You’re designing a new work zone on the busy 6-lane (2x3) highway north of town that involves lane shifts and one lane closure, which will move over the course of the project.

The governor’s office has just called your boss, saying,

“Don’t let it become like the last disaster. Remember?”

Your manager passed this on to you before running off to another meeting. You’re wondering if there is something new you could try, such as using V2I technology.
Section divider
Vehicle-to-infrastructure (V2I) Benefits Framework:

Stakeholder Workshop

March 27, 2018

Project sponsor: USDOT’s Intelligent Transportation Systems Joint Program Office (ITS JPO)
Represented by: Federal Highway Administration (FHWA) Office of Research, Development & Technology
Objectives of the V2I Benefits Framework (1/2)

• Determine the **key elements and relationships** to be included in an eventual tool that will allow **infrastructure owner-operators (IOOs)** to perform **benefit-cost analysis (BCA)** on potential V2I deployments, in order to provide **confidence to deploy** where appropriate
Objectives of the V2I Benefits Framework (2/2)

• Describes a **decision-making tool for IOOs**, not an assessment of overall societal benefits

• Not (at this phase) a functioning model that performs calculations
Key results from 2017 stakeholder engagement

• Interest in a tool that helps select applications based on agency needs, rather than a tool that calculates benefits and costs for a known set of applications

• Formal BCA is not necessary – need basic benefit and cost information to build the internal business case

• Significant interest in modeling phase-in / fleet penetration and how this affects benefits

• Cost information is important but not as cut-and-dried as it might seem. Consider ranges.

Objectives today

- Get your feedback on our approach to the framework and decision-support tool:
  - How do you select mitigations for work zones now?
  - In what ways could a tool following this framework be useful?
  - How could our work be more useful?
Section divider
So you need to plan WZ mitigations...

The situation

Generate options

Evaluate and select

Implement

Image/photo credits:
Congestion: stieberszabolcs via 123rf.com
Funnel: Le Moal Olivier via 123rf.com
Fabulous contraption: tereeez via 123rf.com
Basic flow of the framework...

Countermeasures in the model

Candidates

Non-V2I countermeasures (other models)

V2I applications

Benefit

Cost

Net

Photo credit (funnel): Thanavut Chao-ragam via 123rf.com
Four modules

- Problem

- Application screener
  - Choose apps to look at
  - Benefit filter/calculator
    - Cost filter/calculator
      - Calculator of net benefit
        - Predicted net benefit
# Output

**Table 3: Sketch of envisioned form of output from application chooser module (indicative example for Eco-Approach and Departure from Signalized Intersection)**

<table>
<thead>
<tr>
<th>Relevant KPI</th>
<th>Geographic scope of applicability</th>
</tr>
</thead>
<tbody>
<tr>
<td>crossing-traffic crashes at signalized intersection</td>
<td>R: regional</td>
</tr>
<tr>
<td>secondary collisions at signalized intersection</td>
<td>C: corridor</td>
</tr>
<tr>
<td>delay at intersection</td>
<td>I: intersection</td>
</tr>
</tbody>
</table>

**Sample unit**

- #/year
- #/year
- -daily average minutes
- -average maximum delay over 24h period

**Possible Countermeasure**

- signal optimization along corridor (e.g. signals timed to 30 mph) - etc
- glidepath
- roundabout
- four-way stop (if traffic volumes permit)
- traffic calming
- dynamic speed limits

---

Section divider
Overall view of the framework

- Initial version summer 2017, based on stakeholder expressed priorities
- Revised in accordance with stakeholder feedback December 2017
- Need to make sure the tool can be modular in order to expand functionality in the future
Framework modules, dimensions and their functions

<table>
<thead>
<tr>
<th>Module</th>
<th>Dimensions used</th>
<th>Main function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application chooser</td>
<td>Dimensionless</td>
<td>The user indicates the KPIs of interest; the module suggests applications with potential applicability.</td>
</tr>
<tr>
<td>Benefit filter and calculator</td>
<td>Filter: Dimensionless</td>
<td>Predicts which KPI would likely see a benefit based on agency starting point and input regarding benefits observed or modeled elsewhere.</td>
</tr>
</tbody>
</table>
|                           | Calculator: Units of each applicable KPI | Models benefit in terms of the change in each KPI of interest, in two ways:  
  - Units of that KPI at various penetration rates  
  - Units of that KPI over time |
| Cost filter and calculator | Filter: Dimensionless | Predicts necessary cost elements based on agency starting point.                                                                             |
|                           | Calculator: Money | Puts cost on each element, expressed either in net present value (NPV) or over time.                                                            |
| Calculator of net benefit | Money           | Monetizes the benefit over all KPIs affected, and nets out the cost. Results expressed either in NPV or over time.                              |
Hannah Rakoff
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Jonathan Badgley
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Back-pocket slides
Legend for the module diagrams

<table>
<thead>
<tr>
<th>Icon</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>Pink parallelogram</td>
<td>“Pre-populate” data required to launch framework</td>
</tr>
<tr>
<td>Yellow rectangle</td>
<td>Data (to be input by user)</td>
</tr>
<tr>
<td>Green triangle</td>
<td>Data (output)</td>
</tr>
<tr>
<td>Process flow arrow</td>
<td>Process flow</td>
</tr>
<tr>
<td>Data flow arrow</td>
<td>Data flow</td>
</tr>
<tr>
<td>Salmon bubble</td>
<td>Explanation</td>
</tr>
</tbody>
</table>

Legend
Agency has need(s) (the ‘problem’) → Agency starting point: Details about the problem
- Current statistic(s) for relevant KPIs
- Scale
- Situation
- Agency approach (baseline for comparison)

Application chooser → List of possible countermeasures for all applications in tool’s scope
- Traditional countermeasures
- V2I applications

Table of options filtered based on starting point
- V2I applications
- Traditional countermeasures

Sources of data regarding KPIs affected; magnitude of benefit for each; and relationship of benefit to market penetration
- CV Pilots
- International field operational tests (FOTs)
- Modeling (e.g. at TFHRC, CAMP, JPO, Volpe)
- Others (TBD)

Agency selects a few options to investigate
Benefit filter and calculator

Agency selects a few options to investigate

Sources of data regarding KPIs affected; magnitude of benefit for each; and relationship of benefit to market penetration

Assumptions regarding in-vehicle equipment
- Market penetration vs. time
- Expected benefit at high penetration

Optional: User can vary these assumptions

Benefit filter: Determines which KPIs will be affected

Benefit calculator: Calculates effect on each applicable KPI

Predicted values of KPIs after intervention assuming default penetration rate (e.g. 25%), with sensitivity analysis

Predicted values of KPIs over time after intervention (based on penetration assumptions)
Cost filter and calculator

Agency starting point: Items that affect cost

Agency selects a few options to investigate

Framework runs separately for each application

Cost filter and calculator

Default cost data for all cost elements
- List of all elements within scope
- Default costs for each

Cost filter:
Determines appropriate cost elements

Cost ‘matcher’:
Matches costs to each

Needed cost elements with default costs

Optional input
- Agency-specific costs

Needed cost elements with custom costs

Agency’s current technology/ readiness status

Problem

Choose app for focus

Cost/Benefit Calculator

Predicted net benefit

Calculator of net benefit

Application chooser
Calculator of net benefit

- Needed cost elements with default costs
- Needed cost elements with custom costs
- List of expected monetary values of one unit of each KPI included in framework
- Predicted values of KPIs after intervention assuming default penetration rate (e.g. 25%), with sensitivity analysis on penetration
  - Results in units of each KPI at various penetrations
- Predicted values of KPIs over time after intervention (based on market penetration assumptions)
  - Results in units of each KPI over time
- Calculator of net benefit
- Predicted net benefit ($ terms)
Draft outline for memo on WZ baseline

• Introduction
  • Project context
  • Choice of RSZW/LC
  • Need to document baseline in order to accurately attribute benefit and cost

• Baselines
  • For WZ interventions
    • Process for decision-making at strategic level (e.g., when to work, overall traffic management plan)
    • Interventions currently used (including work scheduling; lane configurations/operations; and ITS/public information)
    • Selection of ITS investments to aid in work zone management (inc. what costs and benefits are counted)

  • For crashes and delay
    • How they are measured; tracked; classified (metrics)
    • Current numbers

  • For costs [case study here]
    • Qualitative; identification of cost elements for WZ mgt.
    • Current status for telecoms, mapping, staffing etc., as feasible
    • Identification of primary gaps, as feasible

• Discussion and recommendations for revising the framework
<table>
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<tr>
<th>2018</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
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<th>July</th>
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<td>Period of performance (POP)</td>
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<td>Technical memo on state WZ baseline</td>
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<td>Feasibility analysis for baseline estimation from NDS data</td>
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- **Period of performance**
- **Target date for deliverable**
- **Multi-agency site visit to TxDOT**

Timeline:

- **3/26-3/28**
  - Technical memo on state WZ baseline

- Draft
  - Phase I final report

- Final