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ITE's Vision Zero Sandbox Design Competition

Dr. Gustavo de Andrade

The McTrans Center is represented in the University of Florida Transportation Institute (UFTI) team in ITE’s Vision Zero Sandbox Challenge, which has been selected as one of two finalists for the Professional Competition category[1]. The McTrans/UFTI team will present their solutions to the judges and the attendees at a session in the Virtual Annual Meeting on Tuesday, July 20, 2021 from 4:00-5:30 p.m. EDT.

This year’s challenge goal was to develop a methodology that used automated conflict data to create low-cost solutions for a variety of intersections in Bellevue, Washington. The McTrans/UFTI team analyzed data on crashes and “near-misses” to identify the priority locations and to determine appropriate low-cost countermeasures for each location.

The HCS module Streets was used to estimate the expected impacts of these countermeasures on both safety and multimodal operational performance. For that end, a crash prediction module embedded in Streets was used, following recent UFTI research and development[2]. This model is able to predict the frequency of different crash types sensitive to signal timing and phasing scheme parameters, such as protected versus permitted phases, split phasing, all red time, and total cycle length. Along with other geometry characteristics, this model includes lane configuration as an input, the number of shared lanes versus dedicated lanes for each movement and left-turn storage area. The integrated methods allow for the evaluation of the tradeoff between safety and operational performance measures. The proposed set of countermeasures were able to reduce the predicted number of crashes by up to 29%. In some cases, the countermeasures aimed at enhancing safety did increase the intersection delay, affecting vehicle LOS, while in some cases it was possible to improve both safety and LOS by using more efficient signal phasing and timing. LOS for bicycles and pedestrian, as calculated by the HCM6 methodology implemented in Streets remained in good standards for all scenarios.

In the current HCS7 version, the safety tool can be found in the signal optimization section under Detailed Input Data on the Streets input screen. In the next release, a new report for the safety model will make it easier to present results and to compare the tradeoffs between safety and operations for intersection analysis.

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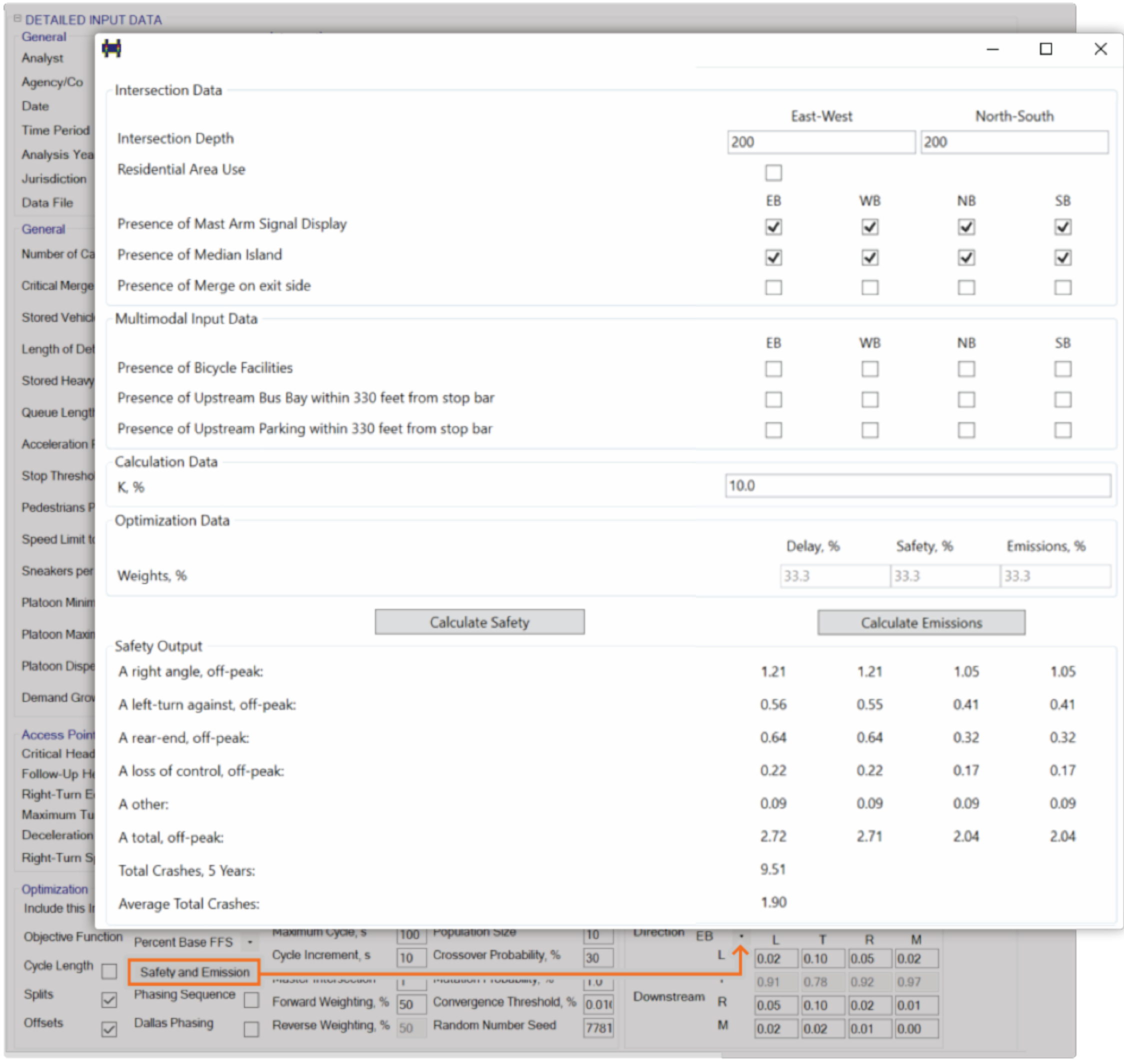
[1] https://www.transportation.institute.ufl.edu/2021/06/ufti-team-selected-as-finalist-for-ites-vision-zero-sandbox-design-competition/

[2] Andrade, G. R., L. Elefteriadou, M. Hadi, V. Khanapure (2020) Method for assessing effect of input parameters on multiobjective optimization of signal control *Journal of Transportation Engineering Part A Systems*, 146 (2)

[3] Andrade, G. R., Elefteriadou, L., Zhang, L. (2017) *Signal Timing Optimization with Consideration of Environment and Safety Impacts, Part B. Final Report*. Southeastern Transportation Research, Innovation, Development and Education Center (STRIDE), University of Florida



STAFF SPOTLIGHT

Christian Breau

Software Developer

Strangely enough, while I graduated from the University of Florida with a master's degree in Civil / Transportation Engineering, I intended to look for a general Engineering job like anybody would. However, I joined McTrans as a developer instead, despite only taking three programming-related classes throughout college. Starting in middle school, my best friend and I decided to try designing our own games, but instead of learning coding traditionally, we did it through what I believe is the best way to learn: we took publicly available objects such as cars, doors, planes, etc. and tried to replicate and improve their code into our own objects, going line by line to understand how everything works. We picked up not only all the basics early but now we feel advanced enough to tutor our friends similarly interested in game or software development.

That experience led me to being a developer at McTrans, a unique experience that feels like a boon in more ways than one. With my equal blend of transportation and development experience, I can work on HCS or similar projects while gaining experience in both fields, whereas at most jobs I would only work with one field at a time. For example, I worked on NCHRP 15-57 (Chapter 38 of the Highway Capacity

Manual) while undertaking an assistantship at the University of Florida, but now that I have been coding it into HCS, I feel a deeper understanding of the methodology as I see it incorporated.

Despite starting my Master's, assistantships, and now work at McTrans in the midst of COVID, I do not feel like I lost any experience at all. Working with McTrans as a research assistant felt very structured and organized, with personal conversations through camera-enabled meetings and an easy-to-manage schedule with Asana. Now that I have joined full-time and we are back in the office, I feel a little out of my environment due to previously only working and studying remote, but the support of my co-workers has made the transition a lot easier.

Crash Cost by Crash Severity Reporting in HSS

Dr. Karla Rodrigues-Silva

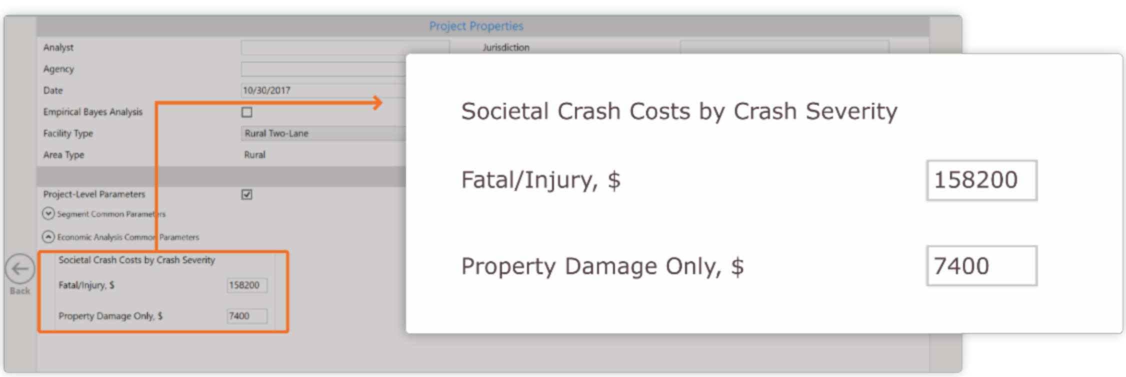
Estimating the cost of crashes due to the impact of a safety treatment has been challenging for decades. Most decisions are based on consideration of factors for which quantitative information converted into crash costs are frequently employed to justify economically roadway safety investments. Following these lines, the combination of crash prediction models of Highway Safety Manual (HSM) and crash costs has become a natural path on the quantification of safety benefits, as a result of road improvement to evaluate substantive safety.

According to the Federal Highway Administration, substantive safety is the actual long term or expected safety performance of a roadway. This would be determined by historical crashes over a long time to provide with high level of confidence the predicted/expected crashes of a location or highway.

Although we have established and accepted methods for the implementation of substantive safety, crash costs still may vary from one place to another, thereby impacting safety benefit-cost analysis (BCA). This customization may require establishing robust knowledge base tools that allows practitioners perform data-driven safety analyses of roads.

To support practitioners and researchers to combine crash analysis that directs to crashes cost, the Highway Safety Software has implemented parameters for Economic Analysis along with HSM Crash Prediction Models. Currently, the implementation is available for all facility types addressed in HSM. HSS allows inputting customized values on the GENERAL tab and the results of crash cost by severity are displayed on your choice of formatted and text report.

HSS Crash Cost by Crash Severity interface



Economic Analysis (Predicted Crashes)			
Crash Severity	Per Crash Societal Crash Cost	Predicted Annual Crashes	Total Societal Crash Cost
Fatal and Injury (FI)	$158,200.00	7.012	$1,109,298.40
Property Damage Only (PDO)	$7,400.00	16.990	$125,726.00
Total	-	24.002	$1,235,024.40

Mixed-Flow Model: A More Accurate Estimate of Effects of Trucks and Grades in Freeways and Highways

Dr. Fabio Sasahara

For several decades, the Highway Capacity Manual has been applying the concept of Passenger Car Equivalents (PCE) to capture the effects of heavy vehicles in the traffic stream. These models assume heavy vehicles have different powertrain and acceleration characteristics and therefore one heavy vehicle would have a greater impact on traffic when compared to a passenger car.

However, the PCE factors may not be accurate when at least one of these conditions exist:

- Significant presence of trucks in the traffic stream
- A long upgrade
- A combination of both factors above

The 6th Edition of HCM (2016) introduced the Mixed-Flow Model to address this issue in freeway basic segments and multilane highway. While the PCE approach assumes vehicle speeds are uniform across all vehicle types, the Mixed-Flow model calculates speeds for passenger cars and trucks individually, yielding more accurate results.

The required inputs for the Mixed-Flow Model include:

- Total percentage of trucks and the proportion distribution of Single-Unit Trucks (FHWA classifications 4-5) and Tractor-Trailer Trucks (FHWA classifications 6-13)
- Grade percentage (%) and length (mi)

For low percentages of trucks and mild upgrades, the results provided by the PCE methodology are comparable to the ones provided by the mixed-flow model. The HCM, however, does not provide a strict definition of what values of %HV and grade are considered significant to support a mixed-flow analysis.

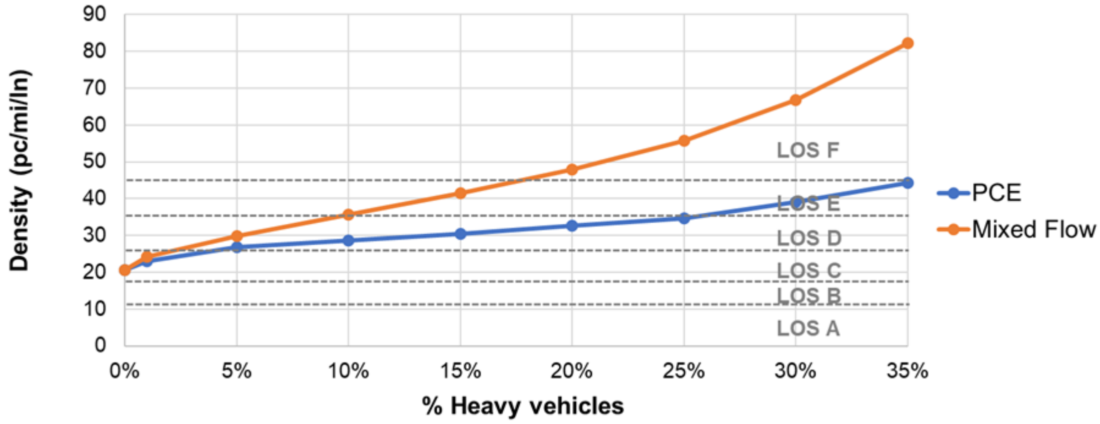
Therefore, the main question remains:
Under what conditions should we consider using the mixed-flow model?

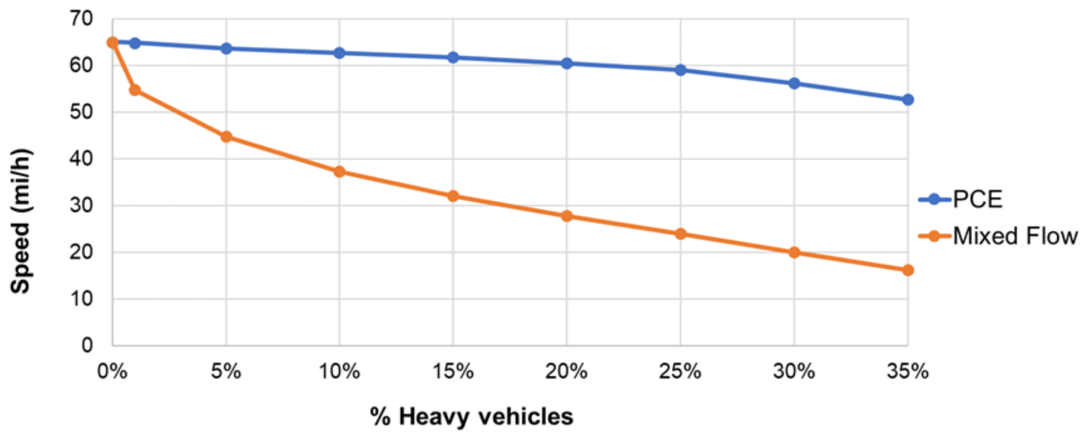
To illustrate the differences between PCE and Mixed-Flow outputs, a sample basic segment with the following characteristics is analyzed:

- Demand: 4,000 veh/h

- Free-Flow Speed: 65 mi/h
- 8% grade, with a 1-mile length
- Truck mix: 30% SUT, 70% TT

Several inputs of the % of heavy vehicles were tested using the Highway Capacity Software and the results comparing the results of both approaches are presented next:





Since this segment has a significant grade of 8%, differences can be noticed even at 1% heavy vehicles, as the mixed-flow model yields a 16% lower speed and a 6% higher density. As the percentage of heavy vehicle increases, the differences between the two methods also increase.

The Mixed-Flow model approach can be activated in HCS by checking the following box (make sure the terrain type input is set as "Specific Grade"):

Demand Data			
Demand, veh/h	4000	Peak Hour Factor	1.00
Total Trucks, %	30.00	Single-Unit Trucks (SUT), %	70
Tractor-Trailers (TT), %	30	Mixed Flow Model	☑

Both results are provided in the HCS report so the user can compare both outputs and assess whether the differences are relevant:

Speed and Density			
Lane Width Adjustment (fLW)	-	Average Speed (S), mi/h	58.2
Right-Side Lateral Clearance Adj. (fRLC)	-	Density (D), pc/mi/ln	36.0
Total Ramp Density Adjustment	-	Level of Service (LOS)	E
Adjusted Free-Flow Speed (FFSadj), mi/h	65.0		

(a) PCE - performance measures

Mixed-Flow Speed and Density			
Auto-Only Breakpoint (BP_{ao}), pc/h/ln	1400	Auto Travel Rate at Cap. ($\tau_{a,cap}$), s/mi	133.9
Mixed-Flow Breakpoint (BP_{mix}), veh/h/ln	0.0	Auto Travel Rate 90% Cap. ($\tau_{a,90cap}$), s/mi	106.7
SUT Travel Rate at Cap. ($\tau_{SUT,cap}$), s/mi	147.0	Speed Calibration at Cap. ($S_{calib,cap}$), mi/h	25.4
SUT Travel Rate 90% Cap. ($\tau_{SUT,90cap}$), s/mi	123.5	Speed Calib. 90% Cap. ($S_{calib,90cap}$), mi/h	31.1
TT Travel Rate at Cap. ($\tau_{TT,cap}$), s/mi	189.8	Speed-Flow Curve Exponent (ϕ)	3.03
TT Travel Rate 90% Cap. ($\tau_{TT,90cap}$), s/mi	166.3	Mixed Traffic Flow Rate (v_{mix}), veh/h/ln	1333
Traffic Int. Term at Cap.($\Delta\tau_{TI,cap}$), s/mi	47.73	Mixed-Flow Speed (S_{mix}), mi/h	22.1
Traffic Int. Term 90% Cap.($\Delta\tau_{TI,90cap}$), s/mi	24.25	Mixed-Flow Density (D_{mix}), veh/mi/ln	60.3

(b) Mixed-Flow - performance measures

Engineering judgement is required to determine what is an acceptable difference in a case-by-case basis. Nevertheless, the Mixed-Flow model approach is not data intensive and can be easily performed in HCS. Therefore, a recommended practice is to always include this approach in your analysis if either grades or presence of trucks are significant.

Highway Capacity Analysis Webinars

18 PDHs provided for each series

Aug 02 - 06 1 - 5 PM ET

Highway Safety Analysis Webinars

8 PDHs provided for each series

Jul 13 - 14 1 - 5 PM ET

HCS Hands-On Training

8 PDHs provided for each series

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