Comparing Operational Activity-Based Models (ABMs):

What is Different and What is Not?

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Presentation Outline

- What is the Issue?
- Why does it Matter?
- Conceptual and Operational Similarities
- Structural and Implementation Differences
- Summary and Closing Thoughts



The Trip-Based or Four-Step Structure





ABMs in the United States



ABMs in the United States

The CT-RAMP Family

The DaySim Family

New York* Columbus Bay Area MTC Atlanta San Diego Phoenix Chicago Miami ...more Portland METRO** San Francisco County Sacramento Seattle Denver Philadelphia Tampa Jacksonville ...more

*The New York Best Practice Model pre-dates the name CT-RAMP

** The earliest implementation (1998) No longer in use

The Two Major Operational Frameworks

The DaySim Family



The CT-RAMP Family

1. Population Synthes	is		
2. Long-term	2.1. Usual work	+ place / school	
		-	
3. Mobility 3.1. Free F	Parking Eligibility 3.2	2. Car ownership →3.3. 1	ransponder Ownership
4. Daily	4.1. Person pattern type	& Joint Tour Indicator	1
Mandatory	Joint usschold level)	latory latoget	Home
Individual Mandatory Tours 4.2.1. Frequency 4.2.2. TOD At-work sub-tours 4.6.1. Frequency 4.6.2. Destination 4.6.3. TOD	Joint Non- Mandatory Tours 4.3.1. Frequency 4.3.2. Party 4.3.3. Participation 4.3.4. Destination 4.3.5. TOD	Allocated Tours	A.5.2. Destination
5. Tour level		+	
5.1. Tour mode	+ 5.2. Stop frequency	→5.3. Stop location	→ 5.4. Stop Departure
6. Trip level	6.1. Trip n 6.2. Auto	node parking	

Academic Models

CEMDAP - Dallas*, <u>Los Angeles</u> AMOS - SE Florida*, Phoenix* TASHA - Toronto* ALBATROSS - Netherlands ADAPTS DASH ...more

*Prototype regions



Okay, the Models are Different... So what? Why does it Matter?

To the Profession in General.....



To a region considering a ABM.....



To a State DOT.....



To a Consultant / Model User.....



To a Software Vendor.....



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To the Profession in General.....



ABMs simulate travel demand is in the form of an *internally-consistent* "travel diaries"

HH ID	Pers. ID	Tour ID	Trip ID	Purpose	Mode	Start	End	Origin	Dest.
1	1	1	1	Meals	Auto	7:30	8:20	853	872
1	1	1	2	Shop	Auto	9:16	9:40	872	881
1	1	1	3	Home	Auto	11:17	12:30	881	853
2	1	1	1	Work	Transit	7:30	8:00	854	600
2	1	1	2	Home	Transit	17:00	17:40	600	854
2	2	1	1	Appt.	Auto	10:00	10:15	854	862
2	2	1	2	Home	Auto	11:15	11:30	862	854
2	2	2	1	Shop	Auto	13:00	13:20	854	881
2	2	2	2	Home	Auto	14:20	14:40	881	854
•	•	•	•		•	•		•	•
•	•	•			•	•	•	•	•

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1	1	1	3	Home	Auto	11:17	12:30	881	853

HH ID	Pers. ID	HH Size	# Cars	Income	Gender	Age		•
1	1	1	1	50,000	М	40	T	



ABMs generate synthetic populations prior to similating travel demand

HH ID	Pers. ID	HH Size	# Cars	Income	Gender	Age	-	1
1	1	1	1	50,000	М	40	•	•
2	1	2	2	45,000	М	38	•	•
2	2	2	2	45,000	F	35	•	•
•	•	•		•	•	•	•	•
•	•	•	•	•	•	•	•	•

A synthetic population is generated using aggregate socio-economic data (similar to what we currently use for 4-step models) as control totals

ABMs distinguish between "long-term" and "short-term" choices



ABMs allow policies to affect <u>all</u> travel choices, and <u>differentially</u> across population segments

Multi-modal transportation system characteristics

Land use and accessibility variables

Individual specific "log-sum" variables



Activity / Tour Generation, Mode, Destination, Time of Day, Joint Travel,

Trip Based Models allow limited policy sensitivity and equal sensitivities across population groups



ABMs allow policies to affect <u>all</u> travel choices, and <u>differentially</u> across population segments



ABMs allow policies to affect <u>all</u> travel choices, and <u>differentially</u> across population segments



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Make a work Tour?

When to start this Tour?

Are there any Secondary Stops?

Where (Location) is the secondary stop?

Use travel times to the chosen destination location

What is the mode for Tour?

Use the "preference" for various modes (the log-sum variable)

Operational Similarities

ABMs focus on internal-internal travel of residents ABMs replace the first three steps of the four-step Model



Highway Assignment

Transit Assignment

Four-Step Model Structure

Operational Similarities

ABMs focus on internal-internal travel of residents ABMs replace the first three steps of the four-step Model

Activity-based Model Structure



Operational Similarities

ABMs interface with popular demand forecasting software





Some Definitions

A Home-Based Tour

Three <u>trips</u> in this <u>tour</u> (Home–Work, Work–Shop, Shop–Home) Two <u>stops</u> in this <u>tour</u> (Work and Shop)



The Day Activity Pattern (DAP) Module

The first step in both DaySim and CT-RAMP models

Determines what tour purposes an individual wants to undertake during the day

Analogous to the "trip generation" module in the four-step model

The Day Activity Pattern (DAP) Module: The DaySim Approach

Assume that there are two tour purposes work (W) and non-work (NW)

What patterns are possible for any individual?

- Neither W nor NW (at home)
- Only W
- Only NW
- Both W and NW

<u>NOTE:</u> Only W means one or more work tours are undertaken, the extract number of such tours is determined later

The Day Activity Pattern (DAP) Module: The DaySim Approach

Assume that there are two tour purposes work (W) and non-work (NW)

Each tour may or may not have secondary stops (trip chaining present or absent)

Considering both issues above, what patterns are possible for any individual?

- Neither W nor NW (at home)
- Only W (w/o stops)
- Only W (w stops)
- Only NW (w/o stops)
- Only NW (w stops)

- W (w/o stops) & NW (w/o stops)
- W (w/o stops) & NW (w stops)
- W (w stops) & NW (w/o stops)
- W (w stops) & NW (w stops)

The Day Activity Pattern (DAP) Module: The DaySim Approach

- Neither W nor NW (at home)
- Only W (w/o stops)
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- W (w/o stops) & NW (w stops)
- W (w stops) & NW (w/o stops)
- W (w stops) & NW (w stops)

The DAP Module in DaySim which of these patterns is chosen by each *person*

Generally seven tour purposes are considered, and so there are many, many more possible patterns

The Day Activity Pattern (DAP) Module: **The CT-RAMP Approach**

For each person, the day is classified into Mandatory (M), Non-Mandatory(NM), and Home (H)

For a household with two persons (workers), what patterns are possible?

- NM (P1) & M (P2) H (P1) & M (P2) • M (P1) & M (P2)
- M (P1) & NM (P2)
- M (P1) & H (P2)
- NM (P1) & H (P2)
- NM (P1) & NM (P2) H (P1) & NM (P2)
 - H (P1) & H (P2)

<u>NOTE:</u> M means one or more mandatory tours are undertaken, the extract number of such tours is determined later

The Day Activity Pattern (DAP) Module: The CT-RAMP Approach

When neither member chooses (H), joint travel is also possible!

Considering both, for a household with two persons (workers), what patterns are possible?

- M (P1) & M (P2) & No Joint
- M (P1) & M (P2) & Joint
- M (P1) & NM (P2) & No Joint
- M (P1) & NM (P2) & Joint
 - M (P1) & H (P2)
 - NM (P1) & H (P2)

- NM (P1) & M (P2) & No Joint
- NM (P1) & M (P2) & Joint
- NM (P1) & NM (P2) & No Joint
- NM (P1) & NM (P2) & Joint
- H (P1) & M (P2)
- H (P1) & NM (P2)
- H (P1) & H (P2)

The Day Activity Pattern (DAP) Module: The CT-RAMP Approach

- M (P1) & M (P2) & No Joint
- M (P1) & M (P2) & Joint
- M (P1) & NM (P2) & No Joint
- M (P1) & NM (P2) & Joint
- NM (P1) & M (P2) & No Joint
- NM (P1) & M (P2) & Joint
- NM (P1) & NM (P2) & No Joint
- NM (P1) & NM (P2) & Joint
- M (P1) & H (P2)
- NM (P1) & H (P2)
- H (P1) & M (P2)
- H (P1) & NM (P2)
- H (P1) & H (P2)

The DAP Module in CT-RAMP which of these patterns is chosen by each *household*

Many households have more than two persons, and so there are many, many more possible patterns

The Day Activity Pattern (DAP) Module

DaySim's I-DAP approach

- Neither W nor NW (at home)
- Only W (w/o stops)
- Only W (w stops)
- Only NW (w/o stops)
- Only NW (w stops)
- W (w/o stops) & NW (w/o stops)
- W (w/o stops) & NW (w stops)
- W (w stops) & NW (w/o stops)
- W (w stops) & NW (w stops)

CT-RAMP's C-DAP approach

- M (P1) & M (P2) & No Joint
- M (P1) & M (P2) & Joint
- M (P1) & NM (P2) & No Joint
- M (P1) & NM (P2) & Joint
- NM (P1) & M (P2) & No Joint
- NM (P1) & M (P2) & Joint
- NM (P1) & NM (P2) & No Joint
- NM (P1) & NM (P2) & Joint
- M (P1) & H (P2)
- NM (P1) & H (P2)
- H (P1) & M (P2)
- H (P1) & NM (P2)
- H (P1) & H (P2)

The CEMDAP approach: The Generation-Allocation Module



The CEMDAP approach: The Generation-Allocation Module



The CEMDAP approach: The Generation-Allocation Module



A Note on Household Interactions

- Allocation of Household Maintenance Responsibility
 - multiple members of the same household generally not found to do grocery shopping on the same day
- Joint Travel & Activity Participation of Household Members
 - getting vehicle trips right
 - choosing "car pool" is not the decision of a single person
 - constraints on other individual trips
- Child Care
 - stay at home to take care of a child
 - escort child to/from school and other activities
 - joint participation in activities with children
- Auto Allocation
 - single vehicle / multi-driver households

Tour Frequency and Primary Destination Location

Largely similar approaches across DaySim and CT-RAMP

Across tour purposes, the more important tours are generated first (mandatory > maintenance > leisure)

In CT-RAMP, the joint tours are generated before independent leisure tours

Some implementations explicitly consider the times and time-of-day periods already allocated to previous tours in generating further tours

Every tour has a primary activity and the location of this activity is modeled – except when this primary activity is work (work location is a "long-term" choice)

Tour Time of Day



Tour & Trip Time of Day

At the tour level, the departure and arrival times are determined *simultaneously* by both models

Generally, the day is divided into 30-minute periods and the arrival / departures times can fall within one of these discrete periods

Within a tour, additional stops are generally chronologically inserted.



Tour and Trip Mode

Largely similar approaches across DaySim and CT-RAMP

DaySim:

Trip chaining (determined from DAP module) determined *before* Tour Mode

CT-RAMP:

Tour Mode is determined *before* determining number of secondary stops (Trip chaining is not known from DAP)

Implementation Differences

- Statistically significant explanatory variables effecting the different travel choices
- Representation of space (especially for calculating accessibilities by mode)
- Number of time-of-day periods for network assignment
- Upward compatibilities achieved via "log-sum" terms
- Adding in all the other non-residential travel demands
- Feedback of assignment results back to demand generation

In Summary

Conceptually

All ABMs simulate internally-consistent (individual level) travel patterns of people All ABMs distinguish between long-term and short-term choices All ABMs strive for extensive policy sensitivity

Practically

Alls ABMs focus on the resident internal-internal travel (data issues) All ABMs still use static-assignment techniques for network loading All ABMs involve proprietary code interfaced with popular planning software

Structurally

ABMs adopt different approaches to generating the overall travel patterns Some ABMs do better with ensuring intra-household consistency in travel choices Are still evolving!

Closing Thoughts

Which ABM should I use?

Choices that are modeled but differently.....

- We <u>don't know</u> whether one approach is necessary superior than the other!
- We <u>do</u> know that a consistent travel pattern can be generated by both approaches!

Choices that are modeled in one but not the other.....

- Is there a critical policy need for incorporating that travel choice?
- Do we have the data to support modeling the additional choice?
- What are the overheads (run times?)
- Is there something more important that I would rather invest in now?

Implementation Issues (software etc.)

• Talk to current uses of that product!

Closing Thoughts

Will there be a "Standard" ABM?

ABM as a conceptual standard ?

- Forget about terms such home-based trips, non-home-based trips, productions, attractions, friction factors, ...
- Move towards modeling individual-level tours and activity patterns...
- Yes, that can happen

<u>A structural standard for ABM ?</u>

- A new "N" step model to replace the four-step model?
- Probably not a good idea....
- Allow larger MPOs with more complex policy questions & data availability to have an elaborate model
- Allow smaller regions with limited forecasting needs and data availability to have an simpler model

Conceptual Standardization and Structural Innovations – The Approach for Future FSUTMS?