Today’s Agenda

- Welcome and Training Outline
  Jorge Aguilar, APWA Monterey Bay Chapter President / Wallace Group

- Intersection Control Evaluation
  Brian Ray, Kittelson & Associates, Inc.

- Highway Safety Manual
  Matt Braughton, Kittelson & Associates, Inc.

- Roundabouts 101
  Brian Ray, Kittelson & Associates, Inc.
JOINT TRAINING OUTLINE

Industry Change and Growth
- Emphasis on Safety Improvements
- Multi-Modal Improvements

Intersection Control Evaluations
- Caltrans Requirement
- Beyond Caltrans

Roundabouts
- Interactive Process
- Design Plans and Constructability

Highway Safety Manual
- Provide Engineers and Transportation Planners with Tools
- Assist with Informing Stakeholders and Decision Makers
Industry Changes and Growth

» MAP-21 and FAST
  - Federal Funding has a renewed emphasis on Multi-Modal and Safety Improvements
  - Funding Applications – Benefit/Cost Analysis
  - Performance Based

» Public Engagement and Support
  - Tools to Convey Information
  - Active Communities

» Planning and Engineering Working Together
  - Combining Strengths and Perspectives
  - Maintain communication throughout the project
Intersection Control Evaluations (ICE)

- Del Rio Road Interchange – City of Atascadero
  - Pilot Project ICE for Caltrans
  - Used Existing Traffic Analysis and Data
  - Eliminated Signalized Alternative
  - Streamlined Approach & PDT approval

- East Boronda Road Widening – City of Salinas
  - Decision Making Tool for 2 Mile Corridor
  - 4 Intersections to Review
  - Traffic Model Volumes & Operations/Initial Cost/Maintenance/ROW Impacts/Water Quality/Safety/etc… Considerations

- Caltrans Requirement
  - Interchange Ramp Termini Improvements Require an ICE
  - Desire to maintain a Streamlined Approach
Roundabouts

- Not the One and Only Solution
  - Highly Skewed Intersections
  - Resolve Queue Storage Lengths
  - Less Severe Collisions
  - Corridor – Wide Nodes/Narrow Roads

- Design Process – Lesson’s Learned
  - Iterative Process
  - Visual Queues
  - Landscape
  - Public Education

- Construction – Lesson’s Learned
  - Construction Staging
  - Lighting
Highway Safety Manual

Solutions for Rural Roads In Our Central Coast Counties

- Quantitatively Estimating Collision Frequency/Severity
- Balance Improvements and Cost Effectiveness
- Quantify Incremental Improvements
- Tool to Help Engineers Communicate with Stakeholders
Evolving Solutions For Highway System Access

...How to Use ICE for Good and Not Evil...

APWA Monterey Bay Training Conference
June 28, 2016
Watsonville, CA

Brian L. Ray
Kittelson & Associates, Inc.
Presentation Outline

➤ Overview
  ▪ Roundabouts on the state system
  ▪ Emerging statewide guidance

➤ Intersection Control Evaluations
  ▪ National Trends
  ▪ Two Step Caltrans ICE approach
  ▪ Tools

➤ Alternative Intersections and Interchange Guides

➤ Sample Application of Interchange ICE

➤ Thoughts for the Future
  ▪ Understanding fundamentals
  ▪ Performance-based Analysis
  ▪ Continued Training
Overview

Roundabouts in California
- Late 1990s: Caltrans Roundabout Task Force
- Internal training
  - Managers
  - Headquarters/District Design Managers
  - District Staff

Various Roundabout Proposals
- Strong support in some jurisdictions
- Concerns!—More analysis, more review
- Concept Approval Report (CAR) Outline 2006 SR 246 Solvang

Concept Approval Report
- Fear of saying “yes”
- “More analysis is needed”-- a way of not really saying “no” or “yes”
- Resources wasted; good roundabout applications lost
- Progress in some Districts less in others
Overview

ICE August 2013
- Two Step Screening
- Challenges in assessing what is enough for a first step
- Learning to adapt ICE to the fullest range of contexts

Highway Design Practices
- Section 405.10 Roundabouts (HDM update March 2014)
- Others: “District 6 “Roundabout Best Practices”
- Challenges? Applying principles versus design standards

CA MUTCD: Interest in updates to include ICE
- All jurisdictions; not just Caltrans facilities
- Focus on objective, adaptive solutions
- Safety and performance-based focus
Presentation Outline

Overview
- Roundabouts on the state system
- Emerging statewide guidance

Intersection Control Evaluations
- National Trends
- Two Step Caltrans ICE approach
- Tools

Alternative Intersections and Interchange Guides

Sample Application of Interchange ICE

Thoughts for the Future
- Understanding fundamentals
- Performance-based Analysis
- Continued Training
States with objective intersection control evaluation policies:

- California
- Indiana
- Minnesota
- Wisconsin
- Other states pending

Supported by FHWA’s Every Day Counts Initiative

- Shortening project delivery
- Enhancing roadway safety
- Protecting the environment

FHWA provides guides on Alternative Intersections and Interchanges

“DOTs should consider and evaluate [roundabouts, diverging diamond interchanges (DDIs) and intersections with displaced left-turns or variations on U-turns] early in the project scoping, planning and decision-making stages, as they may serve as more efficient, economical and safer solutions than traditional designs.”

-FHWA

http://www.fhwa.dot.gov/everydaycounts/edctwo/2012/geometry.cfm
Intersection Control Evaluations

Intersection Control Evaluations simply mean **objective evaluations**
- Would you conduct a “Single Point Diamond Interchange Study”? 
- Then why would you conduct a “Roundabout Intersection Study”?

National trends toward cost-effective solutions
- “Right-sizing” project solutions
- Considering the likely value versus simply addressing projections
- Performance-based Practical Design (PBPD)
- *Performance-based Analysis of Geometric Design of Highways and Streets* (NCHRP Report 785)

Increasing number of states and cities with roundabout policies
- Roundabouts “first” or “also” (San Luis Obispo, CA, Bend, OR)

FHWA also promotes alternative intersections and interchanges
- Published Alternative Intersection/Interchange Guides (AIIG)
- Promoting objective multi-modal, safety, and operations research
Intersection Control Evaluations

➢ What is an Intersection?
  ▪ The connection or crossing of two or more roadway facilities

➢ Typical focus: At-grade forms
  ▪ We have been challenged implementing roundabouts over the last 15 years
  ▪ We now have more “innovative” forms to consider
  ▪ Mostly treatments of left-turning vehicles

➢ Intersection control evaluations apply to grade separated facilities
  ▪ Objective look at interchange form and function
  ▪ Focus is most often upon the ramp terminal intersection control
    ▪ Stop
    ▪ Yield
    ▪ Signalized

➢ A “Diverging Diamond Interchange” is simply an alternative treatment at the ramp terminal intersections
Intersection Control Evaluation  General Steps

- Consider project context
- Initial screening evaluation
- Performance-based decisions
  - Operations
  - Safety
  - Multimodal Quality Of Service
  - Project Phasing
  - Life Cycle Cost
ICE: Common Considerations and Factors

**Considerations**
- Foot Print
- Traffic Operations
- Multi-modal Quality of Service
- User types
- Safety Performance
- Service Life
- Expandability
- Initial Capital Costs
- Benefit/Cost

**Influencing factors**
- Rural/Urban Context
- High-Speed Environments
- Intersection Forms
- Corridors versus Isolated
- Adjacent Traffic Control
- Freight Movement
- Special Vehicles
- Pedestrian and Bicyclist
- Demand
- Special user needs
Key Process Changes and Requirements

- Must consider **signal, yield and multi-way stop control** during or before completing the project initiation phase of the project development process.
- The **safety performance** characteristics must be considered when developing engineering and investment recommendations.
- The **authority** to recommend or approve yield-controlled roundabouts and single point interchanges is **delegated to the Districts**.
Step 1: Assessment/screening of traffic control/management strategies

- Typically part of Traffic Engineering Performance Assessment (TEPA) in support of Project Study Report/Project Development Support (PSR/PDS) process

Outcomes:

- Identify strategies that merit further consideration because they meet the control need and are practical to pursue or implement.
ICE: Two Step Process (Later project steps) – Caltrans Example

Step 2: Traffic Analysis and Engineering Studies

- Typically part of Project Approval & Environmental Documentation (PA&ED) process or Permit Engineering Evaluation Report

Outcomes:
- Traffic and Performance Analysis Findings
- Life-cycle/Investment Analysis Findings
- Future investment needed to extend life
- Multi Modal Level of Service

<table>
<thead>
<tr>
<th>Performance Measure</th>
<th>Signal</th>
<th>Roundabout</th>
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<tbody>
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<td>Operations &amp; Maintenance – Lowest Cost</td>
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</tr>
<tr>
<td>Landscaping Maintenance – Lowest Cost</td>
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<td>Pavement Rehabilitation – Lowest Cost</td>
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<td>Bridge – Lowest Cost</td>
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<tr>
<td>Crash Costs – Lowest Cost</td>
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</table>
KAI Intersection Cost Comparison Spreadsheet

- Compares life-cycle costs of roundabout to traffic signal or stop-control
- Elements included:
  - Safety
  - Vehicular delay
  - Emissions (ROG, NOX, PM10)
  - Operations and Maintenance
  - Capital costs
- Many qualitative elements not included
  - ped/bike
  - economic development
  - community desires
  - livability, etc.

### Cost Performance Measure

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<th></th>
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<td>Predicted PDO Cost</td>
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### Life Cycle Benefit/Cost Analysis

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<td>Safety Benefits of Roundabout</td>
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<td>Delay Reduction Benefit of Roundabout</td>
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<td>Emissions Reduction Benefit of Roundabout</td>
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<td>Total Benefits</td>
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<td>Total Costs</td>
<td>$644,737</td>
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<td>LIFE CYCLE (20 YEAR) BENEFIT/COST RATIO</td>
<td>0.95</td>
<td>Roundabout not Preferred</td>
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<table>
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<tr>
<th>COSTS - Roundabout compared to Traffic Signal</th>
<th>Roundabout</th>
<th>Traffic Signal</th>
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<tr>
<td>Added O&amp;M Costs of a Roundabout</td>
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<tr>
<td>Added Capital Costs of a Roundabout</td>
<td>$267,607</td>
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<td>Total Costs</td>
<td>$309,108</td>
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</table>

Kittelson & Associates, Inc.
Transportation Engineering/Planning
Spreadsheet History

› Created by KAI for Pennsylvania DOT in 2012/2013
  ▪ Incorporated some older KAI spreadsheets for economic calculations
  ▪ “Automation” of safety calculations was largest part of effort
  ▪ Spreadsheet and manual available to PennDOT staff and consultants
  ▪ Limited use in PA, limited promotion by PennDOT

› Modified by KAI for Virginia DOT in 2013/2014
  ▪ Part of “ICE-like” roundabout screening process
  ▪ Spreadsheet and manual available at:
    http://www.virginiadot.org/info/faq-roundabouts.asp

› Adopted by Florida DOT in 2015

› Adapted by KAI for California
KAI modified PennDOT/VDOT spreadsheet for Transportation Authority of Monterey County (TAMC) ICE project in 2014-2016

- Minor modifications to incorporate TAMC/Caltrans unit costs
- Added emissions calculations
- Add tabs to compute approximate costs based on quantities
- New layout of results tab

Projects:
- Munras Ave at El Dorado St
- Del Monte Ave at English Ave
- West Alisal St at Capitol St
- Broadway St at San Antonio/101
- Fifth Street at NB US 101 Ramps
- Project Average
- First St at Central Ave
- Walnut Avenue at El Camino Real
- Sherwood Dr at Sherwood Pl
- Lareles Gr at Carmel Valley Rd
- Tioga Ave at Del Monte Blvd
- East Laurel Dr at St Edwards St
- San Miguel Cyn Rd at Castroville
Spreadsheet goals

- Easy to use
- Requires basic information that is readily available
- Help agency staff/consultants consider roundabouts and assess when they may be appropriate
- Evaluate intersection control across several key criteria beyond just traffic operations

**SUPPORTING BETTER DECISIONS**
What do users need?

- Opening year and design year ADTs
- Turning movement counts
- Operational analysis results from another program to determine:
  - Control delay
  - Basic geometric layout/lane needs
- Historical crash data (optional)
- Average vehicle speeds (only for emissions)
- Preliminary cost estimate
Future Updates

NCHRP Project 3-110 *Estimating the Life-Cycle Cost of Intersection Designs*

- Accommodates more types of intersections and scenarios than PennDOT/VDOT/FDOT/TAMC spreadsheet
- Harder/slower to use
  - Primarily does economic calculation
  - User must do engineering calculations (safety, emissions, etc.) with other tools and type in results

**CONTINUOUS IMPROVEMENT**
**TO SUPPORT PROJECT DECISION MAKING**
Presentation Outline

Overview
- Roundabouts on the state system
- Emerging statewide guidance

Intersection Control Evaluations
- National Trends
- Two Step Caltrans ICE approach
- Tools

Alternative Intersections and Interchange Guides

Sample Application of Interchange ICE

Thoughts for the Future
- Understanding fundamentals
- Performance-based Analysis
- Continued Training
The four guides
Published Fall 2014...Free on the web!
Guide Outline – Consistent for all Guides

- Chapter 1 – Introduction
- Chapter 2 – Policy and Planning
- **Chapter 3 – Multimodal Considerations**
- Chapter 4 – Safety
- Chapter 5 – Operational Characteristics
- Chapter 6 – Operational Analysis
- Chapter 7 – Geometric Design
- Chapter 8 – Signal, Signing, Marking and Lighting
- Chapter 9 – Construction and Maintenance
- Appendices
Types of Alternative Intersections (Chapter 1)

- Displaced Left-Turn Intersection (DLT)
  - Continuous Flow Intersection (CFI)
  - Crossover Displaced Left-Turn Intersection

- Median U-Turn Intersection (MUT)
  - Median U-turn Crossover
  - Boulevard Turnaround
  - Michigan Loon
  - ThrU-Turn Intersection

- Restricted Crossing U-Turn Intersection (RCUT)
  - Superstreet Intersection
  - J-turn Intersection
  - Synchronized Street Intersection

- Diverging Diamond Interchange (DDI)
  - Double Crossover Diamond (DCD)
Displaced Left-Turn Intersection (DLT)
Median U-Turn Intersection (MUT)
Restricted Crossing U-Turn Intersection (RCUT)
Diverging Diamond Interchange (DDI)
Presentation Outline

Overview and Look Ahead
- Roundabouts on the state system
- Emerging statewide guidance

Intersection Control Evaluations
- National Trends
- Two Step Caltrans ICE approach
- Tools

Alternative Intersections and Interchange Guides

Sample Application of Interchange ICE

Thoughts for the Future
- Understanding fundamentals
- Performance-based Analysis
- Continued Training
Overview--General

- City of Atascadero conducted a Specific Plan review for a commercial development
- Mitigations were needed for US 101/Del Rio Road Interchange
- Land use actions included traffic analyses and access recommendations
- Roundabouts were recommended
- ICE Policy had not been in effect
- Project was to advance to PA/ED
- A City led effort with no Caltrans capital investment
Overview—ICE Considerations

- Typical process would have been to conduct CAR evaluations
- Prior work did not conduct a side by side control evaluation
- “Pilot” ICE implementation supported project decision making with Caltrans’ engagement
- Goal: implement ICE principles and establish prototypical framework

- Numerous ICE applications since that time:
  - More than just Caltrans (Santa Barbara and TAMC)
  - Isolated locations
  - TAMC nearly 30 intersections
  - Diverging Diamond Interchanges
Project Overview

To Paso Robles

To SLO
Project Overview
Project Products: Objective Evaluation Results

- Traffic operations evaluations
- Safety performance evaluations
  - Roundabout performance checks
  - Crash comparison
- Footprint-practical and context sensitive
- Design/Service Life
- Supporting or not precluding future projects
- ICE Document outline and final products

Footprint is a first screening focus....
Traffic Operations: Roundabouts Advance

Signalized NB Terminal has insufficient storage for existing traffic….

<table>
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<tr>
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<th>Movement</th>
<th>Volume to Capacity Ratio</th>
<th>Delay (seconds/vehicle)</th>
<th>95th % Queue (feet)</th>
<th>Storage (feet)</th>
<th>Adequate Storage (Yes/No)</th>
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<td>AM</td>
<td>PM</td>
<td>Mid</td>
<td>AM</td>
<td>PM</td>
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<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Left/ Through</td>
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<td>0.48</td>
<td>0.70</td>
<td>6.4</td>
<td>7.9</td>
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<td>Through/ Right</td>
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<tr>
<td>Left/ Through</td>
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<td>0.43</td>
<td>0.33</td>
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**Traffic Operations: Roundabouts Advance**

NB Terminal roundabout is sufficient for existing traffic.

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<td>Mid</td>
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<td>PM</td>
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<td>0.63</td>
<td>0.77</td>
<td>8.9</td>
<td>15.6</td>
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### Traffic Operations: Roundabouts Advance

SB Terminal signalized has insufficient storage for forecast traffic….

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Mitigation requires widening the bridge...
Traffic Operations: Roundabouts Advance

SB Terminal roundabout is sufficient for future traffic.

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Roundabouts require no bridge widening
Footprint: Update prior concepts

- Design Vehicle
- Remove 5th leg
- Tear drop style
- Path overlap

Eliminate future “surprises”!
Footprint: Updated Concepts for Step 1
Footprint: Safety Performance Checks

- Design Vehicle
- Non motorized users
- Fastest Paths
- Path overlap (multilane design)
- Footprint and Sight Distance (consider 3 dimensions)
- Crash Prediction and Comparisons

Focus screening at the places that matter.....
Footprint and Sight Distance:
Where it’s critical...
Critical Success Factors

- Providing sufficient and appropriate analyses
- Considering operational effects of geometric design
- Integrating geometric design considerations in this “operations” activity
- Clear and concise documentation to support decision making and approvals
- Establishing early connections to the subsequent Caltrans design engagement

Do “just enough” to answer questions

ICE is a set of activities not a process....
Presentation Outline

Overview and Look Ahead

- Roundabouts on the state system
- Emerging statewide guidance

Intersection Control Evaluations

- National Trends
- Two Step Caltrans ICE approach
- Tools

Alternative Intersections and Interchange Guides

Sample Application of Interchange ICE

Thoughts for the Future

- Understanding fundamentals
- Performance-based Analysis
- Continued Training
Thoughts for the Future

- Statewide Transportation Analysis Guide (TAG)
  - Integrate multimodal Transportation with smart growth, sustainability, livability, and performance-based investing
  - A standardized analytical framework versus a rote approach

- CA MUTCD: Interest in updates to include ICE
  - All jurisdictions; not just Caltrans facilities
  - Focus on objective, adaptive solutions
  - Safety and performance-based focus

- NCHRP Project 3-110 *Estimating the Life-Cycle Cost of Intersection Designs*
  - KAI produced life-cycle cost spreadsheet for economic calculations
  - Flexible - Accommodates more intersections and scenarios
Thoughts for the Future

➢ Understand the Fundamentals
  ▪ Roadway Geometric Design Basics
  ▪ Intersection Design Basics
  ▪ Interchange Design Basics
  ▪ Operational Effects of Geometric Design

➢ Integrate Performance-based Analysis
  ▪ Consider Project Intended Outcomes
  ▪ Adapt Configurations to Each Unique Context
  ▪ Consider Value-based Approaches
  ▪ Throwaway the Concept of “Throwaway”

➢ Continue Training
  ▪ Planning, operations, and Design Managers
  ▪ Jurisdiction Staff
  ▪ Consultants and Contractors
  ▪ Across Planning, Operations, and Design Practice Areas
Questions and Discussion

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Alternative Intersection/Interchange
Alternative Intersection/Interchange Guides
http://safety.fhwa.dot.gov/intersection/alter_design

Estimating the Life-Cycle Cost of Intersection Designs
http://www.trb.org/Main/Blurbs/173928.aspx