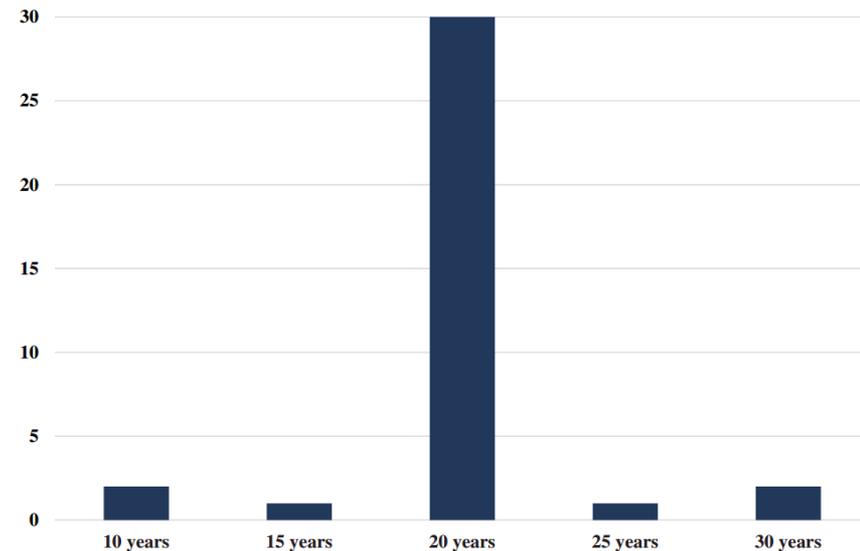
State Agency Use of *NCHRP Report 672* as Reported by State Agency

Use of <i>NCHRP Report 672</i> to Provide Design Guidance	Reporting Number of State Agencies
<i>NCHRP Report 672</i> is the only source of design guidance.	11
Material from other sources supplements <i>NCHRP Report 672</i>	10
Our state has developed guidance to supplement <i>NCHRP Report 672</i>	13
Our state uses material from other sources, and does not use, or rarely uses, <i>NCHRP Report 672</i>	2
Our state has developed separate guidance and does not use, or rarely uses, <i>NCHRP Report 672</i>	1
Total	37

Survey Results

Roundabout Design Life Criteria Reported As Used by State Agencies

Design-Life Criteria	Reporting State Agency Responses	%
Case-by-Case Basis	7	18
Practical Design Policy	4	11
Specific Criteria	0	0
Fixed Design Year	0	0
Fixed Duration	29	76



Number of Reporting States Indicating Roundabout Design Life Used by State Agencies with a Fixed Design-Life Duration

Reported State Agency Use of a Phased Implementation Approach to Multilane Roundabouts

State Agency Use of a Phased Implementation Approach to Multilane Roundabouts	Reporting Number of State Agencies
Yes	23
No	14
Total	37

Survey Results

- Half of the reporting States indicated their State agency had developed design-vehicle guidance.
- Several States simply guide designers to use a large tractor-trailer truck (WB-67) design vehicle, and a few other States are currently in the process of developing guidance for the accommodation of large vehicles.

Survey Results

Illumination Standard/Guidance Reported as Used by State Agencies

Illumination Standard/Guidance	Reporting State Agencies Using Particular Illumination Standard/Guidance	%
AASHTO Roadway Lighting Design Guide	20	54
<i>NCHRP Report 672</i> (IES Design Guide for Roundabout Lighting)	20	54
State-Specific Standard	6	16
Other	8	22

Conclusions

- A significant amount of new material, including this synthesis, has been developed since the publication of *NCHRP Report 672*
- The production of a third edition of *Roundabouts: An Informational Guide* would help to disseminate this updated information to practitioners.

Conclusions

- Several State agencies expressed a desire to identify and disseminate strategies for limiting the cost to install roundabouts
- Cost factors including maintenance of traffic during construction, the use of curb-and-gutter sections, and illumination were expressed as opportunities for more research
- Identifying particular applications, such as interchange ramp terminals, where roundabouts may have additional cost benefits would be beneficial for States looking to maximize the cost-effectiveness of roundabouts.

Conclusions

- States are searching for ways to ensure roundabouts and other intersection forms are evaluated using state-of-the-practice methods and measures
- A comparison of rate of implementation among states with different roundabout policies and particularly Intersection Control Evaluation (ICE) policies may shed more light on the effectiveness of such policies

Conclusions

- Additional research on the effectiveness of public outreach strategies could be helpful to identify strategies and prioritize resources towards strategies that have been shown to have successful outcomes, and help alleviate pushback against roundabouts

Conclusions

- The majority of States are now using a phased implementation approach in the design of roundabouts
- However, there is limited before/after data related to the planned expansion of roundabouts
- Research on best practices for planning and funding the expansion, along with managing traffic during reconstruction, could be helpful to State agencies



CASE STUDIES AND STATE DOT PERSPECTIVE

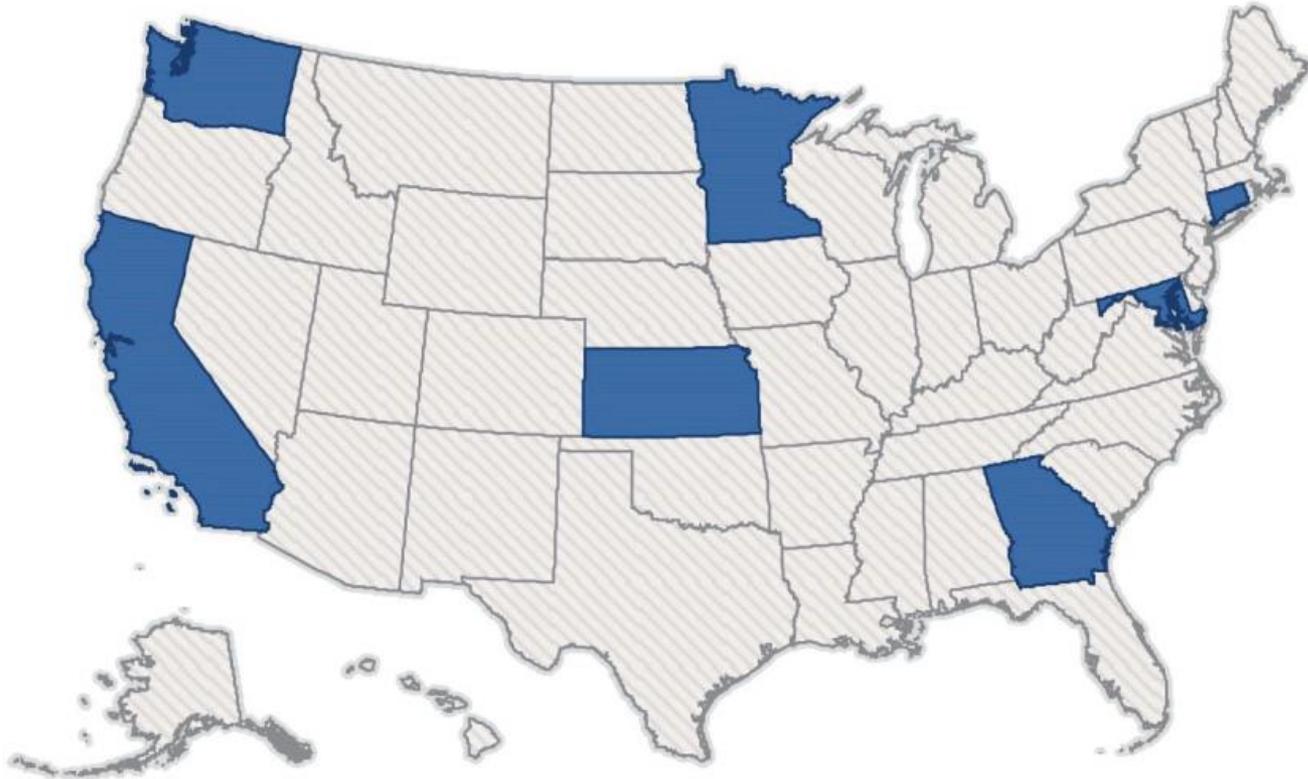
September 19, 2016

Andrew Paul

SELECTION OF DOTs FOR CASE STUDIES

- **Criteria**
 - A mix of early adopter and more recent adoption states
 - Known leaders in the roundabout field
 - A geographic mix of states
 - Preference given to panel member states
 - Preference given to states who have participated in similar interviews in the past to allow for a comparative review.

What state DOTs we talked to?



CASE EXAMPLES OF ROUNDABOUT PRACTICES

- Roundabout Selection
- Modifications to Existing Roundabouts
- Phased Roundabout Implementation
- Design Vehicle Accommodation
- Accelerated, Low-Cost Roundabouts
- Effective Practices

CASE EXAMPLES OF ROUNDABOUT PRACTICES

- Roundabout selection - How does a DOT select an intersection type?
 - The interviews suggest that a policy, directive, or guide suggesting or mandating that a roundabout be considered as an option also drives the selection of roundabouts

CASE EXAMPLES OF ROUNDABOUT PRACTICES

- Modification to existing roundabouts –
 - Most of the modifications to date involved reducing the number of lanes because of excess capacity at the roundabout.
- Kansas DOT



FIGURE 29 As-constructed US-50/Connector Road Roundabout in Emporia, Kansas. *Source: Google Earth Aerial (46).*



FIGURE 30 Modified US-50/Connector Road roundabout in Emporia, Kansas. *Source: Google Earth Aerial (47).*

CASE EXAMPLES OF ROUNDABOUT PRACTICES

- Modification to existing roundabouts – Washington State DOT
 - At two locations, WSDOT reduced the capacity of multilane roundabouts to minimize minor crash patterns.
 - By reducing the number of lanes on the approach to the roundabout, it was able to reduce the number of points where crashes can occur.

CASE EXAMPLES OF ROUNDABOUT PRACTICES

- Phased roundabout implementation
 - At least five of the seven states interviewed have modified roundabouts by reducing capacity.
 - All seven DOTs are now actively attempting to size their roundabouts for immediate and near future vehicle demand.
 - Georgia and Maryland, will open the roundabout as a single-lane roundabout if that configuration is expected to be sufficient for approximately 10 years.

CASE EXAMPLES OF ROUNDABOUT PRACTICES

- Phased roundabout implementation – Maryland SHA



FIGURE 31 As-constructed I-495/Ritchie-Marlboro Road ramp terminal roundabouts. *Source:* Google Earth Aerial (48).

CASE EXAMPLES OF ROUNDABOUT PRACTICES

- Design vehicle accommodation
 - Roundabout design vehicle selection is similar to other intersection control
 - WSDOT determines the specific movements larger vehicles are expected to make at an intersection, and designs its roundabouts to accommodate large vehicles on those movements.
 - WSDOT recently modified its truck apron height from three inches to two inches in certain applications.
 - GDOT tracks the routes of oversize/overweight vehicles statewide, and is able to determine the types of vehicles likely to traverse the proposed roundabout, and the movements the large vehicles are expected to make at the intersection.

CASE EXAMPLES OF ROUNDABOUT PRACTICES

- Accelerated, low-cost roundabouts



FIGURE 33 Intersection of SR-11/SR-124/Galilee Church Road in Jackson County, Georgia, prior to construction.
Source: Zehngraff (50).



FIGURE 35 Intersection of SR-11/SR-124/Galilee Church Road in Jackson County, Georgia, during second weekend of construction of the accelerated low-cost roundabout.
Source: Zehngraff (50).

CASE EXAMPLES OF ROUNDABOUT PRACTICES

- Accelerated, low-cost roundabouts
 - These projects typically include pavement markings and signs, with a budget of \$200,000 to \$300,000



FIGURE 36 Accelerated low-cost roundabout installation at the intersection of SR-11/SR-124/Galilee Church Road in Jackson County, Georgia. *Source: Zehngraff (50).*

CASE EXAMPLES OF ROUNDABOUT PRACTICES

- Effective practices
 - ICE
 - Strict enforcement of the policy
 - Retrofitting Rotaries
 - State-specific roundabout design guidance