OPTIMIZING PEDESTRIAN SYSTEM FUNCTION AND EXPERIENTIAL QUALITY WITH INTEGRATED NETWORK AND AGENT-BASED SIMULATION MODELS

Jeremy Wimpey, PhD; Nathan Reignier, PhD
Talk Outline

- Intro
  - Why model?
  - Setting
- Methods
  - GIS
  - Agent based
  - Validation
- Results
- Discussion
- Questions
Why Model?

- Complex and large systems
- Facilitate monitoring
- Scenario testing (what if?)
- Allow us to be proactive
Why Model?
Why Multiscalar Modeling?

- Large, complex, high use site
  - Highly structured activities
  - Dense use
  - Under design/construction
- Study:
  - Alternatives
  - Scenarios
  - Scheduling
Setting
Site Overview

- ~15,000 Acres
- 40-100K Visitors
- Multi Modal System
- 35+ Miles of Hiking Trail
Research Goals

- Develop multi-scalar systems for modeling outdoor recreation
- Evaluate system performance and experiential quality at multiple scales (PPV, PAOT, LOS)
- Explore ability of models to inform user management and site design for optimization of above
  - Scenario testing
  - Alternatives development
Model Overview

GIS network model
Model Overview

GIS network model

Computational model
Model Overview

- GIS network model
- Computational model
- Simulation model
Model Iteration

GIS network model

Computational model

Simulation model
Model Iteration

- Stochastic Variables
  - Travel Speed
  - Behaviors
  - Distributions
- Sensitivity Analyses
- Propagation
  - Delay
Scenario Testing

GIS network model

Computational model

Simulation model
Scenario Testing

- **Operational**
  - Move-in/out
  - Camp wide events
  - Typical day

- **Emergency**
  - Evacuation
  - Response

- **Alternatives**
  - Closures & additions
GIS: Macro Scale Model

- Cleaned network and coded:
  - Origins
  - Destinations
  - Linkages
GIS: Macro Scale Model

- Network Analyst:
  - Routes (alternatives)
  - Scheduling
  - Aggregate measures (segment loading)
GIS: Segment Analyses

- Segment loading
- Throughput needs
- Critical linkages
- Inform computational model
- Visualize demand
GIS: Segment Analyses
Computational: Scheduling
GIS: Macro Scale Model

- Analysis & outputs used to:
  - Optimize programming
    - Order of destinations
    - Start times, duration
  - Evaluate alternatives and scenarios
  - Locate critical links
    - Congestion/delay
  - Aggregate statistics
    - Multi modal needs
  - Create inputs for micro & meso scale models
Simulation: Micro Scale Model

- Linkage and junction level
  - Utilize social force model (PTV/Helbing)
  - Populated from macro model outputs
- Used to evaluate:
  - Site design
  - Experiential metrics
    - Crowding:
      - PPV, PAOT, LOS
  - Scenarios
Simulation: Micro Scale Model
Micro Model Development

- Pedestrian generation
  - Classes
  - Behaviors
  - Appearance*

- Routing
  - Static
  - Dynamic
Simulation Model Visualization
Simulation Model Outputs

- Measurement areas
- Agent specific
Measurement Area Output

<table>
<thead>
<tr>
<th>Variable</th>
<th>Units</th>
<th>Junction</th>
<th>Elbow</th>
<th>Flow Rate (n/min/ftwidth)</th>
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<tbody>
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<td>Source Volume</td>
<td>N</td>
<td>14.18</td>
<td>9.63</td>
<td>8.62</td>
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<tr>
<td>Pedestrians N</td>
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<td>17.24</td>
<td>15.47</td>
<td>7.73</td>
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<td>Space</td>
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<tr>
<td>Desired Speed</td>
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<td>4.49</td>
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<tr>
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Flow Rate: 8.62 n/min/ft/width
Indicators & Standards of Crowding

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<th>PPV</th>
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<td>people at one time</td>
<td>people per view</td>
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Agent Specific Output

- Speed
- Travel time
- Delay
- Encounters
- Interaction with:
  - Other agents
  - Landscape
  - Soundscape
Simulation Model Expansion
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Simulation Model Expansion

In development:
- Additional complexity
- Mixed activities:
  - Dwell and activity times
- Multiple scenarios
Discussion

- Management and planning:
  - Powerful multi-faceted tools for analyses of visitor movement
  - Dovetail well with existing bodies of traffic and normative research on crowding and use of parks
Moving forward:

- Further integration with:
  - Multi modal models
  - Automation of iteration
- Meso model development
  - Activities and behaviors
- Model validation
Acknowledgments

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Questions & Discussion