Advancing Urban Models in the 21st Century

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Regional Decision System

Better tools
Better data
Better access
Better Decisions
Structural Model Classification

Differ in:
- Geographic scale
- Variables considered
- Statistical tools
- Policy questions
- Resource requirements

Economic-Demographic

Urban Systems
Council/Supervisorial Districts
Community Plan Areas
City Boundaries
Census Tracts
Census Blocks

33,000 MGRAs
The Parcel: The Current Frontier
Presentation Topics

- History of Urban System Models
- Model theory and structures
- Applications and decision making
- Challenges/Opportunities
History of Urban Systems Models
Urban Systems Models 1950s: Emergence

- Linked land use, residential and non-residential activities and the transportation system
- Computer capabilities
- Desire to use scientific methods to assess impact of highways and analyze urban problems
Despite many failed efforts, tremendous knowledge gained about urban spatial patterns

Professional consolidation and attempts to integrate broad spectrum of knowledge

Modeling approaches

- Linear statistical techniques (EMPIRIC)
- Linear program and optimization techniques (POLIS)
- Spatial interaction gravity formulations
Urban Systems Models: Widely Used Today

- Lee's (1973) prognosis was wrong
- At least 20 centers on 4 continents
- Most major regional planning/transportation agencies
- Federal legislation (ISTEA, Clean Air Acts)
- Policy makers under pressure to address issues related to urban form, land use, and transportation
- Increased computing power, data availability, and staff/consultant expertise
Urban Systems Models: Impetus for a New Generation

- Lack of spatial economic framework
- Inability to adequately answer new policy questions
- Excessive “art” and “judgment”
- Not well suited to redevelopment and reuse activities
- Availability of small area land economic information
- Enhanced computing/programming infrastructure
- Modeling community synergies
Model Theory and Structure: Spatial Interaction Models
Spatial Interaction Models

- Forecast in 5-Year time intervals
- Links employment locations and residential locations
- Uses commute patterns, travel times, and land use
- Relies on the spatial interaction gravity model
Employment Forecast

Based on:

- Locations of existing employment and housing
- Employment opportunities and attractiveness
- Transportation accessibility
Residential Forecast

Based on:

- Distance from employment
- Residential opportunities and attractiveness
- Transportation accessibility
Linking the Land Use and Transportation Models

2005-2010

Allocation Model

Employment Forecast → Residential Forecast

Land Use Characteristics

Transportation Model
Highway and Transit

2010-2015

Allocation Model

Employment Forecast → Residential Forecast

Land Use Characteristics

Transportation Model
Highway and Transit

Next Increment
Model Theory and Structure: Production, Exchange, Consumption Allocation System (PECAS)
PECAS: Just Five Choices

- Where to locate?
- What to make and what to consume in the process (called the technology to “use”)?
- Where to buy what is consumed and where to sell what is made?
- What type of space (floors pace and buildings) to build?
- How much space to build?

The interactions among these
PECAS: Components and Treatment of Time

- Model-wide aggregate economic conditions
- Economic changes; migration
- Economic interactions
- Transportation model
- Changes in transportation supply
- Activity allocations
- Space development
- Year t
- Year t+1

PECAS
PECAS: Interactions Among Components

- Model-wide aggregate economic conditions
  - Economic changes; migration
  - Development Activity

- Activity Totals
- Economic Attractions
  - Activity allocations
    - Commodity Flows
    - Transportation model
      - Transportation supply
      - Year t

- Space development
  - Space Prices
  - Generalized Transport Costs
    - Year t+1

- Economic interactions
  - Space Quantities
### Producing Sectors

<table>
<thead>
<tr>
<th></th>
<th>Goods, Services, Labour and Space</th>
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### Consuming Sectors

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### Economic Flows

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### Table

<table>
<thead>
<tr>
<th>Produced Goods</th>
<th>Produced Services</th>
<th>Produced Labour</th>
<th>Produced Space</th>
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<table>
<thead>
<tr>
<th>Consumed Goods</th>
<th>Consumed Services</th>
<th>Consumed Labour</th>
<th>Consumed Space</th>
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</thead>
<tbody>
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</tbody>
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*Note: Images and icons are placeholders for actual visual representation.*
Economic Interactions: Production - Exchange - Consumption
Economic Interactions: Production - Exchange - Consumption

1: production allocation
   allocating production activity to zones

2: technology selection
   allocating production to commodities
   allocating consumption to commodities

3: selling allocations
   allocating produced commodities to selling locations
   buying allocations
   allocating consumed commodities to buying locations

3-level nested logit model
Space Development: Simulation of Transitions

parcel-by-parcel microsimulation

logit models

mid density residential

more the same

commercial

derelict

no change

quantity

zoning dictates set of alternatives
PECAS: Policy Analysis

- Model-wide aggregate economic conditions
- Economic changes; migration
- Economic interactions
- Transportation impacts
- Transportation model
- Activity allocations
- Space development
- Economic policy
- Land consumption
- Land use policy
- Transportation policy
- Changes in transportation supply
- Year t
- Year t+1
Applications and Decision Making:
San Diego County
San Diego
Regional Comprehensive Plan

- Connecting transportation and land use plans
- Using transportation and land use plans to guide other plans
- Making it happen through incentives and collaboration
SW Riverside County
San Diego’s Labor Market
San Diego Daily Interaction with SW Riverside County Increased Dramatically

Interregional Commuting Exchange with San Diego County

- Imperial: 1990 -152, 2000 -375
- Orange: 1990 -5491, 2000 -6813
- Riverside: 1990 1207, 2000 12759
- San Bernadino: 1990 73, 2000 -576
- Los Angeles: 1990 -4596, 2000 -3129
Large Daily Flows Across the Border

Binational Commuting Exchange with San Diego County

<table>
<thead>
<tr>
<th>Year</th>
<th>U.S. Counties</th>
<th>Mexico</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990</td>
<td>-10281</td>
<td>3188</td>
</tr>
<tr>
<td>2000</td>
<td>38799</td>
<td>44468</td>
</tr>
</tbody>
</table>
Forecasting Modeling System

- Demographic and Economic Forecasting Model (DEFM)
- Interregional Commuting Model (IRCM)
- Land Use and Transportation Policies
- Cities/County Forecast (UDM)
- Transportation Forecasting Model (TransCAD)

Spatial Interaction Gravity Models

Trip Generation
Trip Distribution
Mode Choice
Trip Assignment
## 2030 Regional Futures

<table>
<thead>
<tr>
<th></th>
<th>Existing Policies</th>
<th>Smart Growth</th>
<th>Percent Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>PPH</td>
<td>2.87</td>
<td>2.80</td>
<td>-2.4%</td>
</tr>
<tr>
<td>Vac. Rate</td>
<td>3.8%</td>
<td>4.9%</td>
<td>+28.9%</td>
</tr>
<tr>
<td>Interregional Commute</td>
<td>100,000</td>
<td>23,000</td>
<td>-77.0%</td>
</tr>
<tr>
<td>Houses</td>
<td>1,383,800</td>
<td>1,460,800</td>
<td>+5.6%</td>
</tr>
<tr>
<td>Home Price ($2005)</td>
<td>$514,000</td>
<td>$480,000</td>
<td>-6.4%</td>
</tr>
</tbody>
</table>
Future Units - Existing Policies
Future Units - Smart Growth
Existing Plan

Vehicle Trips = 3,600

Vacant (SF)

Vacant (OS)

Comm

Off

Smart Growth

Vehicle Trips = 8,600

Comm

Off

OS

MF

SF

Existing Plan

Smart Growth

Vehicle Trips = 3,600

Vehicle Trips = 8,600
Existing Plan

Vehicle Trips = 32,200

Smart Growth

Vehicle Trips = 26,700
Economic Benefits of a Highway Project

- Without Investment: Cumulative savings of $7.26 billion by 2030
- With Investment: Average Travel Time (In Minutes)
  - 2000: 59 minutes
  - 2010: 34 minutes
  - 2020: 45 minutes

Early Action Project Complete
Benefits of Smart Growth

- Reduces sprawl and land consumption
- Conserves open space and habitat
- Reduces congestion, trip lengths, travel costs, air pollution, and interregional commuting
- Provides greater return on investment in transportation, especially transit
Application and Decision Making:

SACRAMENTO REGION

Blueprint

TRANSPORTATION/LAND USE STUDY
Sacramento Blueprint Study

DEVELOPMENT
Base Case Scenario for 2050
Sacramento Blueprint Study

Development
Preferred Blueprint Scenario for 2050

Randall Seminar Series, February 21, 2008
Sacramento Blueprint Study

TRAFFIC CONGESTION
Base Case Scenario for 2050
Sacramento Blueprint Study
Sacramento Blueprint Study

GROWTH NEAR TRANSIT
Within walking distance of 15-minute or better transit service

<table>
<thead>
<tr>
<th>Base Case Scenario</th>
<th>Preferred Blueprint Scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td>5% Jobs</td>
<td>41% Jobs</td>
</tr>
<tr>
<td>2% Housing</td>
<td>38% Housing</td>
</tr>
</tbody>
</table>

In the Base Case, 2 percent of new housing and 5 percent of new jobs are located within walking distance of 15-minute bus or train service. In the Blueprint Scenario, those figures rise to 38 percent of new houses and 41 percent of new jobs.

VEHICLE MILES TRAVELED
(per household per day)

<table>
<thead>
<tr>
<th></th>
<th>Existing</th>
<th>Base Case Scenario</th>
<th>Preferred Blueprint Scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>41.9</td>
<td>47.2</td>
<td>34.9</td>
</tr>
</tbody>
</table>

The number of vehicle miles traveled per day per household declines from 47.2 miles to 34.9 miles.

DAILY VEHICLE MINUTES OF TRAVEL
(per household per day)

<table>
<thead>
<tr>
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<th>Existing</th>
<th>Base Case Scenario</th>
<th>Preferred Blueprint Scenario</th>
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<tbody>
<tr>
<td></td>
<td>64 minutes</td>
<td>81 minutes</td>
<td>67 minutes</td>
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</table>

Total time devoted to travel per household per day declines from 81 minutes to 67 minutes.

PER CAPITA CARBON DIOXIDE AND SMALL PARTICULATES EMISSIONS
(from vehicles 2050)

<table>
<thead>
<tr>
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<th>Base Case Scenario</th>
<th>Preferred Blueprint Scenario</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>85%</td>
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</table>

With the Blueprint Scenario, per capita, there would be 14 percent less carbon dioxide (greenhouse gas) and particulates (related to asthma) compared to the Base Case.
Applications and Decision Making:
State of Oregon
Oregon Bridge Options Study

- Economic Equity Impacts
- Broadened Policy Discussion

Local Bridges

- Weight Limited Bridge
- Cracked Bridge

State Bridges

- Sauvie Island Bridge
- Cole’s Bridge
- McKenzie/Willamette River Bridges
- Ford’s Bridge

* Medium and high crack density

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Regional Production
Relative to Current Mobility Option

<table>
<thead>
<tr>
<th></th>
<th>TOTAL</th>
<th>Agriculture</th>
<th>Wood Products</th>
<th>Technology</th>
<th>Service Sector</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Allow Deterioration</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Fix Interstates</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>+Freight Rtes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>+Key Local Rtes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Fix All Bridges</td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

2025 Production Relative to Current Mobility Option
- 0-80%
- 80-95%
- 95-99%
- 99-101%
- 101-105%
- 105-120%
- Over 120%
Willamette Valley Forum

- Compared land use forecasts under various policies
- Collaborative visioning

HH Growth Compared to Reference Case
- Many Less Than RC
- Same as RC
- Many More Than RC
Challenges and Opportunities
Technical

- Disclosure rules
- Efficient management, storage, retrieval, and analysis of large, complex data
- Data integration
- More spatial and substantive detail
Integrating Information

- Housing
- Jobs
- Transportation
- Travel Behavior
- Project Costs
- Area Boundaries
- Land Economics
- Demographics
- Income/Wages
- Performance and System Monitoring
- Environmental
**Transparency**

- Information has the power to distort or enhance the reasoning capacity of the public
- Clear description of methods, data, and assumptions (avoid the black box)
- Publicly accessible and understandable
- Outcomes defensible and reasonable
The Future is Now

- Economic motives
- Agent-based modeling
- Developer, consumer and governmental choice
- Micro-simulation
- Synthetic populations, households, and firms
Reducing Congestion with Ridesharing

Existing Conditions

<table>
<thead>
<tr>
<th>Vehicle Colors</th>
<th>SOV</th>
<th>Carpool</th>
<th>Bus</th>
<th>Truck</th>
</tr>
</thead>
</table>

Level of Service: F
Average Speed: 19 mph
10 Mile Travel Time: 31 Minutes

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Reducing Congestion with Ridesharing

Existing Conditions

Level of Service

Average Speed
19 mph

10 Mile Travel Time
31 Minutes

Doubling Carpoools

Level of Service

Average Speed
38 mph

10 Mile Travel Time
16 Minutes
Reducing Congestion with Ridesharing

Vehicle Colors
- SOV
- Carpool
- Bus
- Truck

Existing Conditions
- Level of Service: F
- Average Speed: 19 mph
- 10 Mile Travel Time: 31 Minutes

Doubling Carpools
- Level of Service: E
- Average Speed: 38 mph
- 10 Mile Travel Time: 16 Minutes

Doubling Carpools & Transit Service
- Level of Service: D
- Average Speed: 55 mph
- 10 Mile Travel Time: 11 Minutes
Conclusions

• Integrated spatial economic models a reality
• Are being used in practical policy analysis
• Big job, but shrinking
  – No longer an ‘unknown’
  – Investment that pays off in future
  – Essential: Iterative (Agile) development with initial model running soon

• The Future
  – Continued ‘leading edge’ practical studies
  – Continued partnership with academic studies
  – More ‘bringing forward of experience’
  – On-going challenges with resource requirements
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