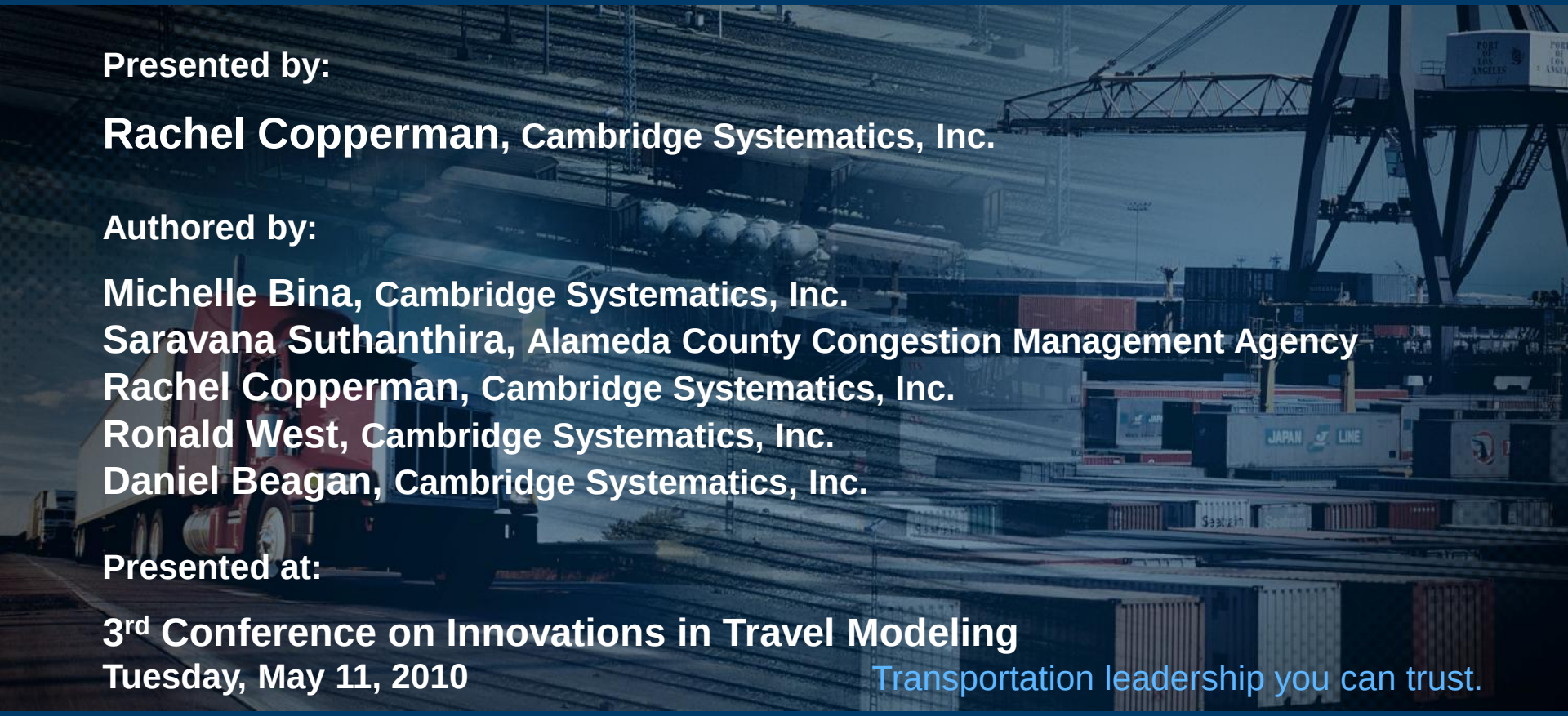
Matrix Estimation as a Calibration Tool in Commercial Vehicle Modeling



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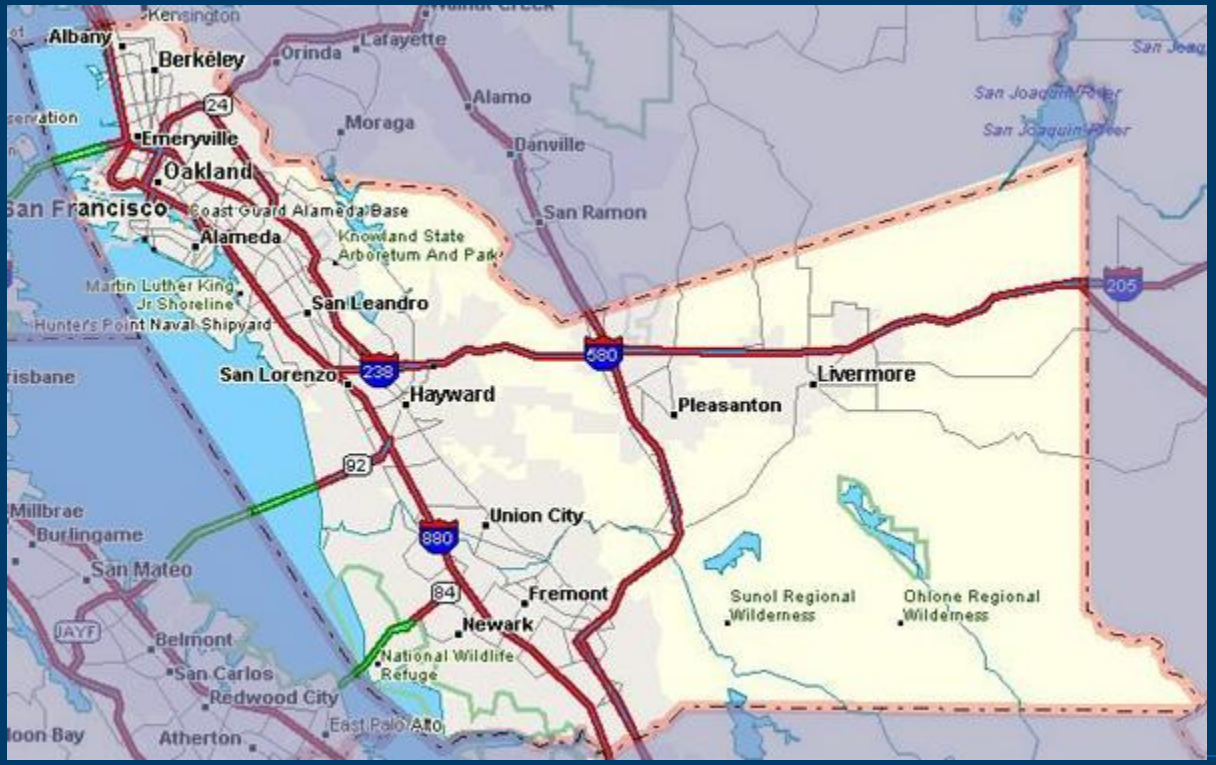
Project Background

- The Alameda County Congestion Management Agency (ACCMA) located in the San Francisco Bay Area, addresses transportation needs by coordinating planning efforts, funding, and other such transportation activities



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- The purpose of the project was to improve the truck component of the 2005 Alameda Countywide Transportation Model
- Collected count data in the ACCMA area and used data as an input into an ODME process. ODME was used for calibration and validation of improved truck model.

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Review of Existing Model

- Trip generation estimates internal productions and attractions for four truck types
  - very small [2-axle, 4 tires]
  - small [2-axle, 6 tires]
  - medium [3-axle], and
  - combo [4-axle +]
- Gravity model is used to distribute productions and attractions between internal zones for each truck type
- All model steps after trip distribution are performed with the four truck classifications aggregated to total trucks

Existing Model Validation

Performance Measure	Total Vehicles	Autos	Total Trucks
Sum of Observed Volumes	3,405,986	3,084,157	321,828
Sum of Modeled Volumes	2,992,611	2,731,870	139,385
Percent Error	-12%	-11%	-57%

- In addition, assigned total truck trips contain zero truck trips at external stations, as well as underestimate volumes on major truck corridors outside of Alameda County

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Overview of Model Improvements

- Model very small [2-axle, 4 tires] trucks in the passenger travel modeling framework, but exclude from the truck modeling framework
- Modify trip generation rates and trip distribution friction factors and impedance variables
- Include internal-to-external/external-to-internal (IE/EI), external-to-external (E-E), and special generator truck trips
- Maintain separate truck classes through the assignment stage and include passenger Car Equivalent (PCE) factors during assignment

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Origin-Destination Matrix Estimation

- ODME procedure is an accepted practice that estimates trip tables based on traffic count data
- Input data includes observed traffic counts on each directional link and the existing truck travel model O-D trip table (used as a seed matrix)
- The ODME process estimates an O-D trip table which, when assigned to the network, produces link flows that optimally match the observed counts
- Cube Analyst is used for the ODME process

ODME Process within Cube Analyst

- Only optimizes one trip table, based on one set of counts, rather than separate trip tables for each vehicle class
- Procedure Used:
  - Seed Matrix: Existing model's O-D table for total truck trips
  - Constraint: Observed total truck trips
  - Existing model's assigned auto trips (drive alone and shared-ride) are preloaded to the network
- Obtain truck trips by vehicle class by applying the existing model's vehicle class ratios to the ODME table
- Added nonzero values to seed matrix cells that represent unassigned external zones as an origin or a destination

Data Collection

- New count data were collected at one dozen highway locations and at 50 arterial locations throughout Alameda County
  - » strategically located to cover major truck routes and truck trip generators across the county
- Performance Measurement System (PeMS) data were examined throughout Alameda County
  - » emphasis on including locations where new data was collected
- Caltrans Traffic Count Book and Truck AADT reports were also consulted
  - » especially for locations outside of Alameda County along major truck routes

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ODME Estimated Trip Table

- A ratio matrix of ODME to Original OD Table was calculated in order to examine the adjustments from ODME
- For internal-to-internal (I-I) zone pairs, the overall adjustment was a decrease of 5%
  - » Fairly accurate existing model trip generation and distribution for I-I trips
- Trip table total increased by 36%
  - » due to IE/EI and E-E truck trips that were not previously included in the original model

Trip Generation – Existing Model

- Separate rates for three truck types: Small, Medium, Combo
- Separated rates for garaged and non-garaged truck trips
  - Non-garaged: production rates = attraction rates
  - Garaged: separate rates for productions and attractions
- Included coefficients which were applied to zonal employment in six categories: Manufacturing, Retail, Service, Other, Wholesale, and Agriculture
- Generated I-I trips only

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Trip Generation – Improved Model

- Eliminated garaged truck trips
- Garage and non-garage rates were averaged to provide a new starting point for the truck trip rates, which were applied only to I-I trips
- Borrowed initial E-I/I-E truck trip rates from Santa Clara Valley Transportation Authority (VTA) Model
- Developed special generator truck productions and attractions for the Port of Oakland

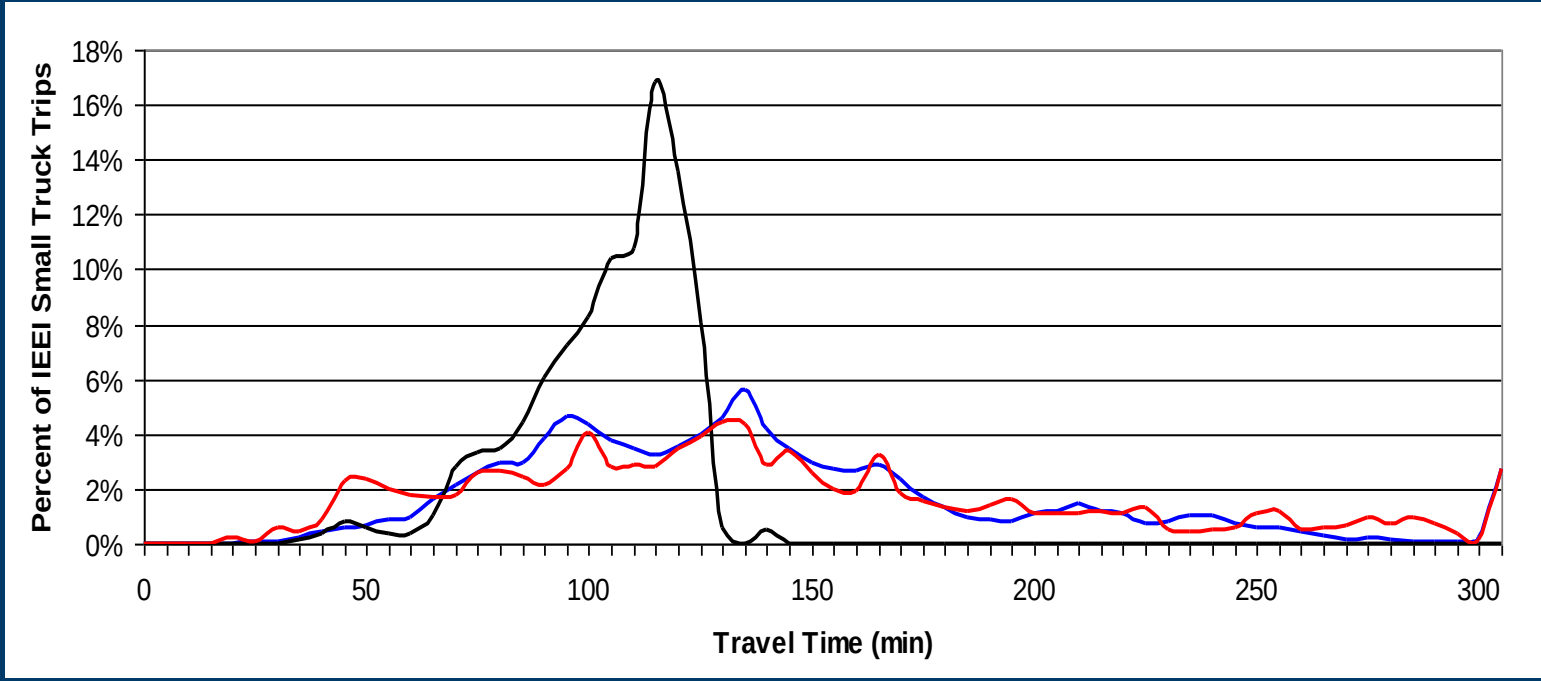
Trip Generation Calibration

- Adjusted I-I Trip Rates through Iterative Process
  - » ODME trip table cells were compared to cells in existing OD table
  - » A ratio of the sum of the changes was calculated for I-I trips
  - » An assumption was made that the ratio could be applied to adjust all trip generation coefficients
  - » Process applied iteratively along with adjustments to the trip distribution and assignment steps
- Similar method was used to adjust E-I and I-E trip rates
- Count data at ports was used to create a look-up table for special generator production and attraction trips

Trip Distribution Calibration

- Existing and ODME Trip Length Frequency Distributions (TLFD) were compared for I-I and E-I/I-E trips
- Comparison resulted in modifications to the friction factors and impedance variables
  - » Off peak skims, rather than AM skims, were used as the impedance variable
  - » Modified friction factors
- Improved Model TLFD more closely matched that of the ODME table

TLFD for E-I/I-E Truck Trips



- Blue line: ODME table
- Black line: Existing Model using AM skims
- Red line: Improved Model using OP skims and adjusted friction factors

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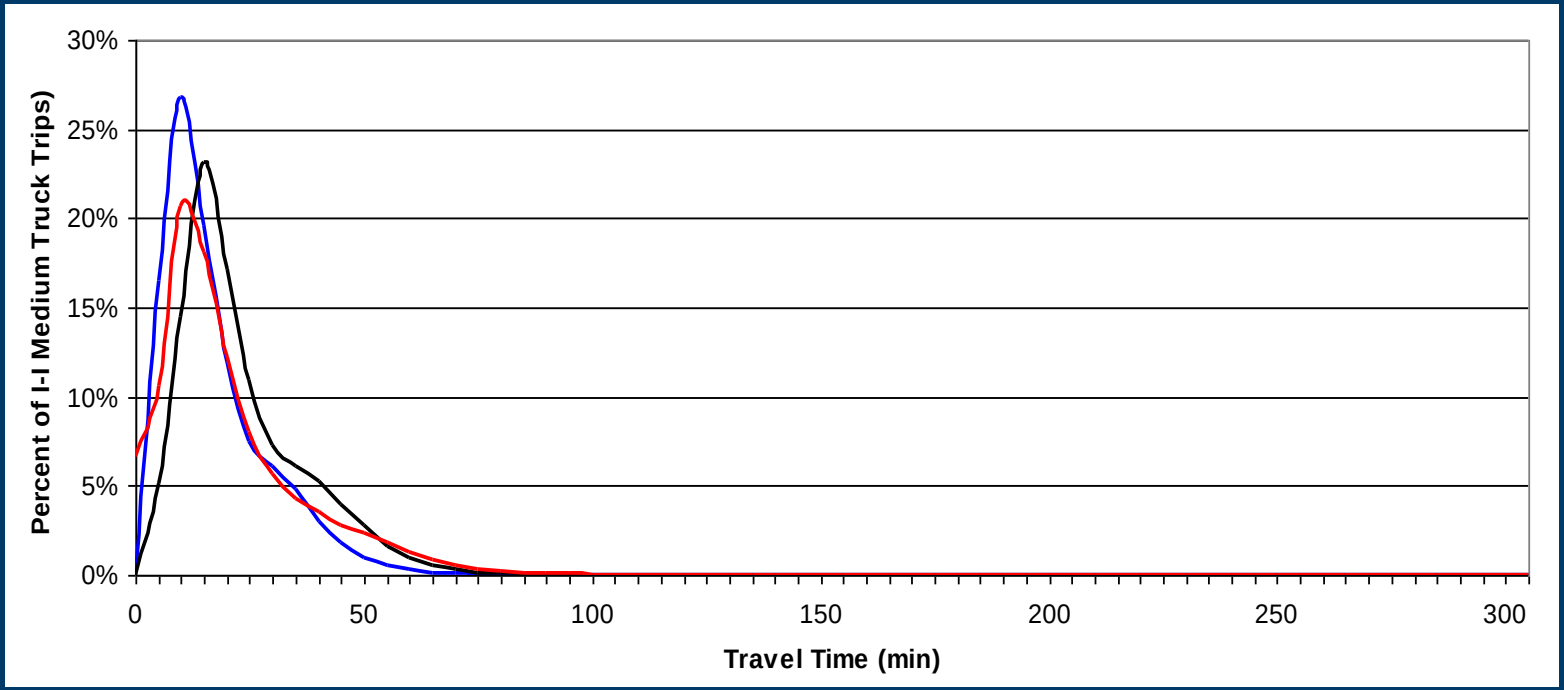
TLFD for I-I Truck Trips



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Final Model Validation Statistics
Truck Classes

	Total Trucks	Small Trucks	Medium Trucks	Combo Trucks
Sum of Observed Volumes	321,828	69,594	76,525	175,710
Sum of Modeled Volumes	310,393	68,343	72,813	178,543
Percent Error	-4%	-2%	-5%	2%
Percent RMSE	93%	138%	122%	100%

- **Calibration efforts yielded an overall 53% decrease in error and 54% decrease in RMSE for total trucks**

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Model Validation

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Sum of Observed	3,405,986	3,084,157	321,828
Sum of Existing Modeled Volumes	2,992,611	2,731,870	139,385
Percent Error Existing Model	-12%	-11%	-57%
Sum of Improved Modeled Volumes	3,379,528	3,059,830	310,393
Percent Error improved Model	-1%	-1%	-4%

Conclusion

- ODME trip table was readily prepared from the original truck tables and validation counts
- ODME table proved invaluable in guiding the enhancements to the ACCMA truck model, including being used to:
  - » Guide the inclusion of external trucks and Port special generator trucks
  - » Develop adjustment factors to be applied to the trip generation rates
  - » Suggest alternative impedance skims and new friction factors for the trip distribution process
- Availability of an ODME-derived truck table greatly expedited the calibration process