The Oregon Statewide Integrated Model (SWIM)

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Outline

• Why SWIM?
• Model evolution
• Model components & their interaction
• Path based evolution
• Integration challenges
• Lessons learned
Why SWIM?

- Early 1990s state/federal mandates required system view
- Remain relevant in regulatory/policy discussions
- Complement urban travel models
- Enough integration to meet our needs
- Address surveyed state policy Qs
  - Land Use – Transport interaction
  - Unique Land Use issues
  - Economy/freight movement
  - Sustainability

- Oregon Approach
  - Broad program (OMIP)
  - Implemented by Oregon Modeling Steering Committee (OMSC)
  - International Peer Review Panel
Ambitious Gen2 Model Objectives

Gen2 Goals
• Full integration
• Explicit representation of economy, land use and transport
• Linkages to environmental analyses and performance indicators
• Build on lessons learned from Gen1 model
• Connect with urban modeling framework

Gen2 Key Criteria
• Flexible geographic scale
• Truly integrated components
• Hybrid formulation
  • Dynamic activities
  • Static economy
• Activity-based models
  • Agent-based micro-simulation
  • “Tight consistency”
• Affordable and tractable
Oregon Model Evolution

- Gen1 – SWIM1 (Tranus)
- Ambitious Gen2
  - Customized/flexible
  - Keep I/O model economic focus,
  - Microsimulate (LU, person, freight)
  - Future network enhancements (loading, DTA)

- Transitional Model – SWIM2
  - Scaled back usable model
  - Drop some microsimulation (LU, assignment)
  - Build user interfaces (MrsGUI to run, SWIM VIZ DB output)

- Ongoing/Planned changes....
  - Don’t try to recreate the wheel (state economic forecast)
  - Software caught up to research (assignment algorithms, visualization)
  - Data driven upgrades (FAF3/Port survey, OR Household Survey)
  - Consistency with other ODOT models (GreenSTEP, Urban ABM, PopSyn)
  - User Ease/Visualization Tools (VISUM, simplified interfaces)
# SWIM2 Component Evolution

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<tbody>
<tr>
<td>Gen2</td>
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<td>Transiional</td>
<td>SWIM2</td>
<td>v2.5+</td>
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## Economy
- ED
- NED (+feedback)

## Land Use
- LD (microsim)
- ALD (from SWIM1)

## Activity Alloc
- PI
- PECAS AA (+Census)

## Synthetic Pop
- HA (microsim)
- SPG
- PopSyn

## Transport
- PT (early ABM)
- CT-RAMP

## Visitor
- none
- LDT (borrowed)

## Freight
- CT (microsim)
- new CT/ET

## Assignment
- TS (DTA plans)
- scaled back
- VISUM

## Interfaces
- none!
- MrsGUI/VIZ DB
- simpler

## Software
- Java
- +R
- +Python

[Link to Urban Models]

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Oregon Statewide Integrated Model
SWIMv2.5 Modules

Component models:
- NED: Economic & demographic
- EF: Economic Feedback (optional)
- SPG1,2: Synthetic population generator
- ALD: Aggregate land development
- AA: Activity allocation (part of PECAS)
- PT: Person travel demand
- CT: Commercial travel demand
- ET: External travel demand
- NA: Network assignment

Legend:
- Alpha-beta zone conversion
- Beta-alpha zone conversion
- Aggregate/equilibrium model
- Microsimulation component
- Mesoscopic component

Feedback in next period
Component Interactions

• Feedback
  - Mix of integrated (mclogsums), connected (dclogsums), consistency
  - Still working on...economy size, environmental
  - Inconsistent level of detail (alpha/beta zones, meta/micro)
  
  Be thoughtful, plan ahead – theoretical/practical issues

• Mix of Software
  - Components: java (transport,economy), python (allocation), R(LU/Freight)
  - Python interface, VISUM assignment
  - Components read/write CSV files

  Mix works fairly well, CSV read/write time

• User Interface
  - Java Orchestrator -> python MrsGUI -> simple setup csv
  - Dashboard/run status
  - Inputs/outputs: csv inputs, SWIM VIZ DB outputs

  Necessary, but keep simple
Path Based Land Use & Transport

Annual land use change, $n$-year transport skims

- Seismic Failure Study – 1-year network improvements
- Oregon Freight Plan – 3-year skims
Integration Challenges

- Different Levels of Detail
  - Easy input/explanation vs. policy sensitivity
  - Difficult linkages across levels (generalized transit in ABM)
  - False precision (ABM for statewide results)
  - Large zones in halo (loading, oscillations)

- Runtime: 30-years took 1 week, now 2-days

- Network & Zones: build flexibility, then fix later

- Visualization is invaluable (LU and network)

- Assembly/Calibration Complexity
  - Inputs: Some must be synthesized, adding errors; Bootstrap inputs
  - Targets: Many, multi-dimensional, inconsistencies, different years, varying confidence levels
  - Parameter adjustment: Many, several combinations possible.
  - SWIM calibration approach:
    (1) Components in isolation; (2) full model baseyear and (3) over time
    - More emphasis on behavioral response than tightly matching targets
**Policy Questions...**

**Current Applications**

- **State Level**
  - Economic impact if don’t invest? (Bridge Options/Rough Roads)
  - How plan under uncertainty? (OR Freight Plan)
  - Economic impact when landslide severed access? (Seismic/Lifeline)

- **Regional/Urban Level**
  - Common vision across diverse stakeholders (WV Livability Forum)
  - Bypass induced demand, commute changes (Newberg-Dundee Bypass)
  - Who and what motivates intercity travel? (Urban model External Flows)

**Qs that still present challenges...**

- How policies impact economy size
- Investment *and* deterioration (lack of investment)
- Impacts from lack of road funding
- VMT Forecast, fuel price sensitivity
- Retirees & Tourism (not economically motivated)
Lessons Learned

• Model Value:
  - Order of magnitude & direction
  - Logical story more important than the model;
  - can bring diverse interests to common understanding;
  - identify trade-offs and winners/losers
  - economic impact key for decision-makers

• Application-driven research
  - Use/show value to maintain support/funding
  - Think big, start small
  - Agile approach
  - Design integration at outset (module links, data systems, user interface)

• Outreach:
  - Seek opportunities to use models
  - Connections generates seeds of support later;
  - Expanded staff skill sets
  - Build bridges to other agencies
  - Peer Panel provides credibility/guidance
THANK YOU...
**SWIM2 Application-drive development**

Key value:
- Economic
- Land Use – Transport Interaction
- Winners/Losers informs choices and mitigation policies

**Model Development**
- SWIM1
  - TRANUS/Oregon (2000)
  - UrbanSim (1998)

**Applications**
- WV Livability Forum (2001)
- East/Central OR Fwy (2001)
- Bridge Options Report (2002)
- Newburg-Dundee Bypass (2004)
- OR Transportation Plan (2005)

**SWIM2**
- Assembled (2004-2006)
- Calibrated (2007-2008)

- OR Amtrak Ridership (2008/2009)
- OR Freight Study (2010)
- Seismic Economic Impacts (2013)
- Rough Roads Ahead (2014)
Oregon Activity:
- 3.7M pop; 1.8M jobs
- 6 MPOs

2,950 alphazones
519 betazones
1) Query
2) Tables
3) Visuals
New Commercial Transport (CT)

- **FAF regions**: Aggregations of counties, mostly corresponding to CMSA or MSAs, in the USA, Canada, Mexico, regions of the rest of the world.
- **Oregon ports**: Marine: Port of Astoria, Port of Coos Bay, Port of Portland; Air: Port of Portland.
- **Distribution centers**: Demand-responsive reconfiguration, storage, and local distribution of commodities to retail and service industries.
- **Economic clusters**: Employment → floorspace by NAICS group within each alpha zone “Pseudo-firms”.
- **Truck tours**: Daily tours by truck type and itinerary, based on activity levels in each economic cluster.

**Commodity flows**: Annual and weekly origin-destination flows by commodity, mode, value, and tonnage.

**Key**: ——— Explicit flows  ----- Not represented
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<thead>
<tr>
<th>Group 2</th>
<th>Production of Labor by Households</th>
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<tbody>
<tr>
<td>Group 3</td>
<td>Use of Space by Non-Household Activities</td>
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<td>Group 4</td>
<td>Use of Labor by Non-Household Activities</td>
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<td>Group 5</td>
<td>Use of Space by Households</td>
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<td>Consumption of Commodities and Labor by Households</td>
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<td>Group 7</td>
<td>Production and Consumption of Commodities by Non-Household Activities</td>
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<td>Group 8</td>
<td>Imports and Exports of Commodities</td>
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<td>ALD</td>
<td>Space Development</td>
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**PECAS AA I-O Table**

Transport Demand and Supply
PI Economic Interactions
Production - Exchange – Consumption

- total consumption
- commodity flows
- exchange zone
- exchange zone
- exchange zone
- selling allocation process
- buying allocation process

- total production
- total production
- total production

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Iterative SWIM2 Calibration Process

- **Stage 1:** Estimate module parameters where data exists

- **Stage 2:** Calibrate individual sub-models in isolation

- **Stage 3:** Calibrate full model, baseyear + over time
  - including Sensitivity Tests of likely policy scenarios
    - 20-years, in 3-year increments
    - unrealistically large change, to identify direction of change
    - “proof-of-concept” scenarios test behavioral response to likely policy levers
Oregon Advice on Integrated Modeling

**Technical**

- Think big, start small
  - Prototypes
  - Building blocks
  - Simplest thing that can possibly work
- Short development cycles
- Design integration with other models & data systems at outset
- Design user interface first, models second
- Early applications
- Build good communications skills for technical staff
**TLUMIP Lessons...**

- TLUMIP program driven by policy needs

- TLUMIP using transport microsimulation models, more planned

- Spatial microsimulation models, replaced in the near term with aggregate models
  - Data limitations (inputs and calibration)
  - Required calibration time
  - Aggregate-microsimulation implementation
  - Runtime

- Advantages of adopted approach
  - Quicker development time
  - Improved understanding from aggregate model
  - Facilitate framework where microsimulation forced to periodically respect equilibrium solution