Exploring Predictive Network Screening Tools
April 13, 2021 11AM EST

Stephen Read, Virginia DOT & AASHTO Highway Safety Manual Steering Committee Chair
Kerry Wilcoxon & Saroja Devarakonda, Arizona DOT
This webinar series features innovative software tools for predictive network screening employed by state transportation agencies around the United States.

Kick-off webinars provide a high-level overview of the tools using a speed-dating format and subsequent webinars will provide a more detailed description and demonstration.

Stephen Read, Virginia DOT & AASHTO HSM Steering Committee Chair
Kerry Wilcoxon & Saroja Devarakonda, Arizona DOT
Exploring Predictive Network Screening Tools (Part 1)

Stephen Read, Virginia DOT & AASHTO HSM Steering Committee Chair
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Exploring Predictive Network Screening Tools (Part 2)

Stephen Read, Virginia DOT & AASHTO HSM Steering Committee Chair
Kerry Wilcoxon & Saroja Devarakonda, Arizona DOT

“Speed-dating” Part 2
April 16, 1pm ET
Network Screening Speed-dating

A quick review of notable agency predictive network screening tools

Connecticut
Agency Overview

Connecticut Department of Transportation (CTDOT) & Connecticut Transportation Safety Research Center (CTSRC) at the University of Connecticut (UConn)

CTDOT Contact:
Joseph Ouellette, State Safety Engineer, joseph.ouellette@ct.gov

UConn Contact:
Eric Jackson, Ph.D., Director, eric.d.jackson@uconn.edu
Shanshan Zhao, Ph.D., Research Scientist, shanshan.li.zhao@uconn.edu
Tool Overview

- Connecticut Roadway Safety Management System (CRSMS)
- Developed by CTSRC and VHB
- Agency use since 2019
- Web-based application and easy access
- Full-implementation of the best practices in the Highway Safety Manual with maps and visualizations
Key Features

- Easier data manipulation with Data Management
- Screening by geographical areas, emphasis areas, crash type and severity, roads, and facility types
- Multiple performance measures and screening methods using EB and sliding window/peak searching
- Visualization of results on maps
- Multiple diagnosis tools with map views, statistical tests, charts and tables, collision diagram, crash tree, and street image viewer
Key Features (Continued)

• Integration of the latest CMF Clearinghouse data
• Create reports, publish, clone, download and save
• Create and compare multiple proposed projects
• Conduct benefit-cost analysis for proposed projects
• Programmatically prioritize projects with limited budgets
• Conduct varied levels of EB before-after analysis for evaluating the effectiveness of projects
Conclusions

• Used by CTDOT, COGs, and consultants for decision-making
• Replace old SLOSSS list (which uses critical crash rate)
• Use more reliable measures and methods
• Integrate maps and visualizations
• Provide more flexibility, repeatability, and shareability while require less expertise
• High initial setup costs but transferable to other states with less

Register: crsms.uconn.edu
Pooled fund: https://www.pooledfund.org/Details/Solicitation/1550
Florida Network Screening Analysis for Signalized Intersections

Alan El-Urfali, P.E.
State Traffic Services Program Engineer
Florida Network Screening Tool Evolution

- Historically, FDOT used AASHTOWare Safety Analyst
- 2019 FDOT developed System Analysis & Forecast Evaluation (SAFE) Tool
- 2020 FDOT published first network screening report with 154 candidate intersections
- 2021 FDOT published second network screening report with 161 candidate intersections
- 2021 FDOT Acquired SPF Tool for visualization and dynamic reporting
FDOT Network Screening Tool (SAFE)

- FDOT homegrown tools to implement HSM Part B Roadway Safety Management Process
- SAS-based code and SAS tools (Jump Pro)
- ETL process for assembling roadway and crash data from multiple data sets
- SPFs calculated with SAS code automatically
- Focuses on Fatal and Severe Injury Crashes
- Performance Measure: Excess Expected Crashes with EB adjustment (most reliable)

Note: ETL is for Extract, Transform, and Load
SAFE Data Structure

- Currently, screening signalized intersections on state highway system
- Group intersections by number of legs and roadway context classification
- Expanding analysis to cover roadway segments, unsignalized intersections and mid-block crosswalks

Context Classification

Intersection Groups

Group 1: C1-C2T 4-leg signalized
Group 2: C1-C3C 3-leg signalized
Group 3: C4-C6 3-leg signalized
Group 4: C3C 4-leg signalized
Group 5: C3R 4-leg signalized
Group 6: C4 4-leg signalized
Group 7: C5-C6 4-leg signalized
Florida Data Warehouse

- **CARS**: Crash Analysis Reporting System
- **DHSMV**: Department of Highway Safety and Motor Vehicle
- **Signal 4**: Signal Four Analytics Crash Database
- **RCI**: Roadway Characteristics Inventory
- **ARBM**: All Roadway Base Map
- **SIS**: Strategic Intermodal System
Safety
Performance
Functions

• State-specific SPFs developed with Florida AADT (Major/Minor) and KA Crashes

• Unique algorithm to identify Candidate and Sister Intersections

• AI machine learning of missing safety countermeasures
FDOT SPF Tool

- FDOT acquired service for SAFE visualization and dynamic reporting
- Unlimited FDOT user access
- Districts use SPF Tool for candidate prioritization, field review, diagnostics and countermeasure selection
## Countermeasures for Intersections

<table>
<thead>
<tr>
<th>Countermeasure</th>
<th>Countermeasure Description</th>
<th>CMF Value</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Backplates</td>
<td>Add 3-inch yellow retroreflective sheeting to signal backplates</td>
<td>0.850</td>
<td>CMF Clearinghouse (CMF ID 1410)</td>
</tr>
<tr>
<td>Crosswalk</td>
<td>Install high-visibility crosswalk</td>
<td>0.810</td>
<td>CMF Clearinghouse (CMF ID 4124)</td>
</tr>
<tr>
<td>Lighting</td>
<td>Provide intersection illumination</td>
<td>0.920</td>
<td>CMF Clearinghouse (CMF ID 5421)</td>
</tr>
<tr>
<td>FYA</td>
<td>Install flashing yellow arrow (FYA)</td>
<td>0.654</td>
<td>CMF Clearinghouse (CMF ID 7683)</td>
</tr>
<tr>
<td>LT Offset</td>
<td>Improve left-turn lane (LT) offset to create positive offset</td>
<td>0.662</td>
<td>CMF Clearinghouse (CMF ID 6095)</td>
</tr>
<tr>
<td>LT Lane</td>
<td>Provide a left-turn (LT) lane</td>
<td>Rural 3-leg intersection 0.850 Urban 3-leg intersection 0.930 Rural 4-leg intersection 0.820 Urban 4-leg intersection 0.900</td>
<td>Highway Safety Manual (Chapter 14)</td>
</tr>
<tr>
<td>RT Lane</td>
<td>Provide a right-turn (RT) lane</td>
<td>0.960</td>
<td>Highway Safety Manual (Chapter 14)</td>
</tr>
<tr>
<td>LPI</td>
<td>Implement a leading pedestrian interval (LPI)</td>
<td>0.870</td>
<td>CMF Clearinghouse (CMF ID 9916)</td>
</tr>
<tr>
<td>DSWF</td>
<td>Install dynamic signal warning flashers (DSWF)</td>
<td>0.820</td>
<td>CMF Clearinghouse (CMF ID 4201)</td>
</tr>
</tbody>
</table>
# FDOT Network Screening Reporting

## Florida Department of Transportation
Traffic Engineering and Operations Office

System Analysis and Forecast Evaluation (SAFE) Candidates Final and Severe Crashes at 4-Leg Signalized Intersections 2016-2018

### District 2

<table>
<thead>
<tr>
<th>RWYID</th>
<th>MILE Post</th>
<th>Days Between Expected KA Crashes</th>
<th>R treat.</th>
<th>Expected Savings of Treatment</th>
<th>Months to Reduce One KA Crash</th>
<th>MILE Post</th>
<th>Days Between Expected KA Crashes</th>
<th>R treat.</th>
<th>Expected Savings of Treatment</th>
<th>Months to Reduce One KA Crash</th>
</tr>
</thead>
<tbody>
<tr>
<td>72100000</td>
<td>3.85</td>
<td>248</td>
<td>Yes</td>
<td>Yes</td>
<td>367</td>
<td>$752,750</td>
<td>25</td>
<td>45.45</td>
<td>367</td>
<td>$752,750</td>
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<tr>
<td>26090000</td>
<td>7.94</td>
<td>271</td>
<td>Yes</td>
<td>Yes</td>
<td>413</td>
<td>$713,444</td>
<td>25</td>
<td>9.25</td>
<td>413</td>
<td>$713,444</td>
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<td>26090000</td>
<td>13.65</td>
<td>176</td>
<td>Yes</td>
<td>Yes</td>
<td>217</td>
<td>$603,855</td>
<td>31</td>
<td>8.41</td>
<td>217</td>
<td>$603,855</td>
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<td>256</td>
<td>Yes</td>
<td>Yes</td>
<td>315</td>
<td>$416,351</td>
<td>45</td>
<td>5.82</td>
<td>315</td>
<td>$416,351</td>
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### Suburban Commercial (SC)

<table>
<thead>
<tr>
<th>RWYID</th>
<th>MILE Post</th>
<th>Days Between Expected KA Crashes</th>
<th>R treat.</th>
<th>Expected Savings of Treatment</th>
<th>Months to Reduce One KA Crash</th>
<th>MILE Post</th>
<th>Days Between Expected KA Crashes</th>
<th>R treat.</th>
<th>Expected Savings of Treatment</th>
<th>Months to Reduce One KA Crash</th>
</tr>
</thead>
<tbody>
<tr>
<td>28900000</td>
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<td>264</td>
<td>Yes</td>
<td>Yes</td>
<td>316</td>
<td>$428,018</td>
<td>53</td>
<td>40.63</td>
<td>316</td>
<td>$428,018</td>
</tr>
<tr>
<td>29002000</td>
<td>2.63</td>
<td>405</td>
<td>Yes</td>
<td>Yes</td>
<td>597</td>
<td>$550,594</td>
<td>41</td>
<td>34.15</td>
<td>597</td>
<td>$550,594</td>
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<tr>
<td>28010000</td>
<td>15.21</td>
<td>214</td>
<td>Yes</td>
<td>Yes</td>
<td>264</td>
<td>$609,552</td>
<td>37</td>
<td>8.52</td>
<td>264</td>
<td>$609,552</td>
</tr>
</tbody>
</table>

### Urban General (UG)

<table>
<thead>
<tr>
<th>RWYID</th>
<th>MILE Post</th>
<th>Days Between Expected KA Crashes</th>
<th>R treat.</th>
<th>Expected Savings of Treatment</th>
<th>Months to Reduce One KA Crash</th>
<th>MILE Post</th>
<th>Days Between Expected KA Crashes</th>
<th>R treat.</th>
<th>Expected Savings of Treatment</th>
<th>Months to Reduce One KA Crash</th>
</tr>
</thead>
<tbody>
<tr>
<td>28070000</td>
<td>20.35</td>
<td>319</td>
<td>Yes</td>
<td>Yes</td>
<td>581</td>
<td>$418,470</td>
<td>64</td>
<td>38.72</td>
<td>581</td>
<td>$418,470</td>
</tr>
</tbody>
</table>

Note: R treat. stands for Recommended Treatment.
Main Features for FDOT Network Screening

• State-specific Safety Performance Functions
  ▪ Group intersections by context classification and number of legs
  ▪ SPFs calculated annually utilizing three-year rolling average roadway AADTs and KA crash data

• Select candidates based on potential safety prioritized by excess expected crashes with EB adjustment

• FDOT unique method for candidate and sister intersections comparison

• Visualize with 2-D/3-D interactive graphics (SPFTool)
  ▪ Provides deeper-dive investigation into contributing factors for selecting most appropriate countermeasures
FDOT Network Screening Cost

- FDOT in-house resources
  - Initial setup, identifying data sources, and developing SAS
- FDOT acquired services (SPFTool)
  - Cloud-based ($25,000 per year)
- SPFTool Customization $20,000 first year
- Projected maintenance cost (Data QC and Validation) $15,000 per year

Image from SPFTool website: http://spftool.com
Question?

Alan El-Urfali, P.E.
State Traffic Services Program Engineer
Email: Alan.El-Urfali@dot.state.fl.us
Tel: (850) 410-5416
Network Screening Speed-dating
A quick review of notable agency predictive network screening tools
Kentucky
Agency Overview

- Kentucky Transportation Cabinet
  - Mike Vaughn - mike.vaughn@ky.gov
- Kentucky Transportation Center/UK
  - Eric Green – eric.green@uky.edu
Tool Overview

• Crash Data Access Analysis Tool CDAT, KTC/KYTC
• 1 year in beta, 1 year in production
• Web app (ASPX with VB.Net code-behind)
• CDAT integrates crash and roadway data and then users can query a segment or intersection to obtain a safety score as compared to other segments or intersections employing techniques from the *Highway Safety Manual*. 
Key Features

• Main features of the tool
  • Mapping interface can be used to query and to display crashes.
  • Charts and graphs provide a better understanding of the crash types and can be compared to other, similar roads.
  • Pre-loaded with current state-based SPFs for a variety of crash types and severities.
  • Users can use CDAT to prioritize projects or evaluate highway improvements.
  • Helps promote the importance of roadway homogeneity.
Step 1
Please define a county, route and starting/ending milepoints.

County

ADAIR
Limit to Prefix:
- PV
- CS
- CR
- PR
- PS
- LN
- FD
- KY

Clear Prefix

Route

001:KY-0055-000
- Only Show Main Line
- Only Show Ramps
- Show All

More information on main line, ramps, and other section IDs can be found [here](#).

Milepoints

0 to 21.305

NOTE: CDAT uses a route and milepoint that is post-processed to improve accuracy (KTC_RT and KTC_MP)
Map Used to Select Segment
Filter by Crash Type

Check any boxes below to limit the results to only include the crash types selected (checking more than one will limit results to be of both crash types).

- Motorcycle
- Commercial Vehicle
- Lane Departure
- Run Off the Road
- Young Driver
- Mature Driver
- Pedestrian Involved
- Bicyclist Involved
- Distracted Driving
- Aggressive Driving
- Impaired Driving
- Unrestrained
- Hit and Run

Crash type definitions and intersection descriptions
Review Crash Types

*Contributing Factor codes of 99 (none detected) are excluded

Note: You can click a graph title for more information.
State-Specific SPFs

Step 3
Safety Performance Functions.

Please select an SPF for the segment

- No Recommended SPF
- Rural Two-Lane
- Urban Two-Lane
- Rural Multi-Lane Divided
- Rural Multi-Lane Undivided
- Urban Multi-Lane Divided
- Urban Multi-Lane Undivided
- Rural Interstate and Parkway
- Urban Interstate and Parkway

Choose a severity type for the SPF (this should match your severity filter from Step 2)

- KABCO
- KAB
- CO

SPF Information

Number of Crashes: 101
Theta: 1.532
Theta defaults to 100 if no model is selected
Model form: SPF = e^(a*AADT+b*Length)
Length: 21.305
AADT: 3594.5
a: -4.492
b: 0.844

AADT is 100 if there is no count for a segment
Any values that are changed will be shown in orange. Values will be shown in red if non-numeric values are entered.

Adjustment Factors (optionally add notes)

1
1
1
1
1
1
**Safety Score**

Disclaimer: Advanced analysis is based on using statewide SPFs generally based on all crashes. If you apply any crash filters then you must use adjustment factors to obtain accurate results. Moreover, statewide SPFs are based on predominate base conditions. You must also apply adjustment factors if the segment or intersection you are analyzing has geometrics different from these base conditions. As always, use engineering judgement.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crash prediction at site</td>
<td>239.1</td>
</tr>
<tr>
<td>EB Estimate</td>
<td>117.6</td>
</tr>
<tr>
<td>Excess Expected Crashes (EEC)</td>
<td>-121.5</td>
</tr>
<tr>
<td>Standard Deviation (+/-)</td>
<td>14.5</td>
</tr>
<tr>
<td>Level of Service of Safety (LOSS)</td>
<td>2</td>
</tr>
</tbody>
</table>

...crashes per time period
Conclusions

• Why was the tool selected developed?
  • To provide better access to crash data and help all transportation professionals in KY have a better understanding of safety performance across the state.

• What are the benefits of the tool?
  • Easy and consistent access to crash data and methodologies.

• How has the tool impacted decision-making?
  • Helps a variety of Divisions understand where there are safety improvement opportunities as they develop projects (Planning & Design) and administer annual programs (Maintenance & Operations)
Additional Tool Overview

- SPF-R - KTC/KYTC
- 5 years
- R script (soon to be a web tool)
- SPF-R is a Safety Performance Function development tool that runs within R and Rstudio although a web version of the tool is under development.
- https://github.com/irkgreen/SPF-R
Key Features

• Main features of the tool
  • An SPF can be developed from a CSV of segments or intersections.
  • A variety of model forms can be used with examples provided.
  • SPF-R can perform SPF development as well as network screening on the same dataset.
  • CURE plots and other metrics are provided to improve model development.
Thank You!

- Kentucky Transportation Cabinet
  - Mike Vaughn - mike.vaughn@ky.gov
- Kentucky Transportation Center/UK
  - Eric Green – eric.green@uky.edu
Discussion

For additional information go to www.highwaysafetymanual.org or contact Kelly Hardy, P.E. at khardy@aashto.org

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