

# Application of Time-of Day Choice Models Using EMME/2

## *Washington State DOT Congestion Relief Analysis*

*presented to*

**19<sup>th</sup> International EMME/2 Users' Conference**

*presented by*

**Arun Kuppam, Cambridge Systematics**

**Maren Outwater, Cambridge Systematics, Inc.**

**Mark Bradley, MBRC**

**Larry Blain, PSRC**

**Robert Tung, RST International**

**Shuming Yan, WSDOT**

**October 19, 2005**

**Seattle, Washington**

**Transportation leadership you can trust.**

**CAMBRIDGE**  
SYSTEMATICS

# Project Objectives

- **To capture variations in time of day by 30-minute time periods**
- **To develop an approach that is sensitive to pricing scenarios**
- **To capture travel behavior that reflects tendency to shift to nearby time periods**

# Shortcomings of previous TOD Model

---

- **Five discrete time periods**
- **Model calibration based on unweighted survey**
- **Variation by income groups not captured**

# Characteristics of New TOD Model

- A logit time of day choice model, applied after mode choice to auto trips
- 32 time periods – half hours except first and last periods
- Variables include demographics, trip characteristics (carpool, bridge crossing), delay
- Includes costs measured in units of time
- Use of non-linear “shift” variable within 3 larger time periods

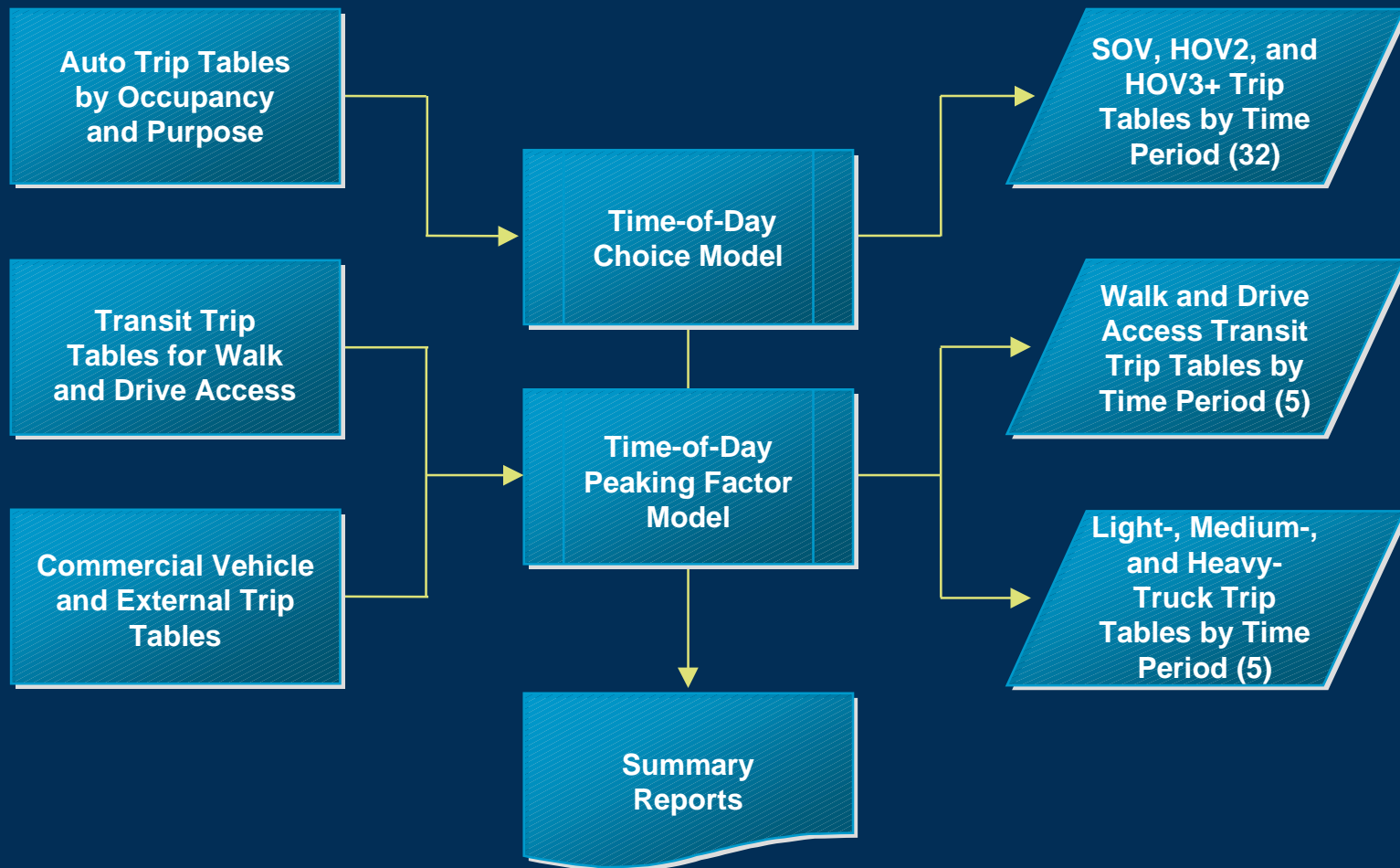
# Time Periods

- **AM Peak** – 10 30-minute time periods from 5:00 a.m. to 10:00 a.m.
- **Midday** – 10 30-minute time periods from 10:00 a.m. to 3:00 p.m.
- **PM Peak** – 10 30-minute time periods from 3:00 p.m. to 8:00 p.m.
- **Evening** – 1 3-hour time period from 8:00 p.m. to 11:00 p.m.
- **Night** – 1 6-hour time period from 11:00 p.m. to 5:00 a.m.

# Model Specification

- Multinomial Logit Structure with 32 alternatives
- $$U = ASC + C1*(Delay) + C2*[(Delay.min.20 + \sqrt{Delay-20}.max.0)*Shift] + C3*[(Delay.min.20 + \sqrt{Delay-20}.max.0)*(Shift^2)] + C4*(Bridge\ Dummy) + C5*(Bridge\ Dummy*Shift) + C6*(Carpool\ Dummy) + C7*(Carpool\ Dummy*Shift) + C8*(Household\ Size) + C9*(Household\ Size*Shift) + C10*(Income\ Group) + C11*(Income\ Group*Shift)$$
- Where, Delay for AM =  $\max[(AM\ GC - NI\ GC), 0]$   
Shift 'Early' for AM =  $(7.5 - T)$   
Shift 'Later' for AM =  $(T - 7.5)$   
 $T = Hour - 1, 2, 3, \dots, 24$   
Bridge Dummy = 1 or 0  
Carpool Dummy = 1 or 0  
Household Size =  $\min(hhsize, 4)$   
Income Group =  $\langle \$45k, >\$75k$

# TOD Modeling System



Legend:



Input Files



Models/Processes



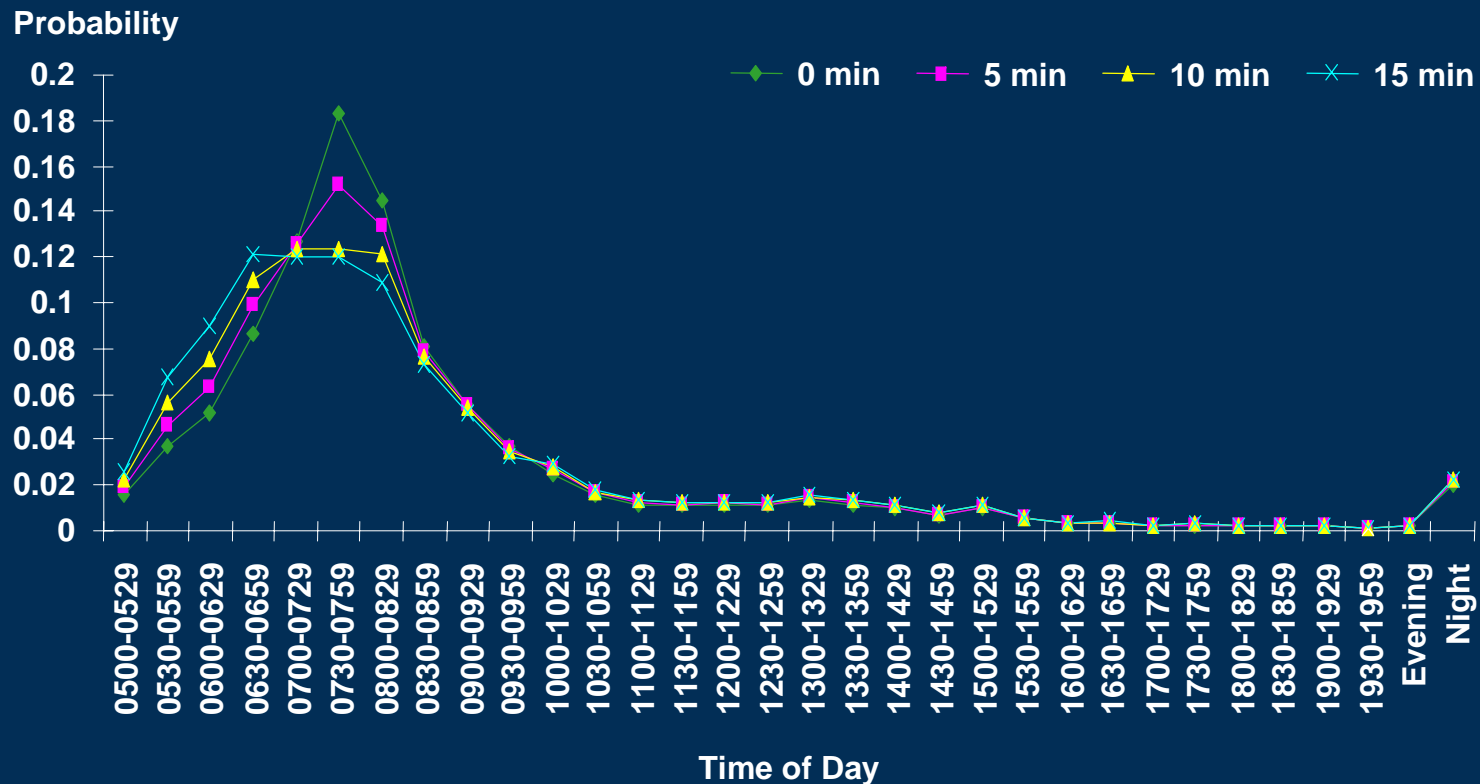
Report Output Files



Data Output Files

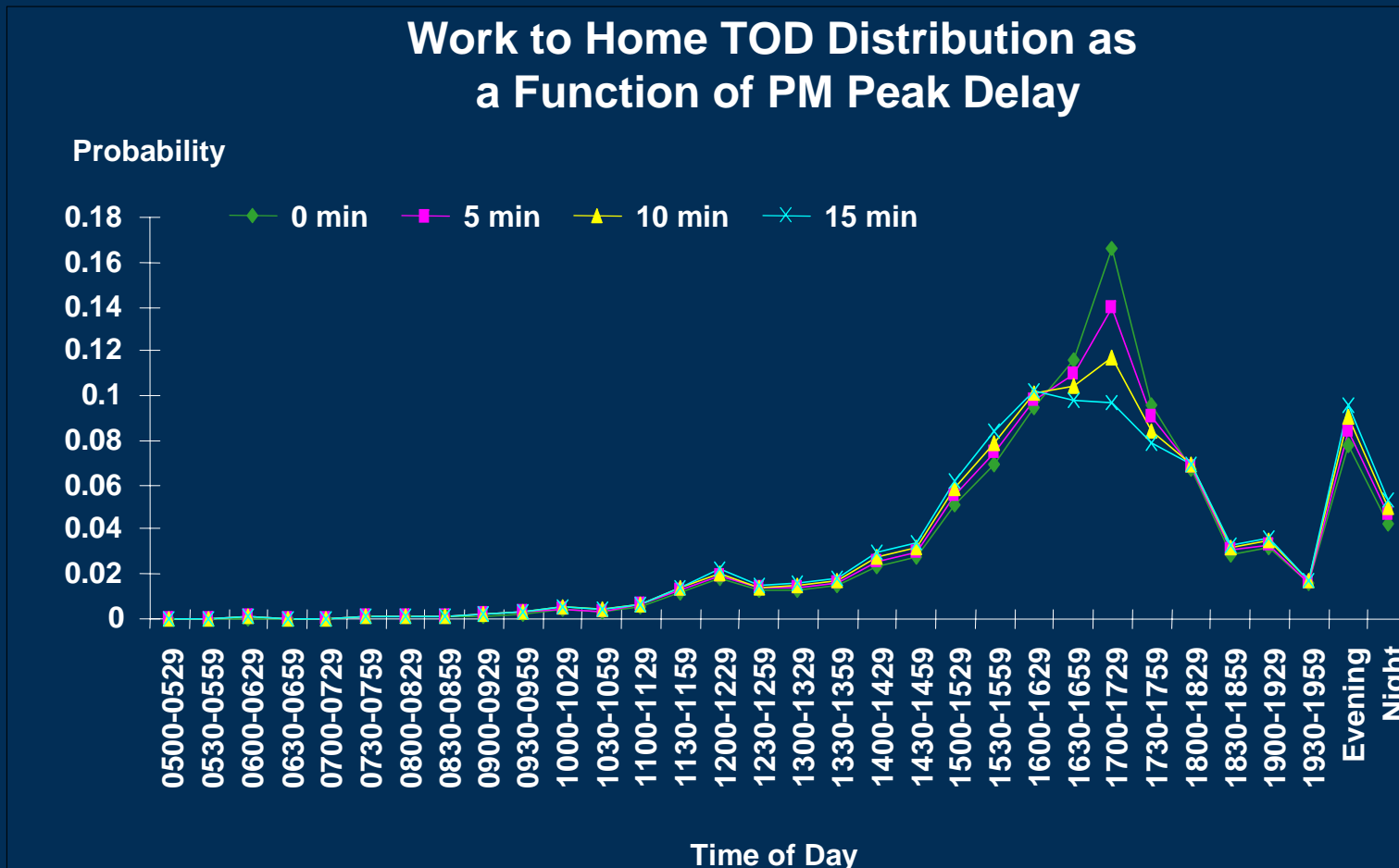
# Probabilities from TOD Model Application Home to Work

## Home to Work TOD Distribution as a Function of AM Peak Delay



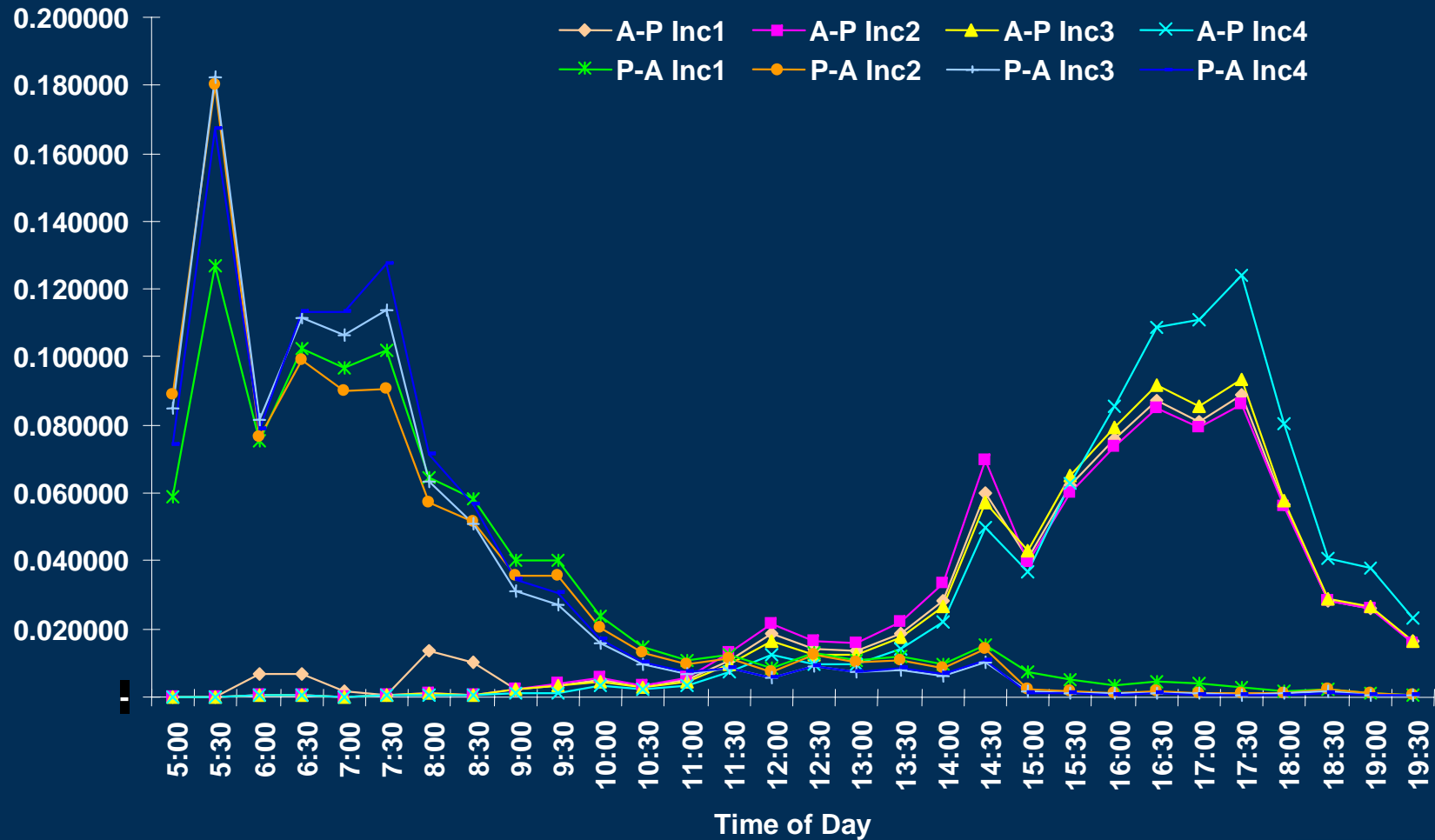
# Probabilities from TOD Model Application

## Work to Home



# Probabilities from TOD Model Application HBW Drive Alone Trips – Variation by Income Group and Direction

Shares of Trips



# Validation Results

- **Two-stage Validation**

- **Stage 1 – Validate TOD shares by trip purpose, mode of travel, and direction, results within +/- 0.02**
- **Stage 2 –Validate VMT against traffic counts by TOD, results within +/- 10%**

	<b>Time Period</b>	<b>2000 Counts (VMT)</b>	<b>2000 Model (VMT)</b>	<b>Percent Difference</b>
<b>AM Peak</b>	6 a.m. to 9 a.m.	4,428,739	4,480,908	1.2%
<b>Midday</b>	9 a.m. to 3 p.m.	8,555,459	8,337,805	-2.5%
<b>PM Peak</b>	3 p.m. to 6 p.m.	5,399,197	5,712,866	5.8%
<b>Evening</b>	6 p.m. to 10 p.m.	4,376,938	4,188,376	-4.3%
<b>Night</b>	10 p.m. to 6 a.m.	2,736,413	2,861,614	4.6%
<b>Total</b>		25,496,746	25,581,569	0.3%

# Conclusions

- **Time-of-day choice models can be estimated with 30+ time periods with existing data**
- **Models are sensitive to time and cost tradeoffs, as well as demographic factors and bridge constraints**
- **Calibration by mode, trip purpose, and direction, as well as for volumes provides more behavioral understanding of results**
- **Initial sensitivity tests indicate that models produce reasonable results**

# Acknowledgements

- **Project was completed in support of model improvements for**
  - Washington State Department of Transportation
  - Puget Sound Regional Council
- **Expert Review Panel requested additional detail on time periods**
  - University of Wisconsin, Milwaukee, WI
  - North Central Texas Council of Governments, Dallas, TX
  - Portland Metro, Portland, OR
  - Sound Transit, Seattle, WA
  - Atlanta Regional Commission, Atlanta, GA