

Integrating Second-by-Second Traffic Movement Data Generated from Traffic Simulation Models onto MOVES Project Level Analyses

John Byun

Operating Mode vs. VSP Bins

		Speed Class (mph)			<i>PLUS</i> One mode each for idle (Bin 0), and deceleration/braking (Bin 1) ----- <i>Gives a total of</i> 23 opModes
		1-25	25-50	50 +	
VSP Class (kW/tonne)	30 +	16	30	40	
	27-30				
	24-27		29	39	
	21-24		28	38	
	18-21				
	15-18			37	
	12-15		27		
	9-12	15	25		
	6-9	14	24	35	
	3-6	13	23		
	0-3	12	22	33	
< 0	11	21			

Source: US EPA

Emissions from Vehicle Running Movements

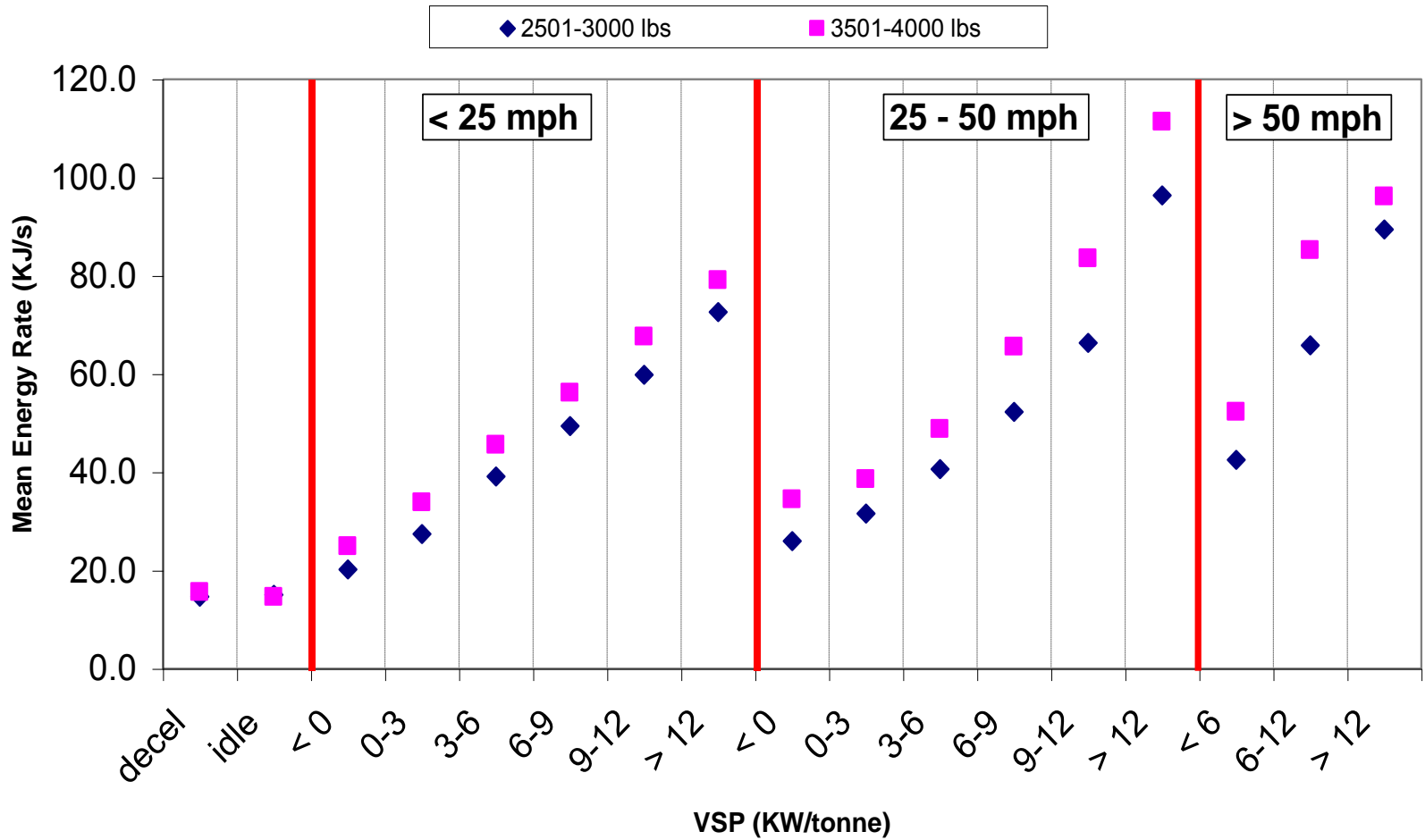
- Operating Modes
 - Three distinctive classes of vehicle speed
 - 0-25 mph, 25-50 mph & 50+ mph
 - VSP Classes
 - For each speed class

Operating Mode Bins (Running Energy Consumption)

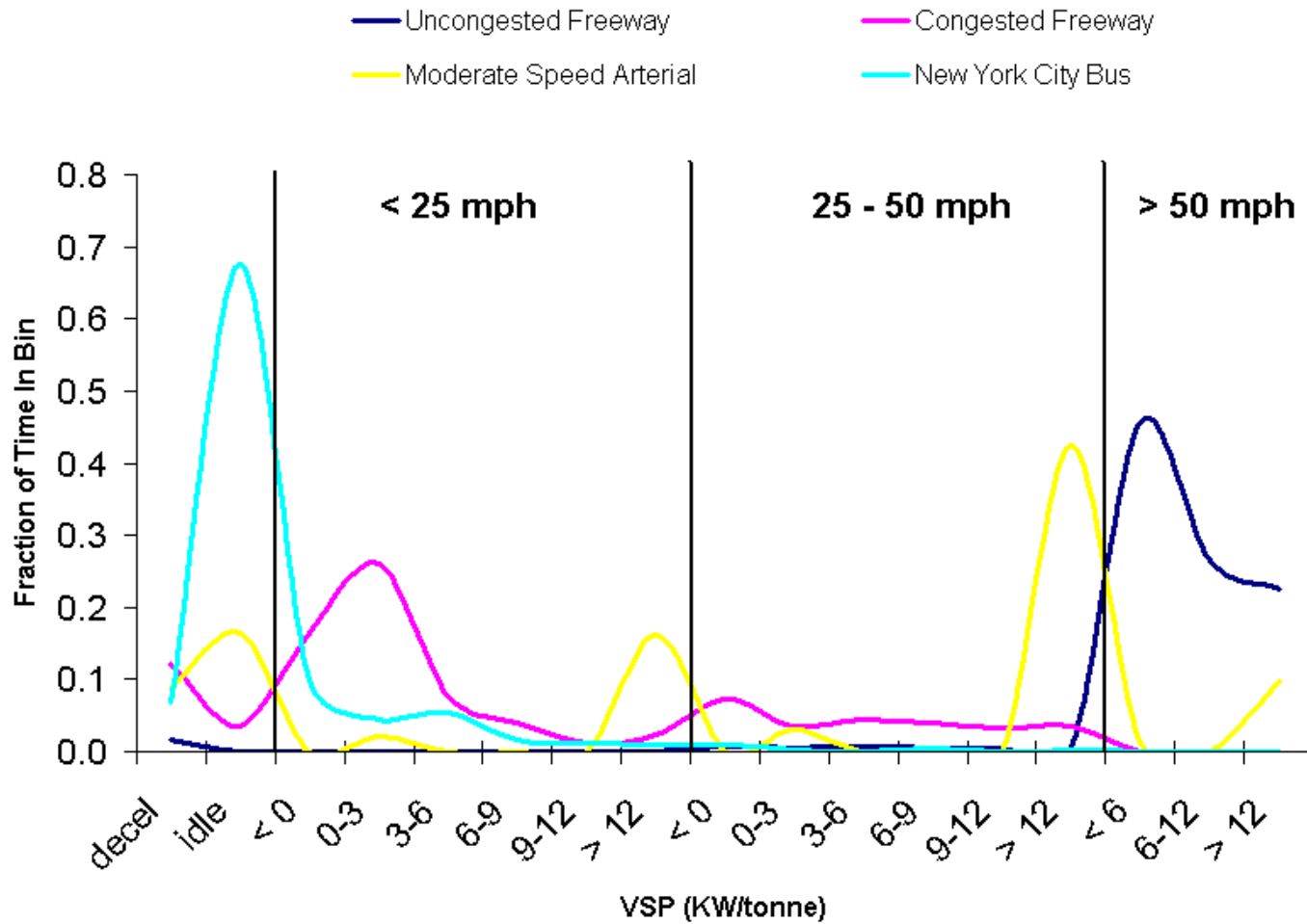
Braking (Bin 0)			
Idle (Bin 1)			
VSP \ Speed	0-25mph	25-50	>50
< 0 kW/tonne	Bin 11	Bin 21	-
0 to 3	Bin 12	Bin 22	-
3 to 6	Bin 13	Bin 23	-
6 to 9	Bin 14	Bin 24	-
9 to 12	Bin 15	Bin 25	-
12 and greater	Bin 16	Bin 26	Bin 36
6 to 12	-	-	Bin 35
< 6	-	-	Bin 33

Energy Consumption Rates By Bin

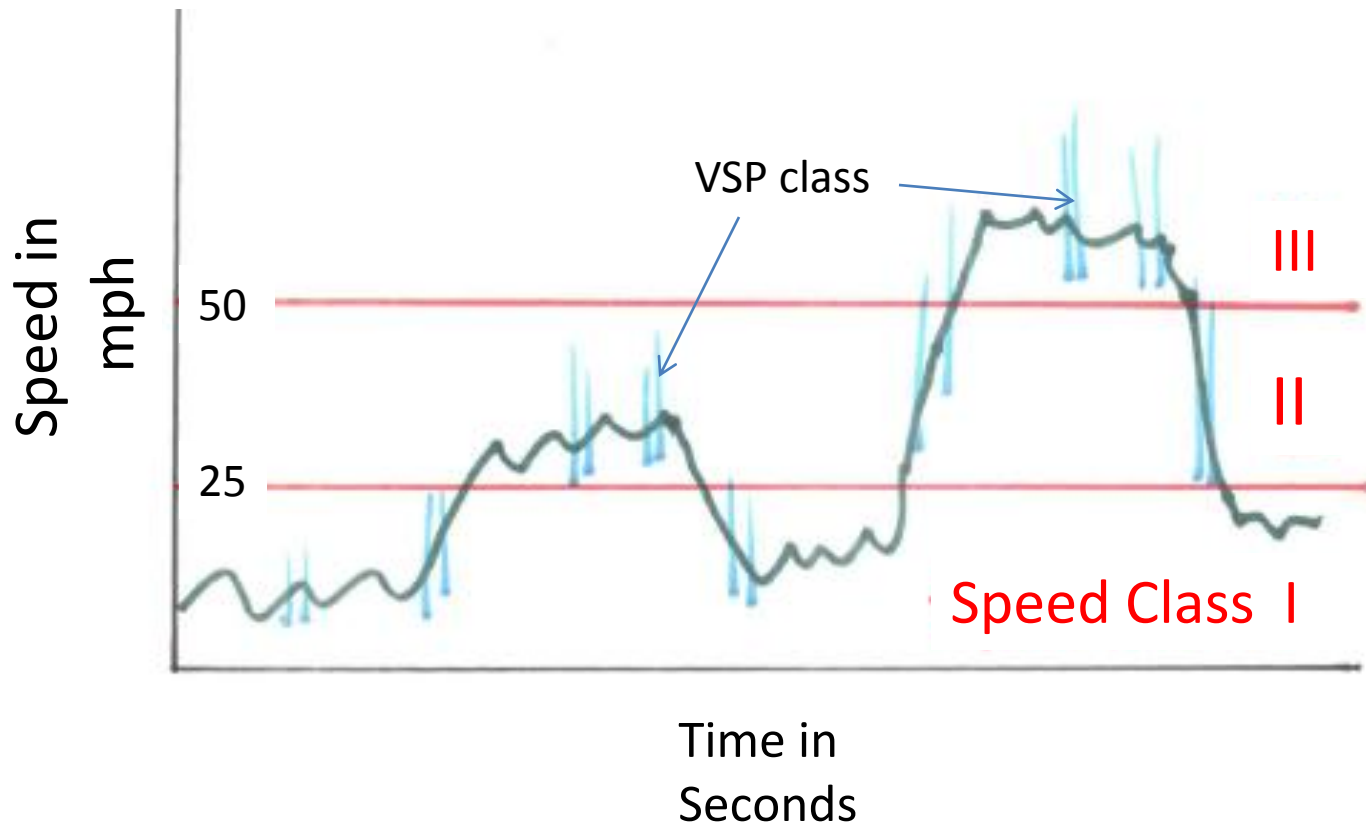
Source Bin: Gasoline / 86-90 MY / 2.0-2.5 liter



Distribution of Time By Bin



Second-by-Second Vehicle Trajectories VS. MOVES Operating Modes



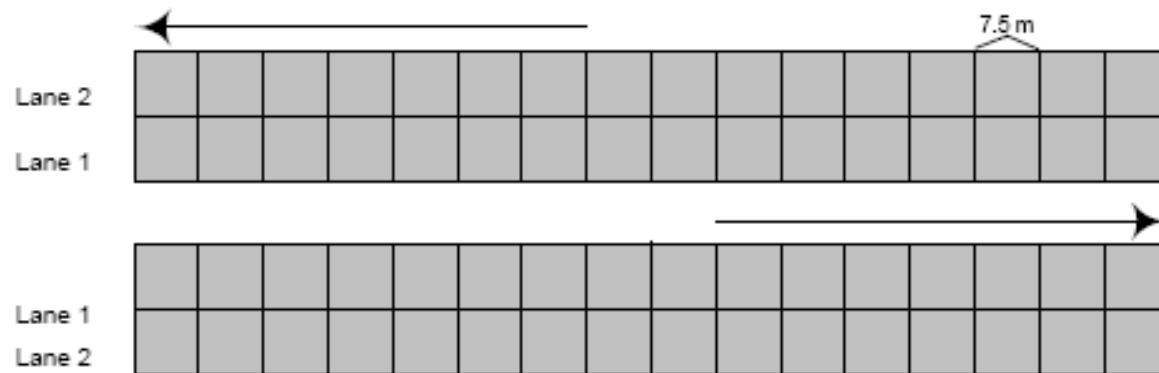
Common Micro Simulation Techniques

- NETSIM, & CORSIM etc.
 - Each second, all movements (advancement and lane changes) are executed for each vehicle
 - Each vehicle movements are recorded in X & Y coordinates
 - No cell blocks in the lane
- TRANSIMS
 - Each section of the roadway is divided into cells of one grid lane wide by 7.5 m long
 - Each time step (second), a vehicle on the network decides to accelerate, brake, or change lanes in response to the occupancy of the nearby grid cells in accordance with their current velocity

Real World Traffic Flow vs. Traffic Simulation

- Second-by-Second vehicle movements in simulation are based on the model developer's logic
- No model validation/calibration done for second-by-second vehicle movements
- Average speed comparisons may be performed with some statistical validity

TRANSIMS Link with Grid Cells



Cell: The smallest unit of division on a grid. The Microsimulator uses a cell size of 7.5 meters long. Vehicles may occupy more than one cell of the grid (e.g., transit vehicles).

Emissions from Vehicle Running Movements

- Based on Operating Modes
 - Three distinctive classes of vehicle speed
 - 0-25 mph, 25-50 mph & 50+ mph
 - VSP Classes
 - For each speed class

VSP Info. Generated from AZ I/M Data

VSP represents the vehicle's tractive power normalized to its weight, and calculated is a function of velocity, acceleration, weight and the Vehicles road-load coefficients

$$\text{VSP}_t = \frac{Av_t + Bv_t^2 + Cv_t^3 + v_t a_t}{m}$$

<p>v = velocity, m/sec a = acceleration m/sec² m = weight (tonne) A = rolling resistance (kW-sec/m) B = rotating resistance (kW-sec²/m²) C = aerodynamic drag (kW-sec³/m³)</p>

Then smooth VSP, using a weighted-centered moving average...

$$\text{VSP}_{wcm,t} = \frac{1}{4} \text{VSP}_{t-1} + \frac{1}{2} \text{VSP}_t + \frac{1}{4} \text{VSP}_{t+1}, \text{VSP} \neq 0$$

Source: EPA Office of Transportation and Air Quality

Calibration Steps for Second-by-Second Movements

(Field Data vs. Simulated Data)

- 1) Average speeds
- 2) Calibrate for 4 speed classes (idle, 0-25 mph, 25-50 mph, & 50 +)
- 3) For each speed class
calibrate for VSP bin distribution

Note: **Moving averages (second-by-second vehicle movement data)** may be helpful

Suggestions for Model Improvements

- Developing links for PM Hot-Spot Model based on vehicle operating characteristics
 - Acceleration, deceleration, & cruise are an essential parts for modeling pollutant dispersion
 - Using existing drive schedules for **average speeds** of accel., & decel. links are problematic
 - **Adding accel., decel, & cruise specific(?) driving schedules would improve AQ dispersion model's accuracy**
- How about Highway Ramp Drive Schedules?
 - On ramps & Off ramps (accel & decel links)