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Think Forward

Isolating the Effects of HOV Weaving: A Trajectory-Based Microsimulation Approach

presented to

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presented by

Cambridge Systematics, Inc.

Shaghayegh (Rira) Shabanian

Background and Motivation

- Caltrans' HOV degradation report, submitted annually to FHWA
- Must identify root causes and recommend corrective actions
- Weaving impacts are difficult to assess using data alone

Methodology Overview

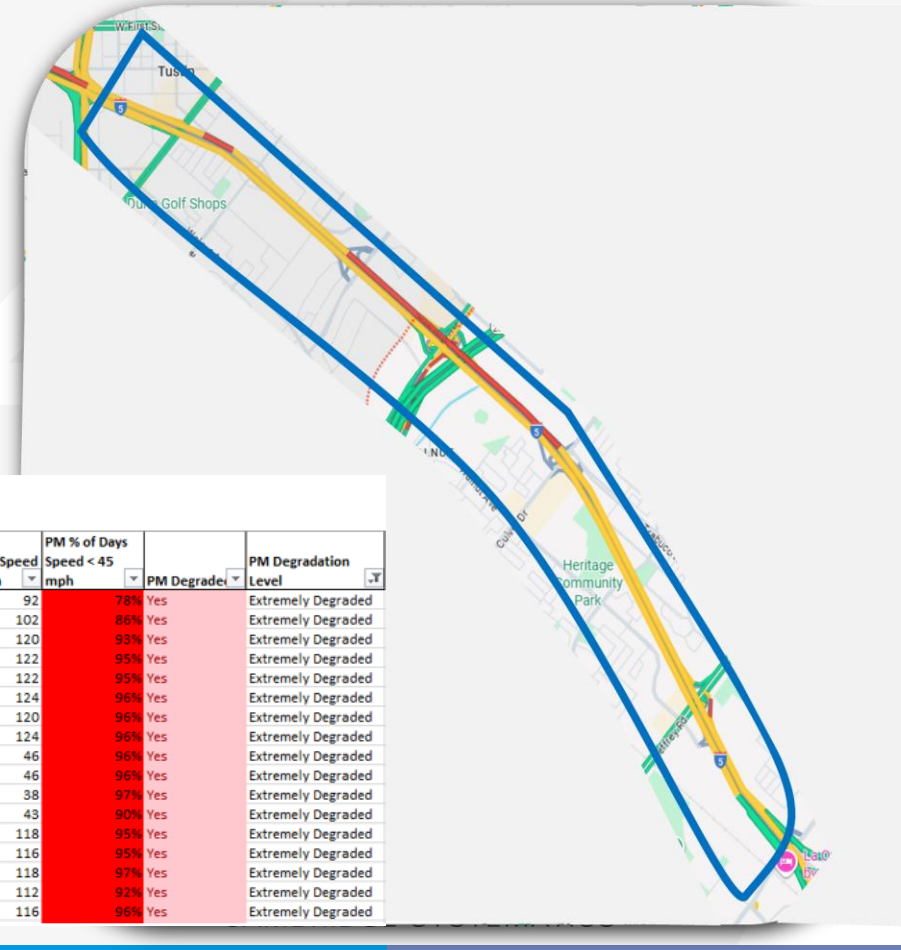
- Literature review on modeling (HOV) weaving
- Pre-screening potential corridors
- Tool selection
- Detailed simulation
- Alterative analysis

Pre-screening

- Primary Assessment
  - Initial assessment by Caltrans
  - Continuous access
  - No direct connector
- Secondary Assessment
  - Detector coverage and health
  - Ramp volumes
  - HCS operational analysis
  - Video coverage

Selected Segment

- I-5 Northbound between Sand Canyon and Red Hill, between 1:00 to 8:00 pm.
  - Severe degradation
  - Weaving determined as a cause in past 2 reports
  - High ramp volume
  - LOS of E in HCS analysis
  - Good CCTV camera coverage
  - Acceptable PeMS coverage



I-5 Northbound – PM Peak Period

Abs Postm	Station #	Name	PM Avg Spee	PM Days With Data	PM Days Speed < 45 mph	PM % of Days Speed < 45 mph	PM Degrade	PM Degradation Level
96.308	1204859	SAND CANYON 2	25.3	118	92	78%	Yes	Extremely Degraded
96.758	1204876	N OF SAND CNYN	19.6	118	102	86%	Yes	Extremely Degraded
97.338	1204922	JEFFREY 1	17.5	129	120	93%	Yes	Extremely Degraded
97.408	1204935	JEFFREY 2	16.5	129	122	95%	Yes	Extremely Degraded
98.058	1204956	YALE	17.0	129	122	95%	Yes	Extremely Degraded
99.801	1205043	JAMBOREE 1	14.6	129	124	96%	Yes	Extremely Degraded
100.351	1205086	TUSTIN RANCH	22.7	125	120	96%	Yes	Extremely Degraded
102.251	1208975	B ST	23.5	129	124	96%	Yes	Extremely Degraded
102.651	1209011	N OF 55	22.7	48	46	96%	Yes	Extremely Degraded
103.151	1209693	1ST	30.9	48	46	96%	Yes	Extremely Degraded
103.481	1209727	4TH	34.9	39	38	97%	Yes	Extremely Degraded
103.851	1212047	GRAND 1	41.4	48	43	90%	Yes	Extremely Degraded
106.451	1210034	LA VETA	25.9	124	118	95%	Yes	Extremely Degraded
106.651	1212013	N OF 57*	25.9	122	116	95%	Yes	Extremely Degraded
106.851	1212142	CHAPMAN 1	31.0	122	118	97%	Yes	Extremely Degraded
107.251	1205373	CHAPMAN 2	36.8	122	112	92%	Yes	Extremely Degraded
107.351	1212268	STATE COLLEGE	35.2	121	116	96%	Yes	Extremely Degraded

Selected Tool

Compared TransModeler, Aimsun and Vissim for:

- Literature on weaving analysis / Lane changing behavior
- Lane-based calibration
- Modeling HOV's preference

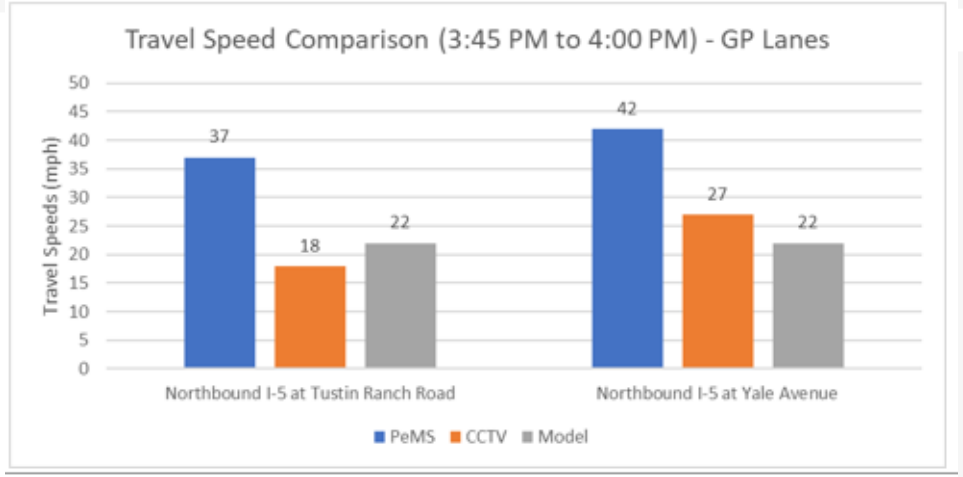
Functionality	Vissim	TModeler	Aimsun
Having separate user classes for GP and HOV	✓	✓	✓
Controlling violation for open access HOV	Shold test	Shold test	Shold test
Controlling HOV Lane Utilization	✗	✓	✗
Location-based driving behavior	✓	✓	✓
Replicating lane changing density by location	Shold test	Shold test	Shold test
Controlling lane utilization by heavy vehicles	✓	✓	✓

Data Sources

- Travel Demand Model
- PeMS
- Truck counts
- Intersection and ramp Count
- Observed origin-destination data
- Vehicle occupancy data
- Signal timing
- Ramp metering rate
- Videos
- Crash data

Data Cross-Validation

- **Volume:** Ramp volume discrepancy between PeMS and observed OD data; videos and field checks confirmed volume from OD data
- **Truck use:** Allowed on right 2 lanes, but video shows heavy use of 3rd lane
- **Speed:** PeMS indicated GP lanes faster than HOV, video showed opposite



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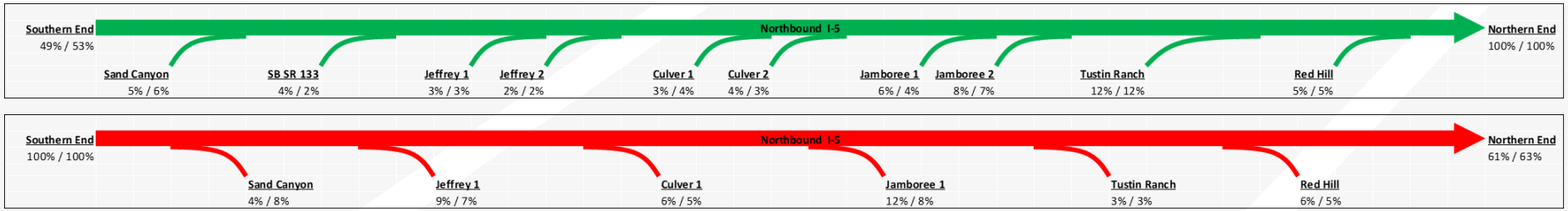
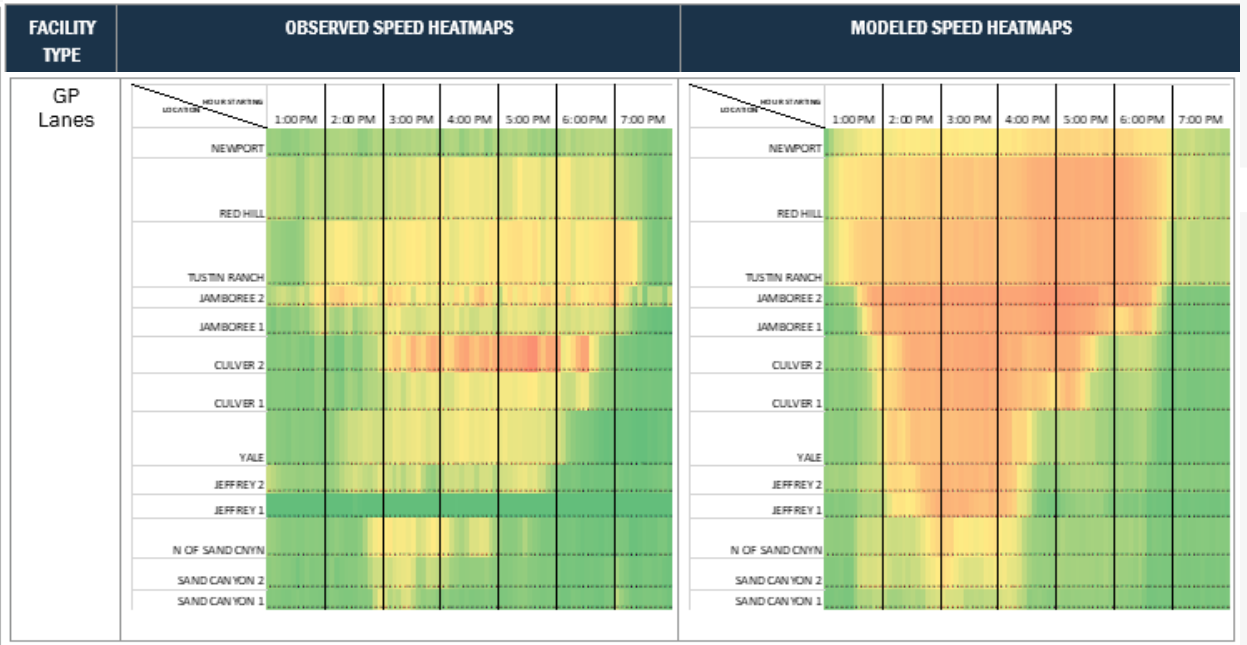
Calibration Summary

- Iterative process between ODME and driving behavior
- Adjusted:
  - Car following: longer headways
  - Lane changing: shorter look ahead distance
  - speed distribution across lanes
  - Lane utilization: forced some of through traffic to use the most left GP lane
  - HOV lane utilization: increased bias towards using HOV
  - Jam density: adjusted based on videos of queued vehicles

Calibration Summary



OD Comparison – 3:00 to 4:00 pm



Speed Heat Maps – HOV and GP lanes

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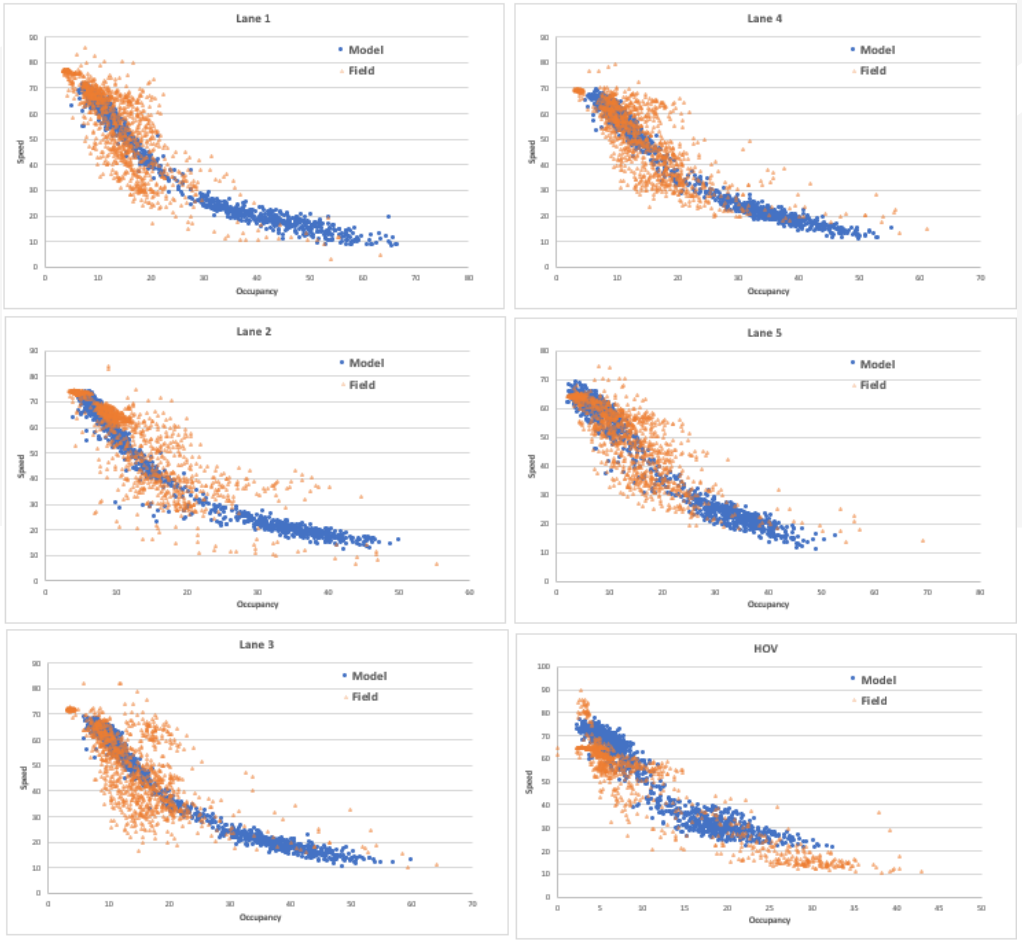
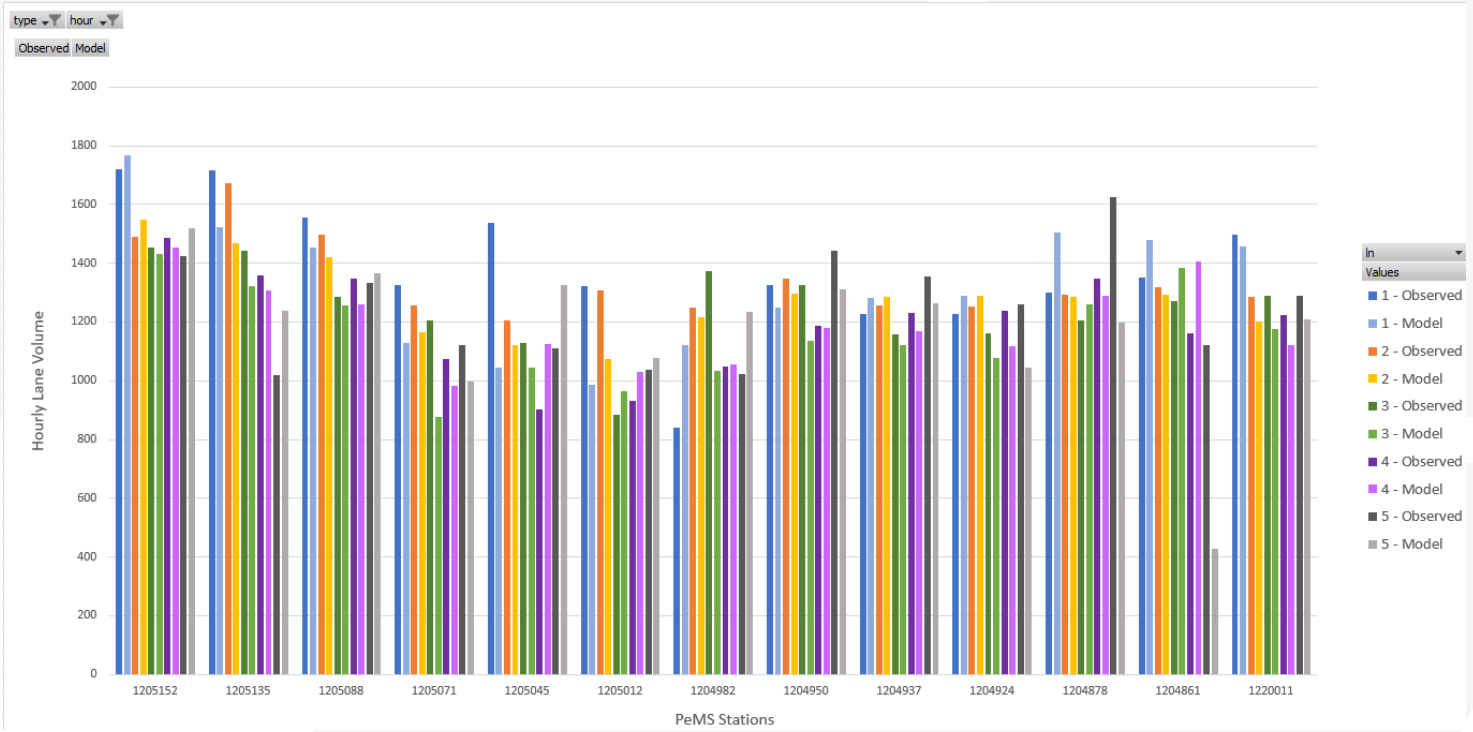
Calibration Summary



Lane Level Fundamental Diagram



Hourly Lane Utilization

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Scenarios Tested

- Five scenarios based on direct access between HOV lane and ramps
  - Alternative 1: direct access everywhere but to major ramp SR-55
  - Alternative 2: direct access everywhere
  - Alternative 3: direct access at SR-55 and selected ramps
  - Alternative 4: direct access only at SR-55
  - Alternative 5: converted continuous access to limited access

Performance Measures

- Corridor travel time and delay

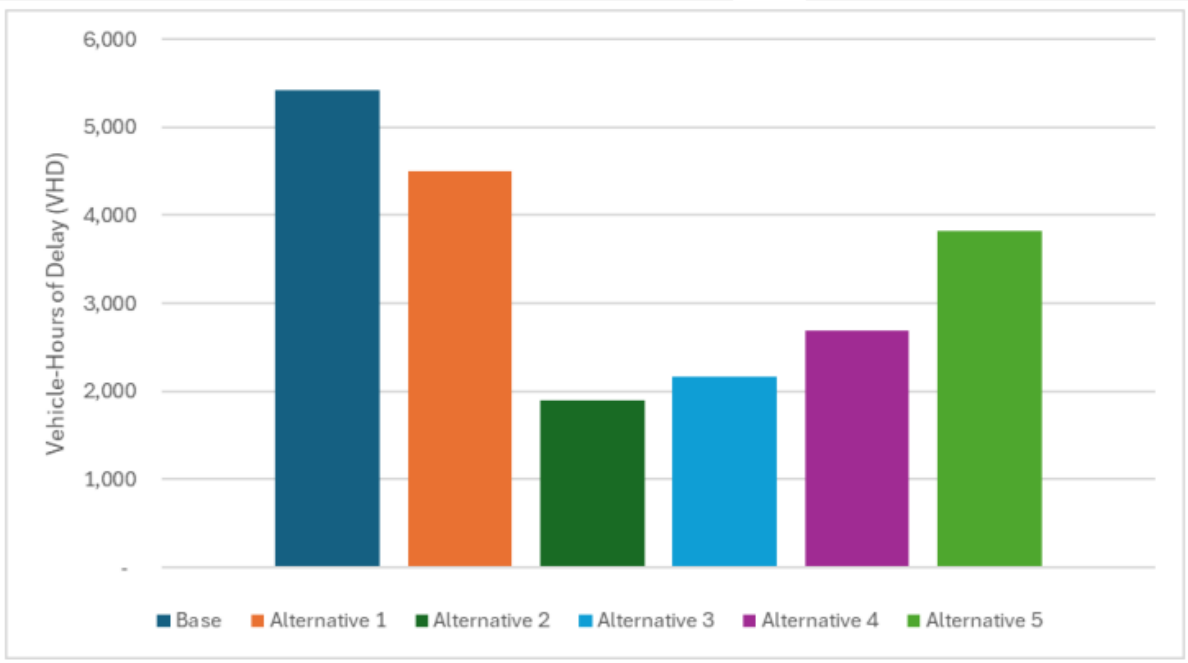

FIGURE 4.15: TOTAL VEHICLE-HOURS OF DELAY BY SCENARIO

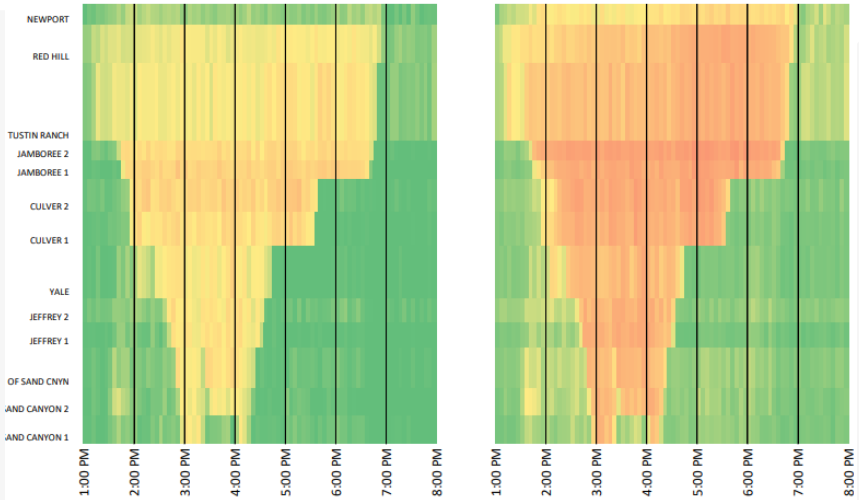

FIGURE 4.7: HEAT MAP, BASE (LEFT=HOV LANE; RIGHT=GP LANES)

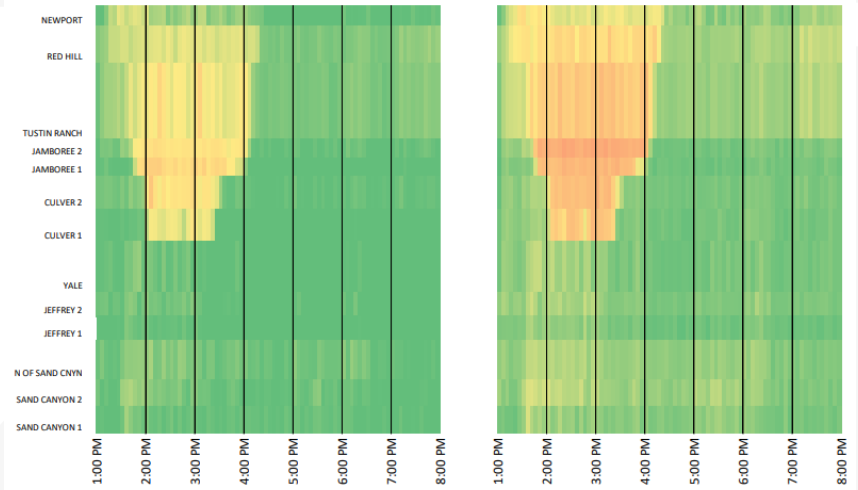

FIGURE 4.9: HEAT MAP, ALTERNATIVE 2 (LEFT=HOV LANE; RIGHT=GP LANES)

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Performance Measures

- Number of lane changes from and to HOV

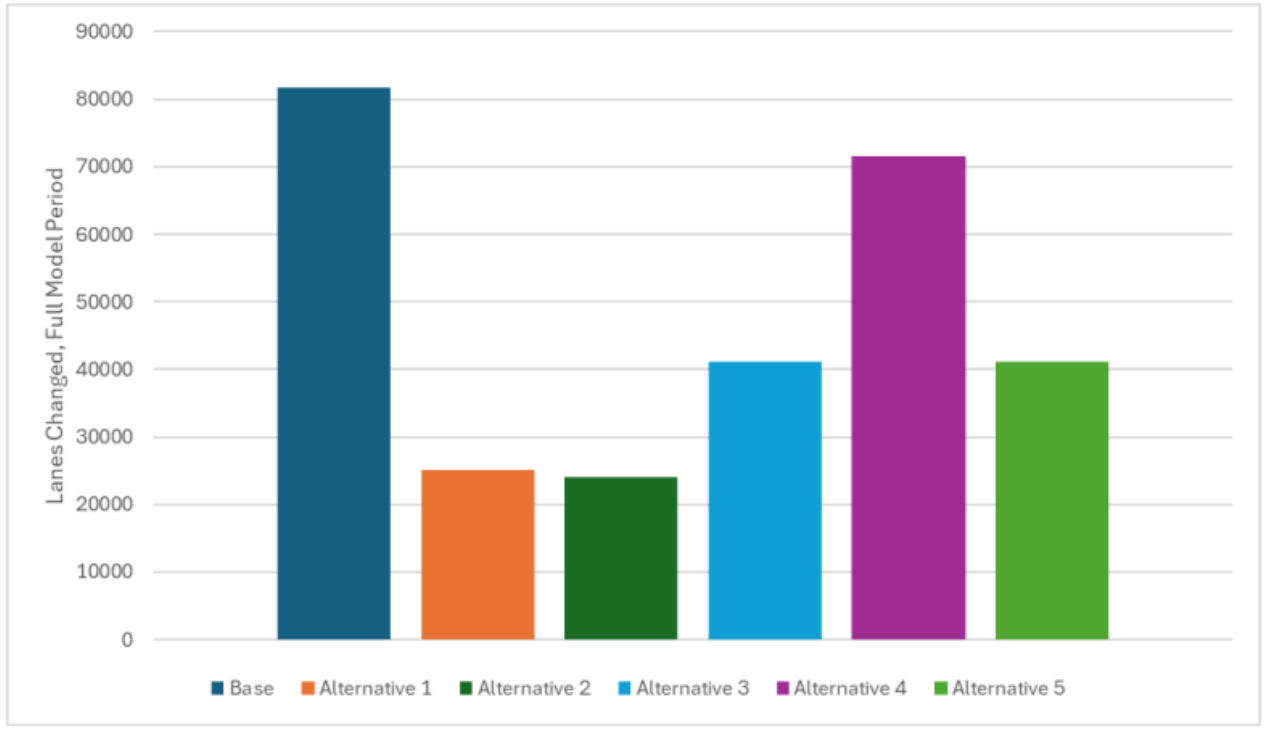

FIGURE 4.19: TOTAL LANES CHANGED DURING HOV MOVEMENTS, BY SCENARIO

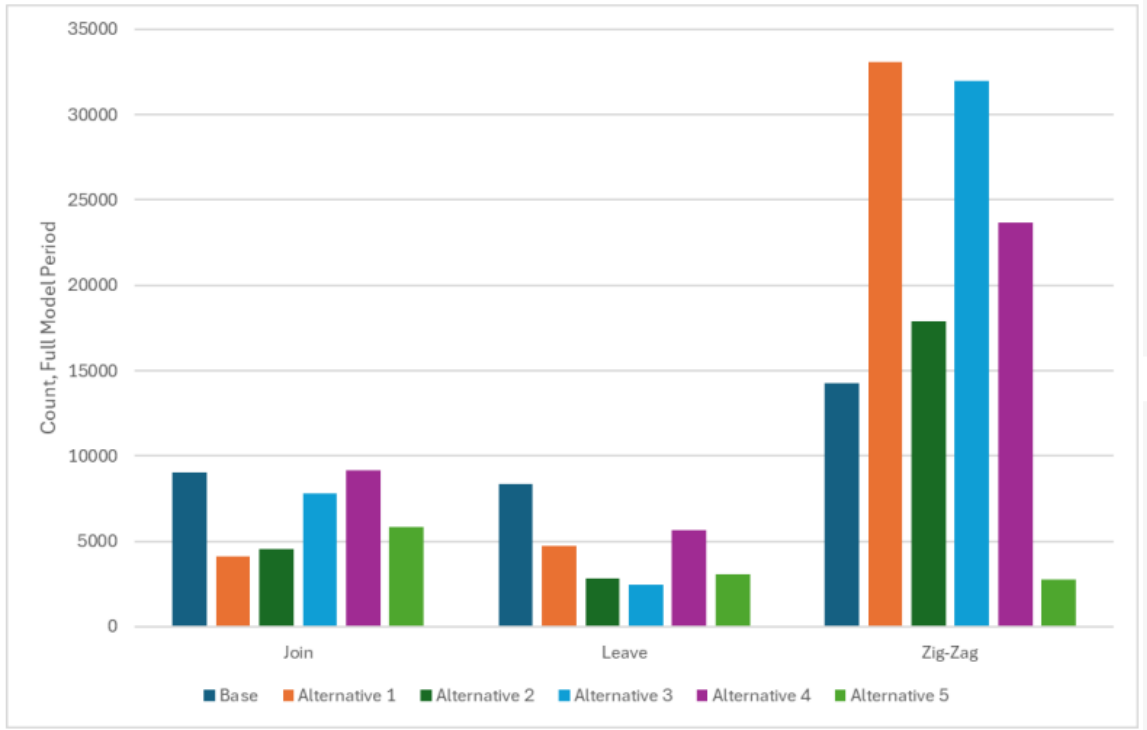

FIGURE 4.18: HOV LANE MOVEMENTS BY TYPE

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Conclusion

- Simulation can help to isolate and quantify the effect of weaving
- Pre-screening is valuable, with potential data-driven approaches
- Data cross-validation proved essential, guiding key calibration decisions