Traffic Simulation and Visualization

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Traffic Simulation

**Definition**: Simulation is the art/science of reproducing the behavior of a system without actually operating that system. One manipulates a model of the system to gain insight into its operating characteristics.

- Deterministic or Stochastic
- Computational and Simulation tool
- Microscopic, Mesoscopic and Macroscopic
Uses of Simulation Models

- **Evaluation of alternate treatments**
  The engineer can control the experimental environment and the range of conditions to be explored.

- **Testing new designs**
  Quantify traffic performance responding to different geometric designs.

- **As an element of design process**
  Model can be used for evaluation; the detailed statistics provided can form the basis for identifying design flaws and limitations.
Uses of Simulation Models

- **Embed in other tools**
  Can be integrated within software tools designed to perform other functions.

- **Training personnel**
  Real-time laboratory to train operators.

- **Safety analysis**
  Recreate accident scenarios.

- **Emission analysis**
When should we use?

- Mathematical treatment of a problem is infeasible or inadequate
- Mathematical formulation represents the dynamic traffic/control environment
- Need to view vehicle animation to see how the system behaves
- Congested conditions persists over a significant time
Limitations of Simulation Modeling

- Time consuming
- Requires considerable input data
- Requires verification, calibration and validation
- Modeler has to fully understand the system
- Most models ignore cyclists or pedestrians
Applications

- Traffic Operations
- Signals
- Transit Operations
- Light Rail
- Pedestrians and Cyclists
Benefits Multiple Agencies

**Transportation**
- Studies & Analysis
  - Congestion/Choke Points
  - New Technologies
  - Highway Improvements
  - Toll Lanes
  - Rail

**Economic Development**
- Studies & Analysis
  - Commercial
  - Residential
- **Tourism**
  - Virtual Tours

**Emergency Management**
Explore the findings of this study for
- Evacuation Planning
- Evacuation Rehearsals
TYPICAL SIMULATION STEPS

1. Project Scope → Collect Data → Run Model
2. Calibrate
   - No → Back to Collect Data
   - Yes → Validate/Alternatives
3. Validate/Alternatives
4. Analysis
Popular Traffic Simulation Models

- CORSIM
- PARAMICS
- VISSIM
- AIMSUN
- WATSIM
- DYNASMART
Network Coding

Coded as background on:

- GIS file
- Google Earth
- AutoCAD files
- Microstation files
- BMP or JPEG files
BMP
AutoCAD
Data Needed and Sources

- Traffic counts
- Signal timings
- Truck data
- Road Geometrics
- Pedestrian data
- Transit data
- Florida DOT
- City of Orlando transportation department
- Counties
- Metroplan
- Field data collection
Model Calibration

- To accurately replicate actual traffic flow and conditions
- Check input and coding accuracy
- Compare field counts to simulated counts
Parameters changed:

- Capacity
- Speed
- Signal timings
- Turn percentage
- Lane change
- Driver behavior
Model Validation

Validated using different set of data

- Travel time
- Queue length
- Speed
- Volumes
- Other parameters
Measures of Effectiveness

- Delay
- Travel time
- Queue length
- Clearance time
- LOS
Related Research Projects

- I4 Corridor 3D Visualization and Simulation
- Central Florida Commuter Rail 3D Visualization and Simulation
- LYNX Evacuation
- Airport Emergency Planning
- Orlando Downtown Analysis
- Port of Jacksonville
Dynamic Workzone Analysis
Toll Plaza Simulation (SHAKER)
Red Light Running Study
Emergency Evacuation Analysis
Airport - Objectives

- Execute and evaluate the effectiveness of emergency readiness plans for the OIA.
- Develop a transportation network using WATSim to determine the most effective deployment strategy for the emergency response services in case of any disaster or hazard in and around the OIA area.
- Examine the policies, procedures, and components that affect and are affected by emergency preparedness events.
Results - Airport

<table>
<thead>
<tr>
<th>Event</th>
<th>Delay (sec/veh)</th>
<th>Travel time (person hours)</th>
<th>Travel time (vehicle minute)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base</td>
<td>198.9</td>
<td>2614.7</td>
<td>759.91</td>
</tr>
<tr>
<td>Incident without diversion</td>
<td>231.09</td>
<td>2730</td>
<td>789.48</td>
</tr>
<tr>
<td>Incident with diversion</td>
<td>166.92</td>
<td>2758.9</td>
<td>689.56</td>
</tr>
<tr>
<td>Security Check</td>
<td>210</td>
<td>2656.8</td>
<td>766.57</td>
</tr>
<tr>
<td>90% increase in demand</td>
<td>619.38</td>
<td>4588.4</td>
<td>1309.23</td>
</tr>
</tbody>
</table>
LYNX - Objectives

• Study the effect of evacuation on traffic network.
• Evaluate different evacuation alternatives and find best destination.
Results - LYNX

Network performance comparison

- Base case
- Complete area blocking
- East garage
- Traffic incident
- West garage without rerouting (all buses)
- West garage withrerouting (all buses)
- West garage without rerouting (half buses)
- West garage withrerouting (half buses)
- South garage
- West garage without rerouting (no buses)
- West garage withrerouting (no Buses)
- Alternative bus route (North Exit)
- West and south Garage

Total network delay (vehicle hour)
DYNAMIC LANE MERGING AT WORK ZONES
NO MERGING BEFORE THE TAPER

DYNAMIC LATE MERGE
MERGING TO THE OPEN LANE BEFORE THE SIGN

DYNAMIC EARLY MERGE

University of Central Florida

University Transportation Center
Center for Advanced Transportation Systems Simulation
DLM System
DLM System Operation
• NOTE: Distance between Additional PCMS and any other sign shall not be less than 500’.
CHAPTER 4: MOE and Data Collection

Data Collection

FIGURE NOT TO SCALE

C-4

C-3

C-2

C-1

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DLM System Design

Early Merge Display: RIGHT (or LEFT) LANE MERGE NOW

Late Merge Display: MERGE AHEAD/USE BOTH LANES

Minimum activation time Shall not be less than 5 min.

DLM will be activated once speed drops to 45 mph

DLM will be deactivated once speed exceeds 50 mph
MOE and Data Collection

**Operation MOE:**
- Travel Time
- Delays
- Queue length

**Safety MOE:**
Traffic conflicts as a surrogate: (1) Forced merges (2) Sudden braking

**System effectiveness MOE:**
- Number of lane changes
- Lane Volume distribution

- Demand Volume
- Throughput Volume
- Vehicle Classification
Results

### DLM

#### Speed Fluctuations

- Dynamic early/late is better than MAS
- Early merge is better under low volumes (<1500)
- Late merge is better for volumes >1500

#### WZ Throughput

- Dynamic early/late is better than MAS
- Early merge is better than Late merge
3D Traffic Visualization

To show the behavior of the traffic in the real world surroundings (3D)

- **3D Animation – Non Real-Time**
  - Importing results from Traffic Simulation Software to 3D Animation Software like WATSIM
- **3D Simulation – Real Time**
  - Importing 3D Models from 3D Modeling Software to Traffic Simulation Software like VISSIM
- **3D Modeling/Animation Software**
  - Maya, 3D Studio Max (3DS Max), Light wave, etc.
- **Traffic Simulation Software**
  - WATSIM, VISSIM, etc.
3D MODELING

- Model any 3D object
  - Grass, Trees, Buildings, Bus stops, Poles, Street Lights
- Build fresh from the scratch
- Build on top of AutoCAD files
- Build on top of pictures
- Exports as .3ds file
COLORING and TEXTURING

● Gives life to the models
● High level texturing
  – Gives the look of the real object
● Ways of Texturing
  – Giving colors to the objects
  – Applying textures from a bitmap file
  – Paste the textures in Photoshop file using Adobe Photoshop based on co-ordinates
**WATSIM+MAYA**

1. Database from Open Flight and Maya
2. Network coded in UNITES using Open Flight Database
3. Simulation using WATSIM
4. Conversion of WATSIM output to XML
5. Gaming Engine Visualization

**VISSIM+3DS**

1. Building models in 3DS Max
2. Network coded in VISSIM
3. Exporting 3D files into VISSIM using V3DM
4. Simulation using VISSIM
5. 3D View
Procedure

- Commercial gaming technologies communicates with the simulation software
- Simulation feeds traffic flow into the gaming visualization system
- Vehicular models populate the database and are controlled via parallel discrete event simulation engine
- Visualization is developed from "as-built" CAD data and can realistically represent the “true” surroundings of the area being viewed
Benefits

- **simulation repeatability** to be used for after-action reviews, that can further determine causality of impacts of transportation systems
- Immerges users into the simulated environment to provide *real-time feedback and multi-view perspective*
- **Cost effective** solution to support “what if” analysis and research for a variety of traffic conditions
I-4 and Commuter Rail Screen Shot
3D DEMO