TRANSIMS Studies at the University at Buffalo

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Presentation Outline

• **Project 1:**
  • Modeling the University at Buffalo North Campus in TRANSIMS

• **Project 2:**
  • Using TRANSIMS for On-line Transportation System Management during Emergencies

• **Future Research**
Introduction

- A University transportation system
  - Micro-scale of a regional system
  - Unique characteristics

- Feasibility of TRANSIMS for model traveling on a university campus

- A case study of UB’s north campus
UB North Campus

- Located in Amherst, NY, and occupies 1,192 acres and has more than 146 buildings.

- UB is currently in the middle of a strategic planning (UB2020) to grow by as much as 40%.
Project Outline

01 UB TRANSIMS Network Development

02 Demand Estimation & Parking Choice Model

03 Simulation Results and Analysis

04 Future Research
TRANSIMS Model Development

**Input**
- Network Data
- Travel Demand Data

**Output**
- Second by second movement of every traveler in the system over a 24-hour period

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UB TRANSIMS Model: Data Collection

Digital Map:
- GIS Shape Files & Satellite Images
  - Center-lines of the road network
  - Polygons of Buildings
  - Centriods of Parking lots

Occupancy:
- Excel File from UBPD
  - 9 AM, 10 AM, 11 AM, and 12 PM
  - Records of 28 parking lots out of a total number of 47 lots

Counts:
- Counts by Radar & Tube
  - 24-hour traffic counts at the entry and exit points to the north campus (a total of 9 key locations)
Network Coding

GISNet (Shapefile -> Text)
  Get basic files for TRANSIMS (node, link, shape)
ArcNet(Text -> Shapefile)
  Counting through lanes and pocket lanes
  Setting road types and speed limits
GISNet (Shapefile -> Text)
TransimsNet
  Creating intermediate tables, including activity locations and signal warrants files
IntControl
  Creating signal tables
  ArcNet(Text -> Shapefile)
  Specifying signs and signals (Location & Type)
  GISNet (Shapefile -> Text)
TransitNet
  Creating transit network files from route header and nodes files
Simulation Results and Analysis

Future Research
Travel Demand Estimation: Zoning
Demand Estimation: Gravity Model

- **Trip Production**
  \[ T_{ij} = \frac{Out_{ti} O_{tj} F_{ij}}{\sum_j O_{tj} F_{ij}} \]

- **Trip Attraction**
  \[ T_{ij} = \frac{In_{ti} V_{tj} F_{ij}}{\sum_j V_{tj} F_{ij}} \]

\[ F_{ij} = 1 / (\text{Free-flow travel time between zone } i \text{ and zone } j)^2 \]
Travel Demand Estimation

START

t = 9, Get P_i from Parking Occupancy Data

Get OUT_i from Traffic Counts

For each i and each j,
\[ T_{ij} = \frac{OUT_i P_i F_i}{(P_{i1} F_{i1} + P_{i2} F_{i2} + \ldots + P_{i8} F_{i8})} \]

For each i and each j,
\[ OD_{ij} = OD_{ij} + \min(P_{ij}, T_{ij}) \]
\[ P_{ij} = \max(0, P_{ij} - T_{ij}) \]

All \( T_{ij} \leq P_{ij} \)?

Yes

No

t = t + 1

Update P_{t+1} using P_t and OD

Save OD for Hour t

END

STEP 1
(Trips Exiting Campus)

Get A_i from Updated P_i

Get IN_i from Traffic Counts

For each i and each j,
\[ T_{ij} = \frac{IN_i A_i F_i}{(A_{i1} F_{i1} + A_{i2} F_{i2} + \ldots + A_{i8} F_{i8})} \]

For each i and each j,
\[ OD_{ij} = OD_{ij} + \min(A_{ij}, T_{ij}) \]
\[ P_{ij} = \max(0, A_{ij} - T_{ij}) \]

All \( T_{ij} \leq A_{ij} \)?

Yes

No

STEP 2
(Trips Entering Campus)
Results – Occupancies at 10 AM

Occupancy Results for 10:00 AM
Occupancy Results for 11:00 AM

- Estimated

- Field

Parking Lot

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Occupancies at 12:00 PM

Occupancy Results at 12:00 PM

- Estimated
- Field

Parking Lot

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Simulation Result & Analysis: Animations

Congested Traffic Condition 19:00 – 20:00

Traffic Bottleneck Analysis at 10:00 AM

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Future Research

• With “Track 1” completed, work on a “Track 2” is planned for the next phase of the study

• Developing a Game-Theoretic Parking Choice Model

• Interest in innovative approaches to modeling students’ activities
Using TRANSIMS for On-line Transportation System Management during Emergencies
Scope of Work

- Why Buffalo-Niagara?
  - One among a handful sites nationwide selected for TRANSIMS deployment
  - Well known for its winter weather and lake-effect snow events
  - Critical links – the three border crossings
  - Not too big and not too small
Scope of Work

- **Project Objectives/Outcomes:**
  - Further development of the Buffalo TRANSIMS model
  - Modifying TRANSIMS to allow for modeling impact of inclement weather
  - Simulating emergency scenarios in the Buffalo-Niagara area
  - Feasibility of using TRANSIMS for online transportation system management during emergencies
  - Use TRANSIMS as an aid for predicting border crossing delays
Research Tasks

- Task 1: Further Development of the Buffalo Model
- Tasks 2 & 3: Define traveler behavior during emergencies
- Task 4: Model the new behavior in TRANSIMS
- Task 5: Use TRANSIMS to evaluate likely emergency scenarios in the Buffalo-Niagara area
- Task 6: On-line transportation system management
- Task 7: Border crossing delay prediction
- Task 8: Peer-review and final report
Task 1: Further Development

- Build on Volpe’s Work, and extend the micro-simulator
  - Initially - extend sub-network in the north-west direction to include Niagara Falls and the Rainbow bridge, and in the south-east direction to include I-290 and part of Amherst
Task 1: Further Development

- Specific area would depend upon the emergency scenarios of interest
- Additional Resources:
  - UB-NITTEC feed
  - Related studies (UB TRANSIMS study, NYSERDA Smart Growth study, GBNRTC's simulation, signal optimization and corridor studies)
  - Naturalistic Driving SHRP2 Study – CUBRC/Calspan
  - Integrating Education and Research
Tasks 2 & 3: Data Acquisition

- **Two Primary Sources:**
  - NITTEC’s monitoring and surveillance network
    - Data archiving – working on building a prototype ITS data warehouse
  - Instrumented Vehicles
    - Calspan has already started to do that
    - Hope to be able to augment with data from the naturalistic driving experiment

- Some studies exist in the literature

- Data used to quantify changes in volume, speed & travel time during inclement weather conditions.
Task 4 – Modeling New Behavior in TRANSIMS

• ** Modifications for snow events:**
  - Changes to TRANSIMS CA traffic model in terms of reduced speeds & longer headways during snow events
  - Activity generation pattern of travelers to reflect the lower-than-normal volumes

• **Wide-area network disruption:**
  - Activity generation pattern to reflect simultaneous initiation of new trips
  - Drivers’ behavior to become more aggressive
Task 5: Evaluate likely emergencies

- Scenarios may include:
  - Inclement weather
  - Critical transportation link loss
  - Wide-scale network disruption scenarios

- Particular emphasis will be placed on simulating emergency or accident-related scenarios involved the border crossings.
Task 6: On-line Transportation System Management

- Real-time DTA Models
  - DynaMIT in Hampton Roads, VA and in LA
  - Use the model to interpolate in-between sensors and to evaluate impact of proposed control strategies
Task 6: On-line Transportation System Management

- **Extensions**
  - Ability to receive traffic-related information in real-time from sensors, probe vehicles, ...etc.
  - On-line calibration
    - Updating activity patterns or trip tables
    - Calibrating CA model
Task 7: Border Crossing Delay Prediction

- **Two-stage process**
  - Short-term prediction of border crossing traffic using an on-line TRANSIMS model
  - Queuing models to estimate delay

- Currently working on another small study to develop predictive models for border crossing based on time-series forecasting methods
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