



STREET

Simulating Transportation for Realistic
Engineering Education and Training

Where Simulation meets Reality

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Henry Liu, Chen-fu Liao

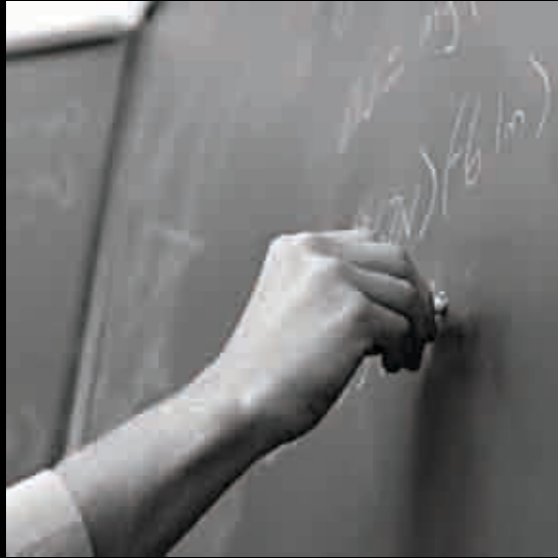
University of Minnesota

May 23, 2012

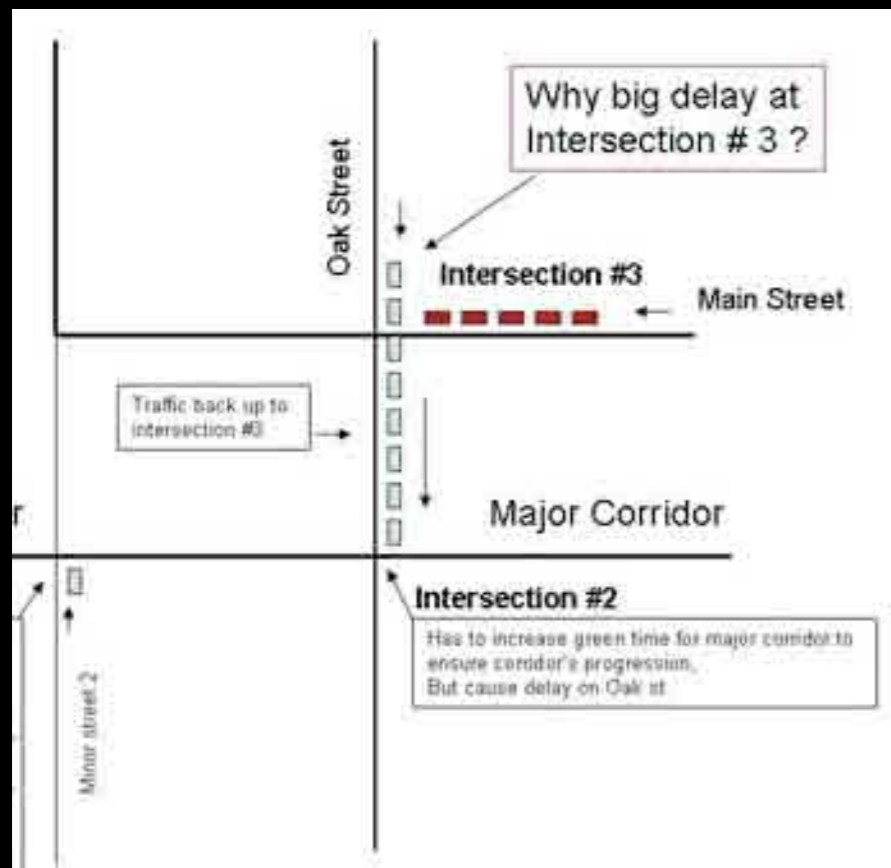
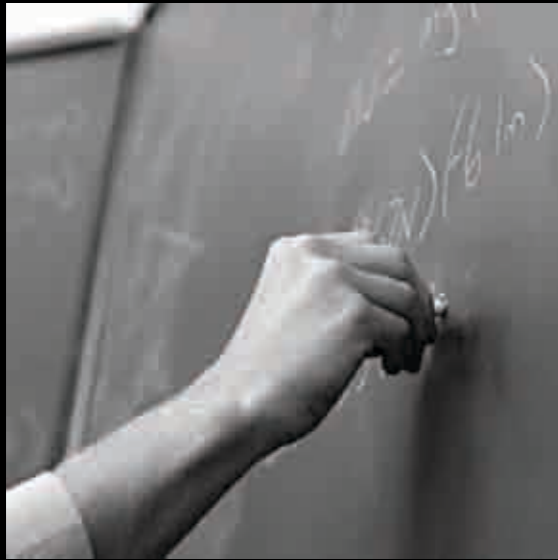
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Motivation

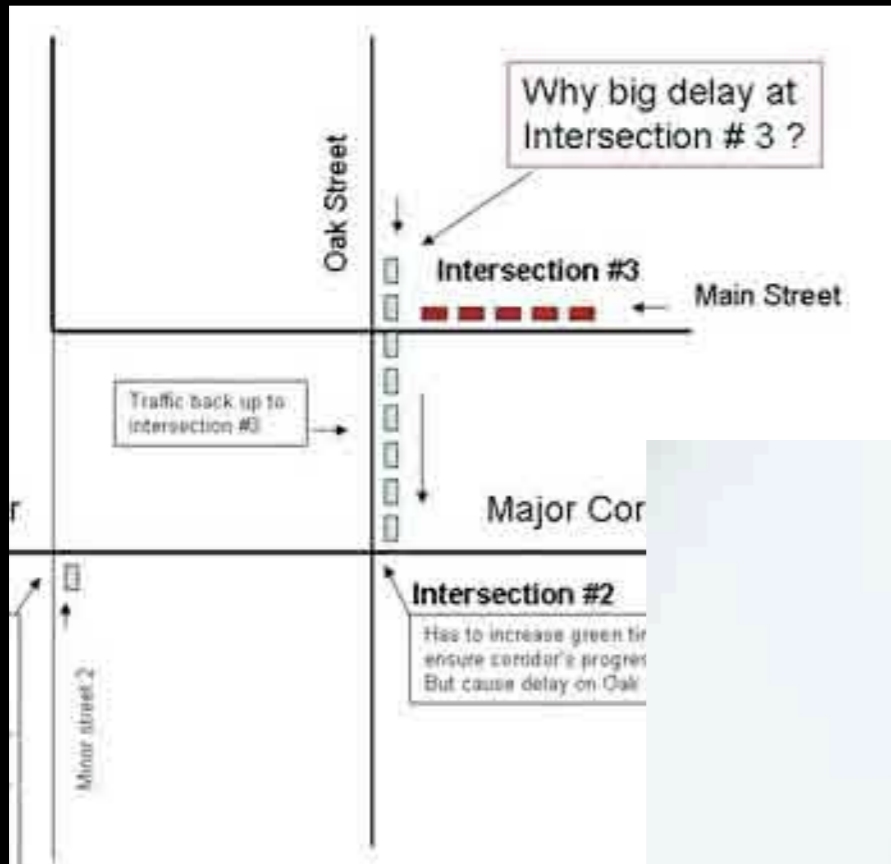
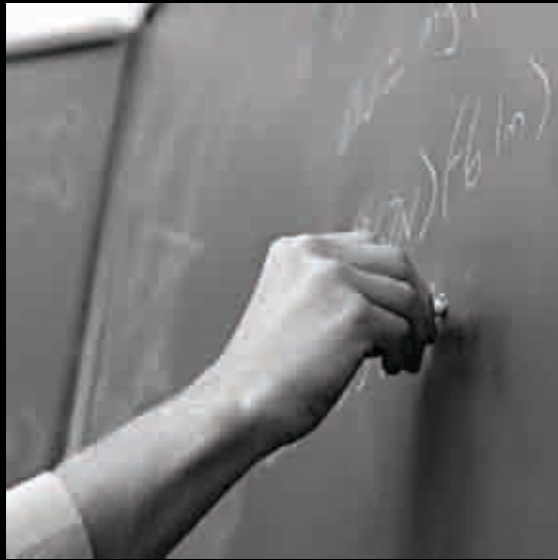
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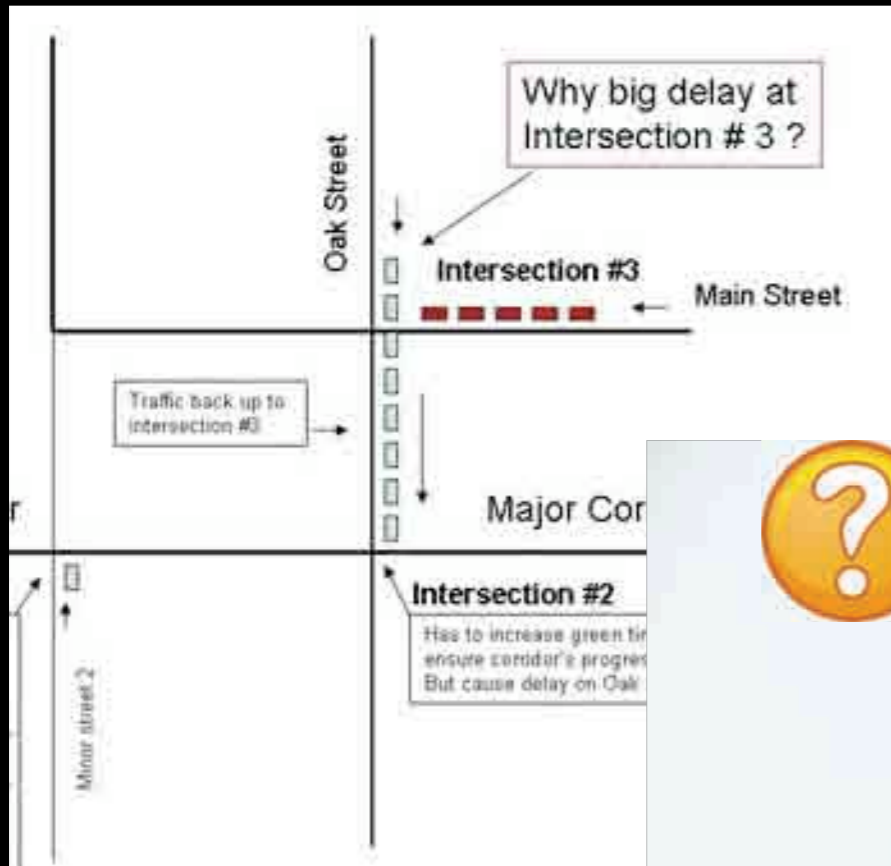
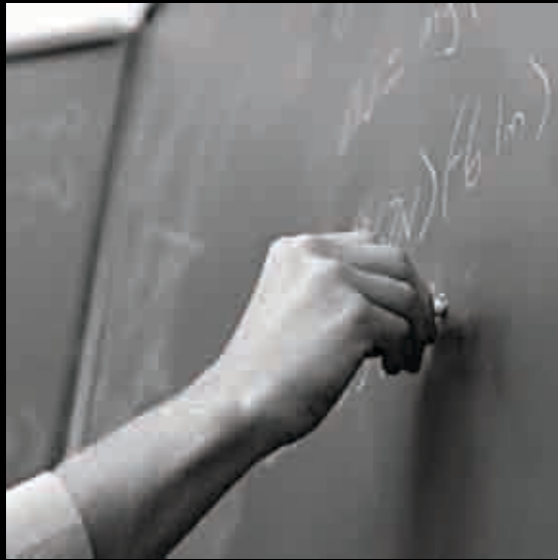
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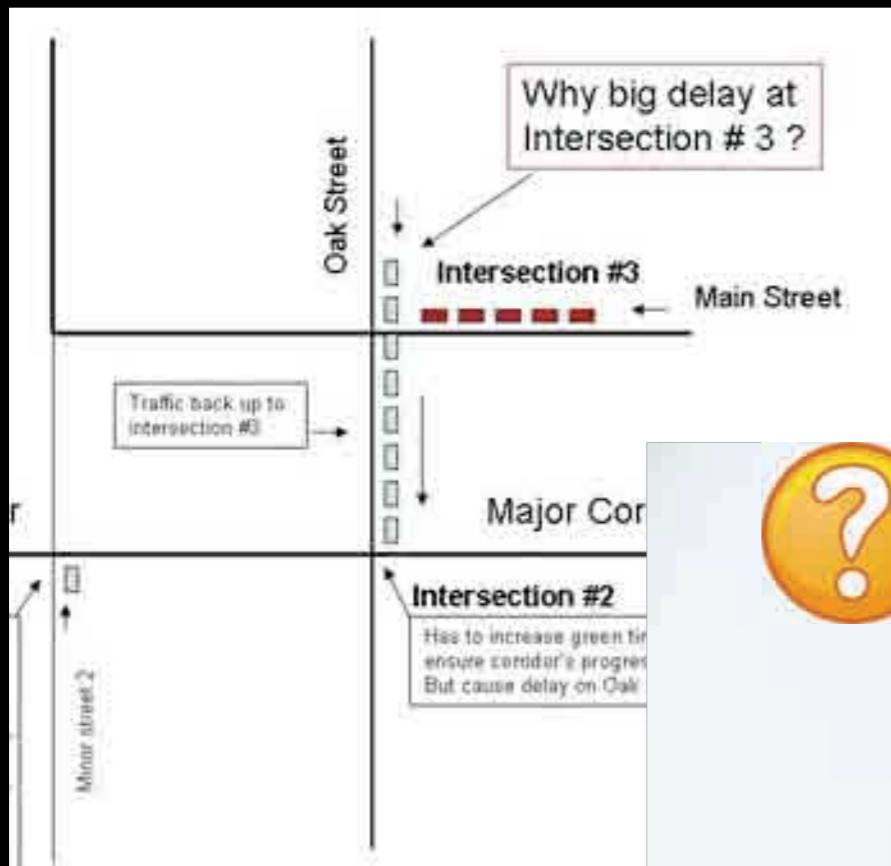
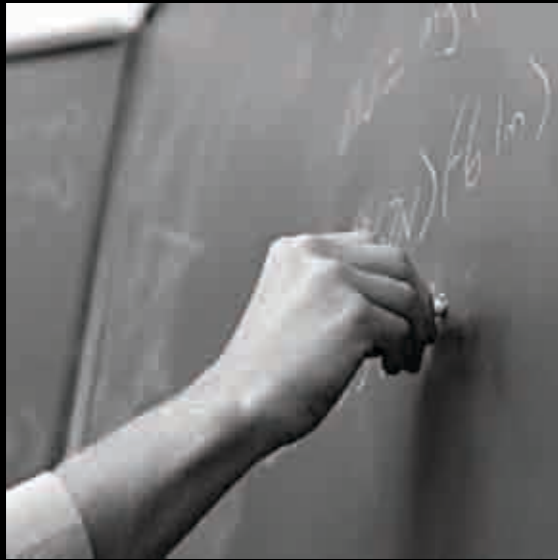
Motivation



Motivation



Motivation



STREET: Simulating Transportation for Realistic Engineering Education and Training



Funding

National Science Foundation's Division of Undergraduate Education

Match support from the ITS Institute at UMN

Seed grants from the Digital Media Center at UMN

Principal Investigators

Professors Henry Liu and David Levinson

Modules

ROAD (Roadway Online Application for Design)

OASIS (Online Application for Signalized Intersection Simulation)

ADAM (Agent-based Demand and Assignment Model)

SONG (Simulation of Network Growth)

SAND (Simulation and Analysis of Network Design)

SOFT (Simulation of Freeway Traffic)

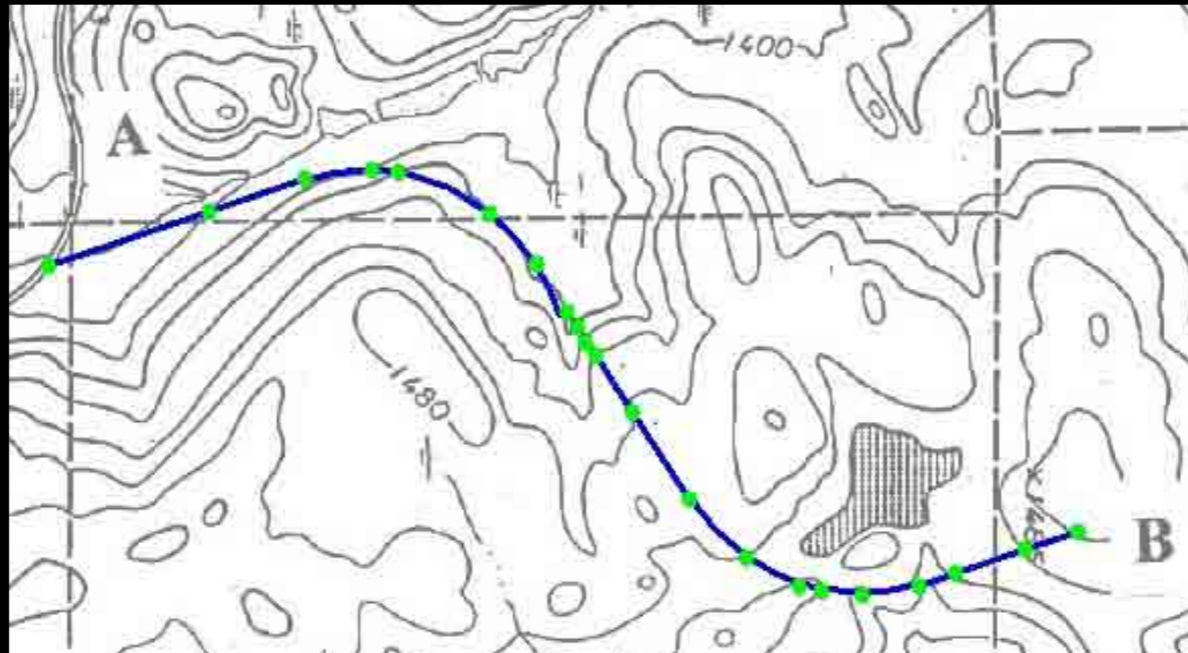
CLUSTER (Clustered Locations of Urban Services, Transport, and Economic Resources)

ABODE (Agent Based Model of Origin Destination Estimation)

ANGIE (Agent-based Network Growth with Incremental Evolution)

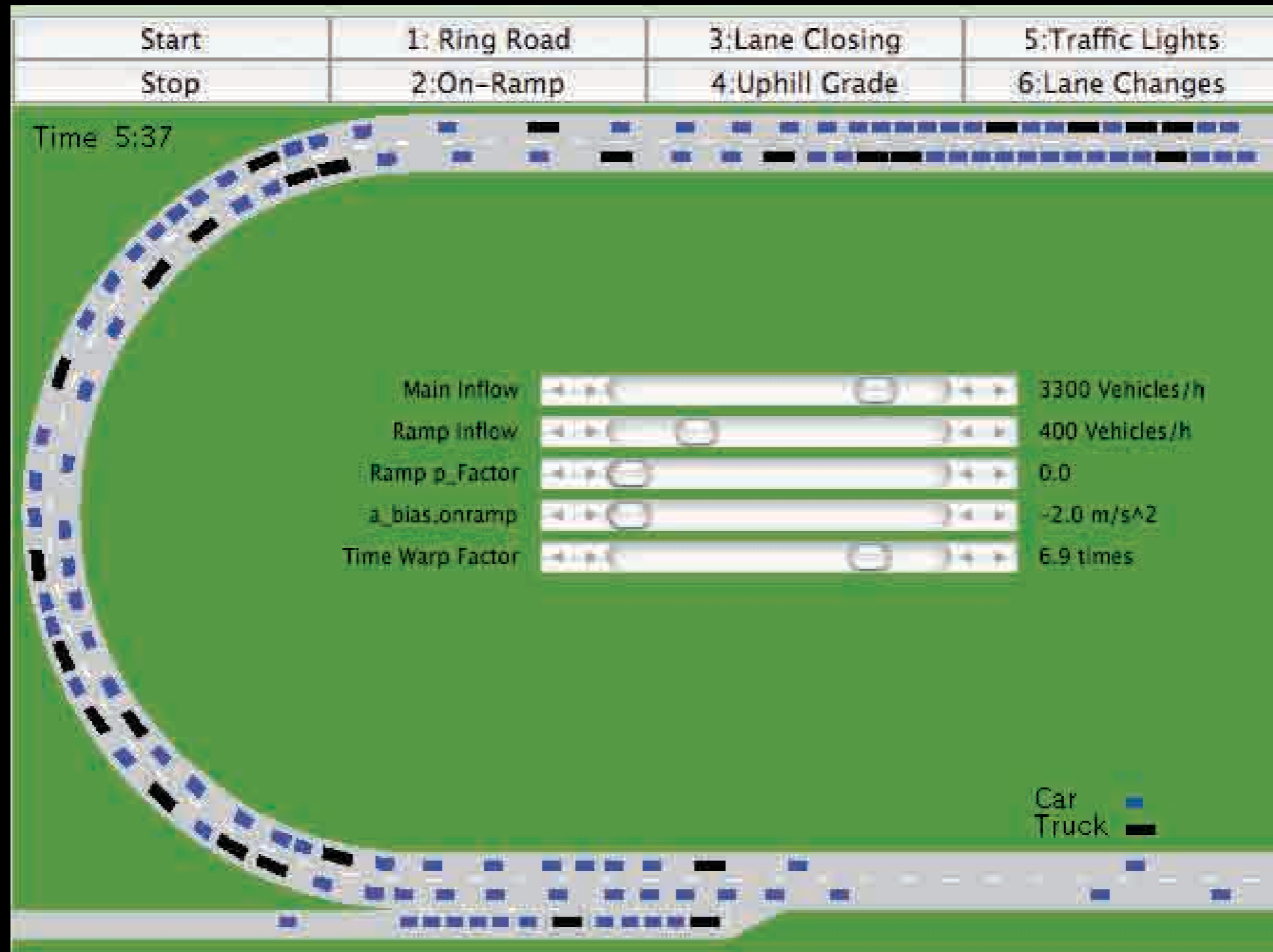
ROAD

Roadway Online Application for Design



SOFT

Freeway traffic simulator



OASIS

Actuated Signal Control Module

Actuated Signal Control - Settings

Main Street: North-South East-West

North Bound ↑

Speed (mph) 34
Volume (vph) 450
of Lanes 4
 Exclusive Left Turn

West Bound ←

Speed (mph) 35
Volume (vph) 450
of Lanes 4
 Exclusive Left Turn

East Bound →

Speed (mph) 35
Volume (vph) 450
of Lanes 4
 Exclusive Left Turn

South Bound ↓

Speed (mph) 35
Volume (vph) 450
of Lanes 4
 Exclusive Left Turn

Click Here to Continue

CONTROLLER SUBMENU

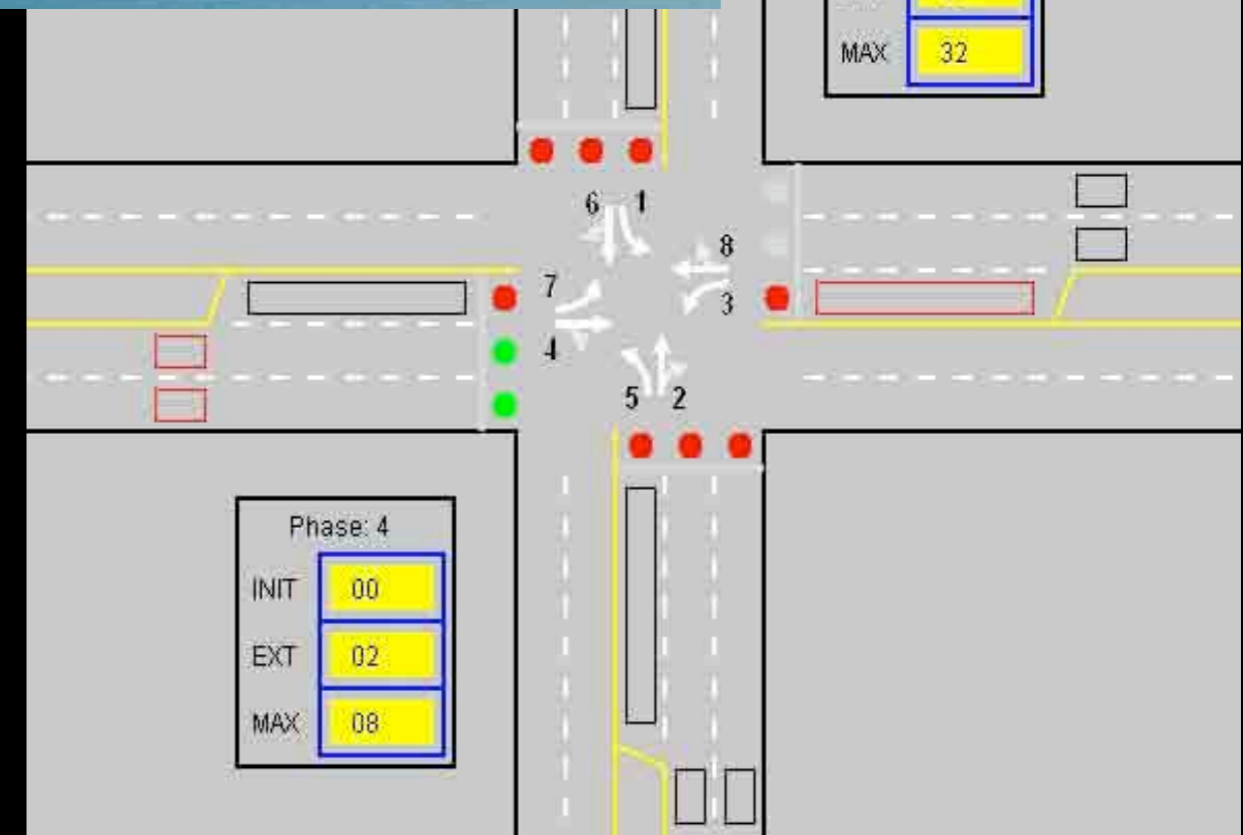
- 1. TIMING DATA
- 2. PH OVLP ASSIGN
- 3. PED CARRYOVER
- 4. RECALL DATA
- 5. OVERLAP DATA
- 6. START/FLASH DATA
- 7. NO SERVE PHASES
- 8. DIMMING
- 9. OPTION DATA

PRESS KEYS 1..9 TO SELECT

Actuated by Mouse
Time: 55 sec

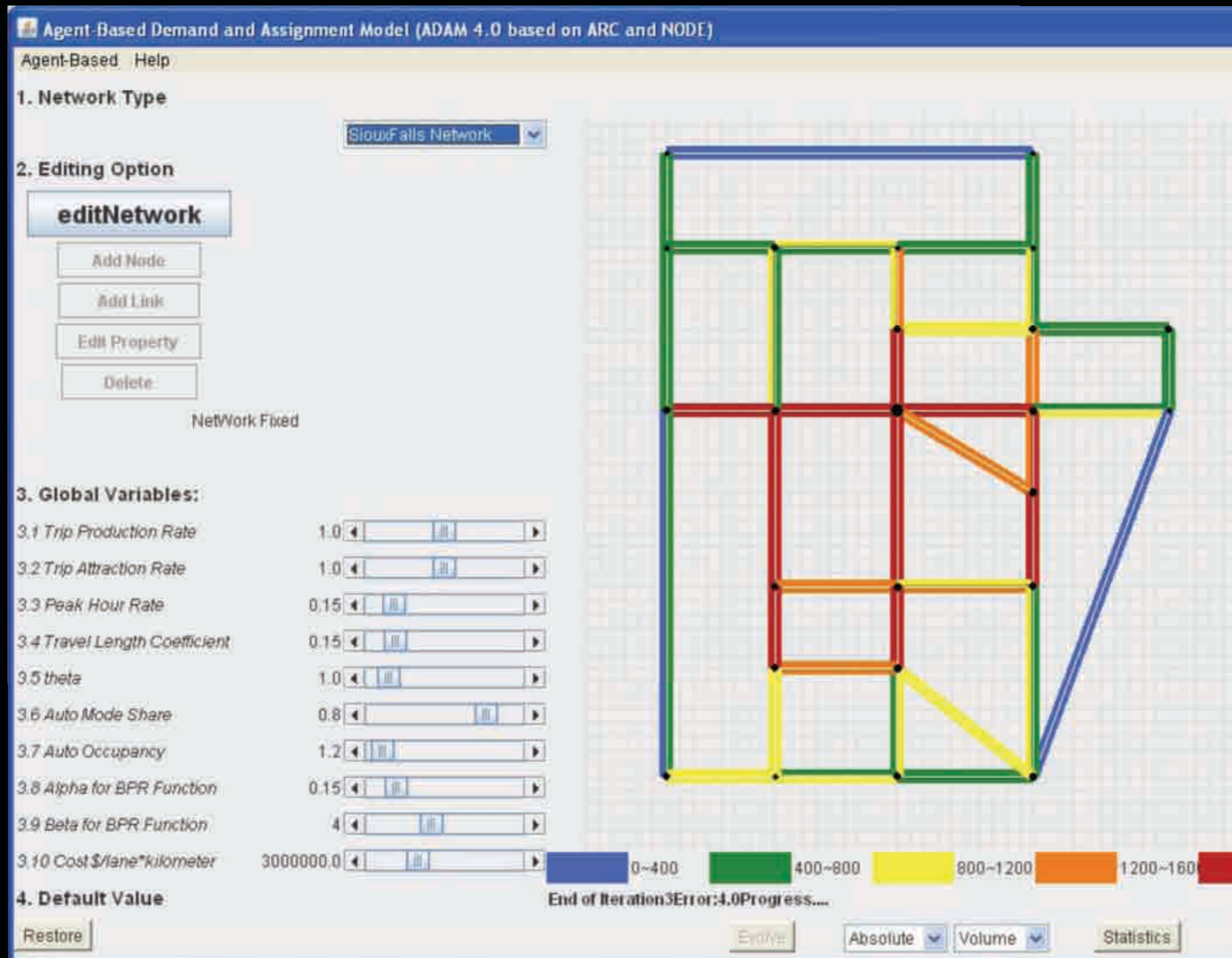
Phase: 8

INIT	02
EXT	00
MAX	32



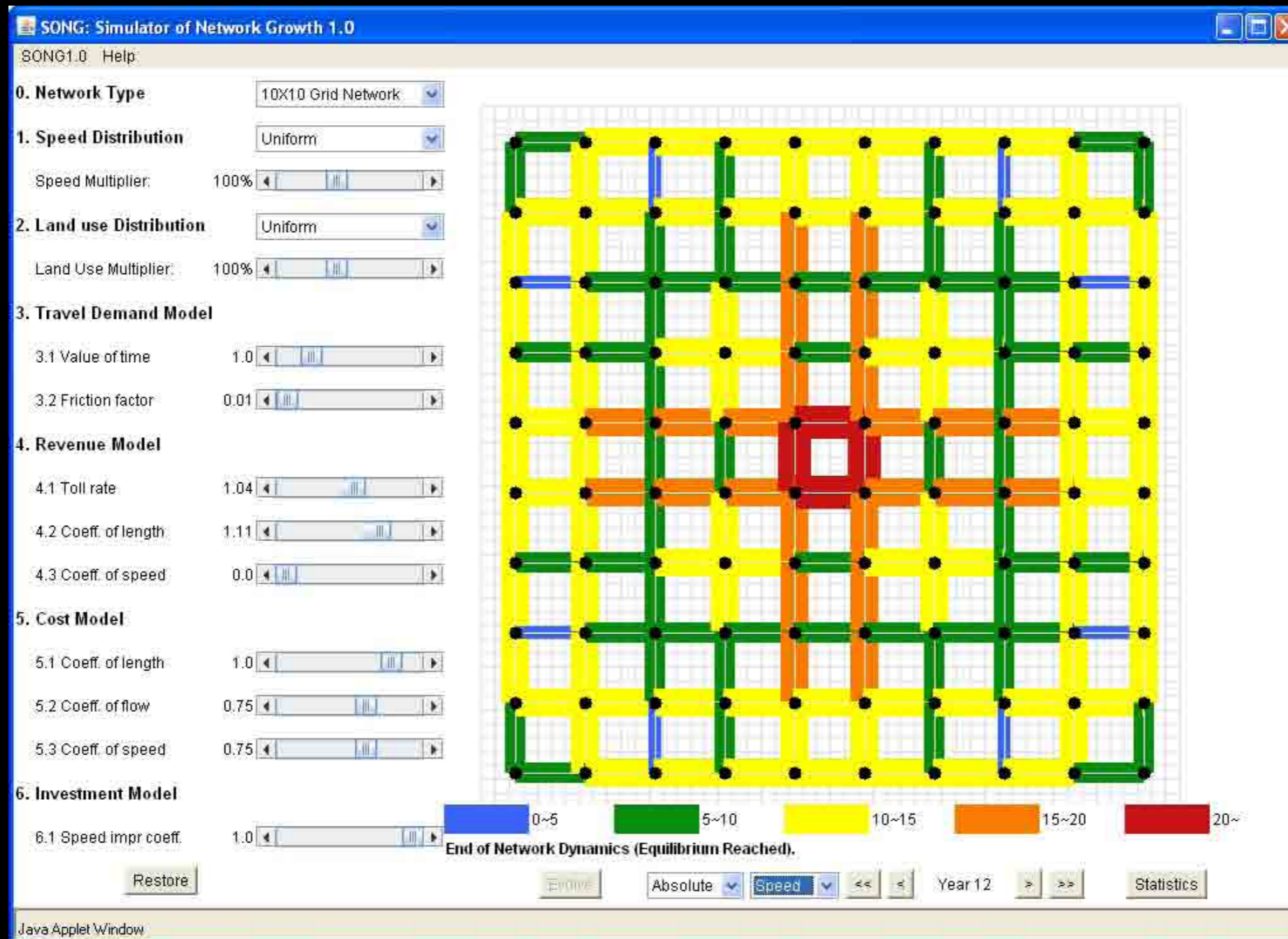
ADAM

Agent-based model of travel patterns



SONG

Simulating transportation network growth



CLUSTER

Retail location choice on supply chains

Clustering Locations of Urban Services, Transport, and Economic Resources (CLUSTER)

Types of products: Homogeneous goods: x

(Consumer) distance scaling parameter: 1.0

Num of cells: 100

Customers on each cell: 10

Number of rounds: 10

product x

Retail price: 2.5

Supplier's price: 1.5

Number of retailers: 5

Retailers' shipping cost(\$): 0.02

Number of suppliers: 5

Individuals' demand: 20

product y

Retail price: 1.5

Supplier's price: 1.0

Number of retailers: 5

Retailers' shipping cost(\$): 0.02

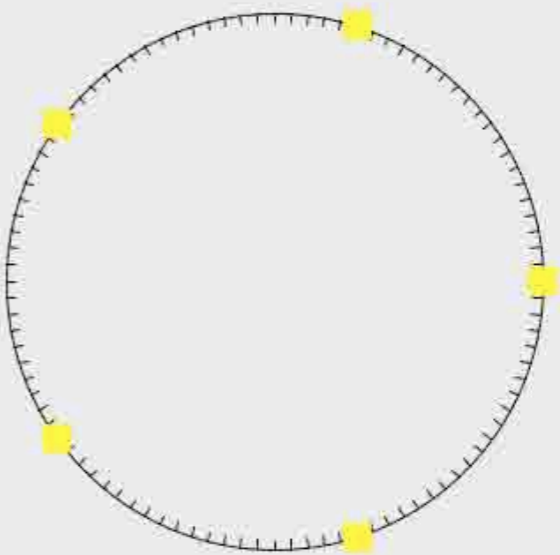
Number of suppliers: 5

Supplier y's offset: 2

Individuals' demand: 20

Evolve Restore

<< < Round 0 > >> Statistics



ABODE

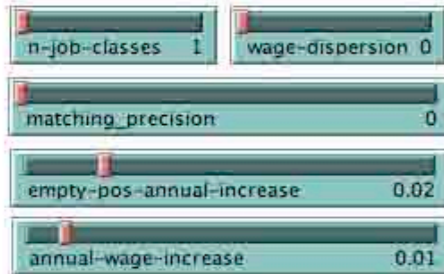
Matching trips' origins and destinations

ABODE (Agent Based Model of Origin Destination Estimation)

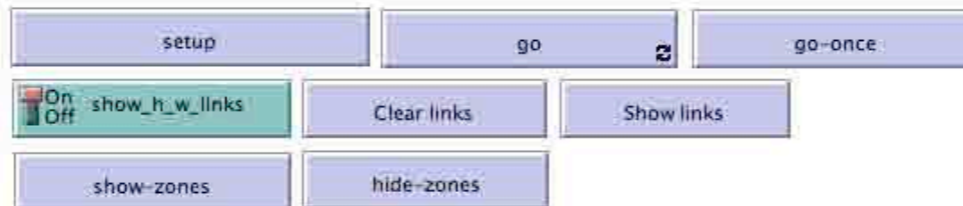
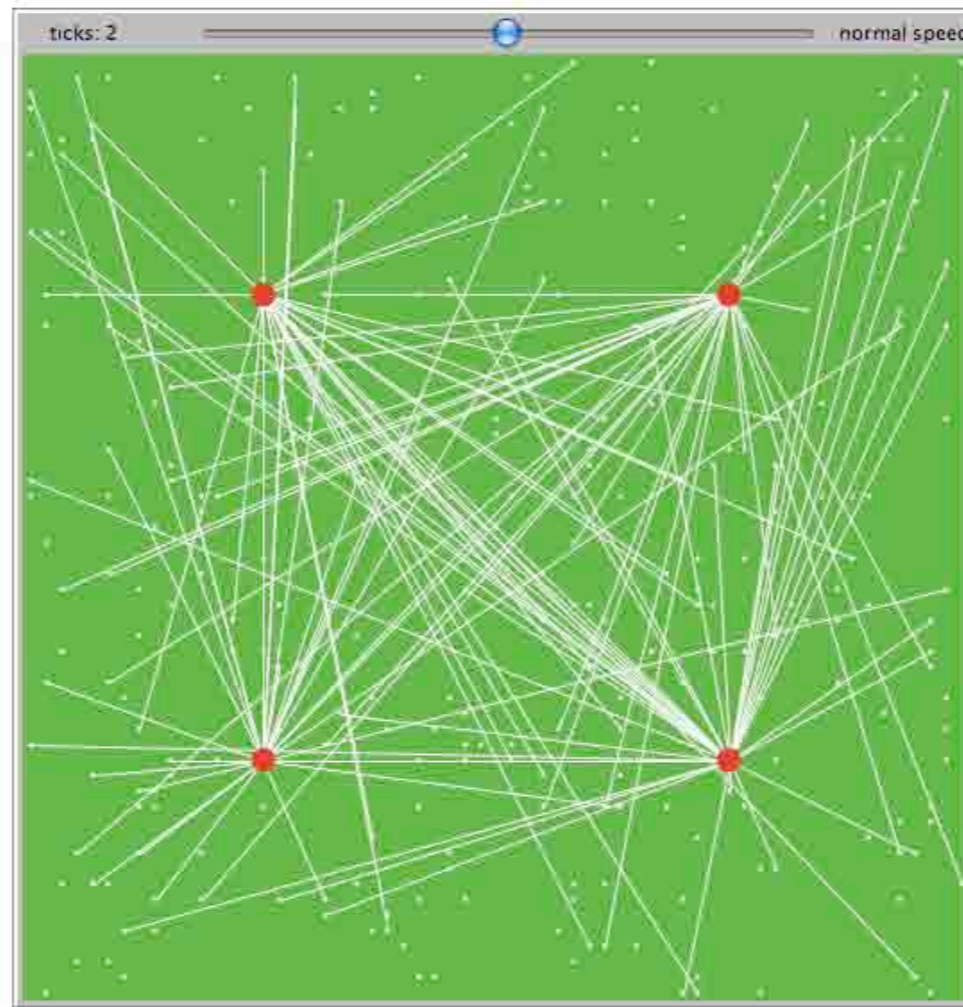
Model Setup Parameters



Job related settings

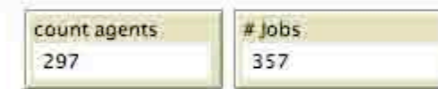


Worker related settings

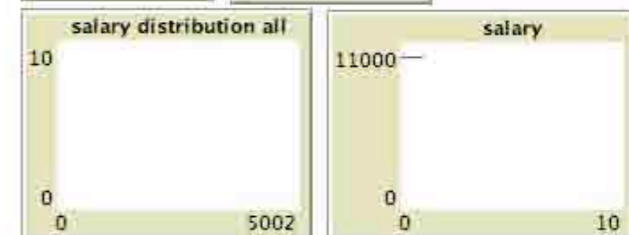
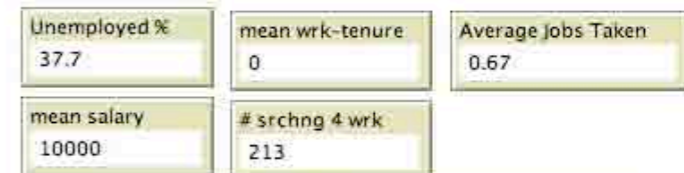


Simulation Monitors

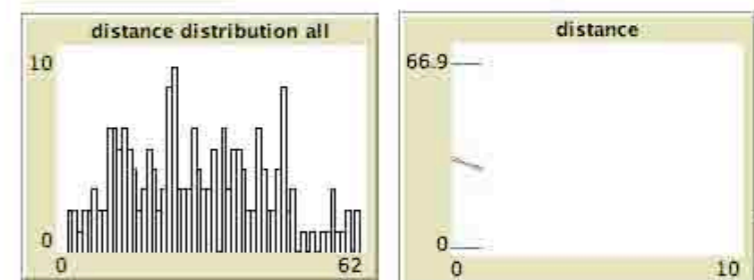
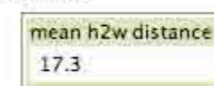
General



Labor market



Commute



ANGIE

Urban road/skway network growth

ANGIE: Agent-based Network Growth model with Incremental Evolution
Developed by the Nexus Reserach Group at the University of Minnesota

Scenario setting

Scenario
Single-center grid-like city

Parameters

Common parameters

Distance decay parameter
delta 0.68

Number of rounds
rounds 10

Parameters in the Grid-like City

Number of rows/columns
Grid-size 5

Distance between rows/columns
Scale 4.0

Cost of an edge
newedgecost 463

Value of a central location (red)
w_center 2835

Value of an ordinary location (green)
w 700

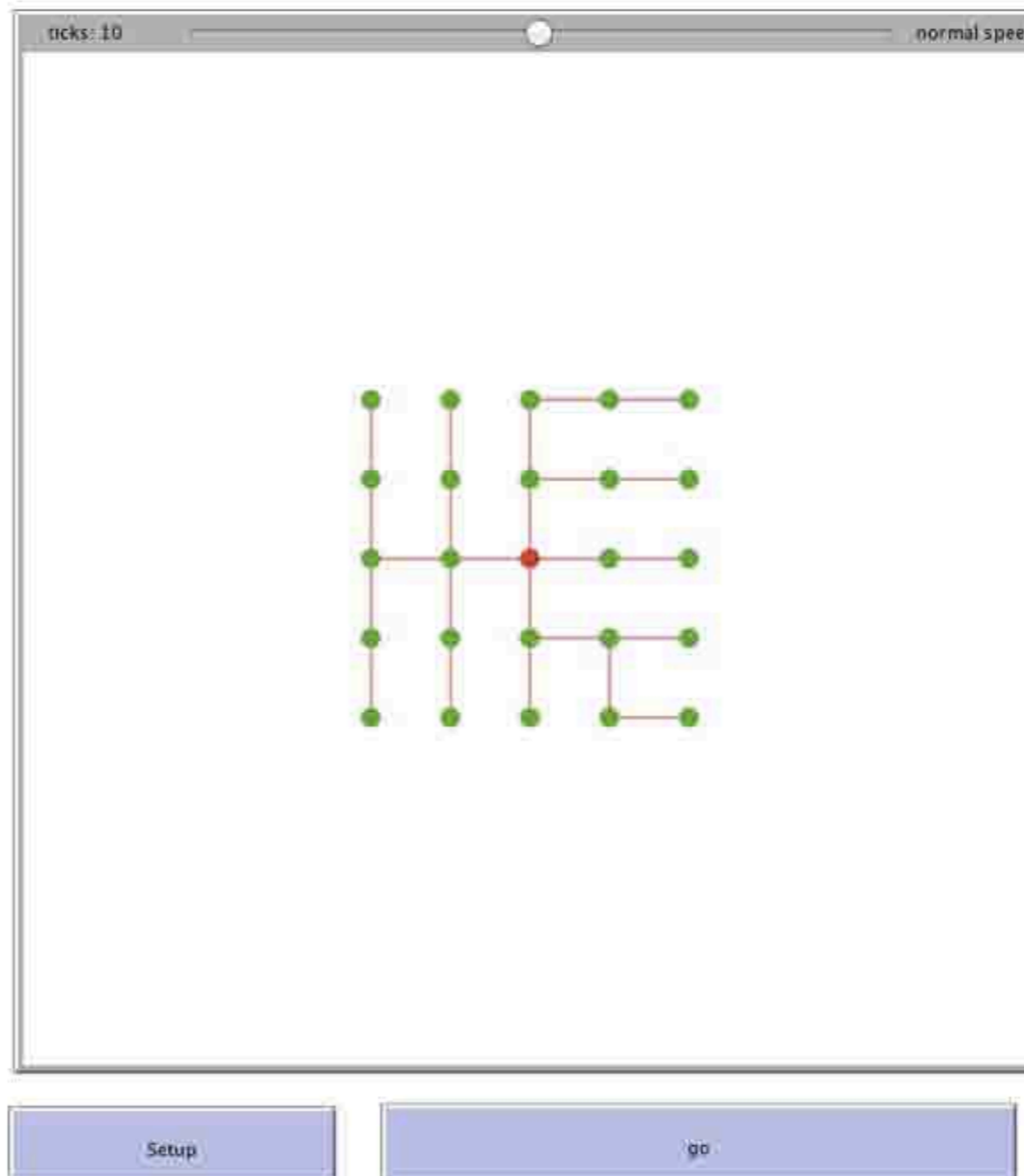
Parameters in the Minneapolis skyways

Show downtown streets (google map)
 On show_downtown_streets

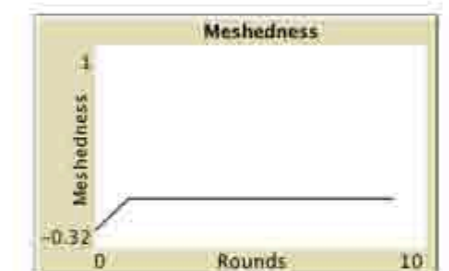
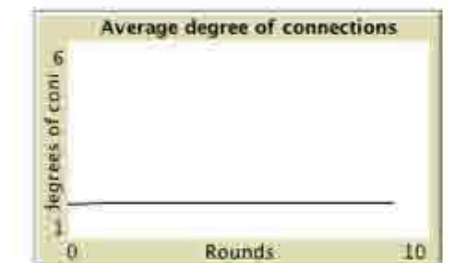
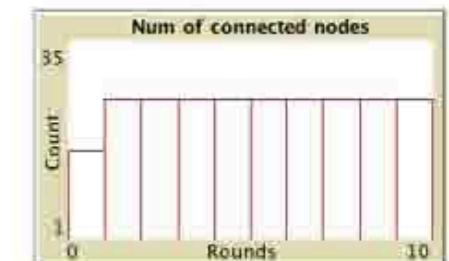
On show_actual_skyways

Cost per unit length of an edge
unitedgecost 330

Value of accessing an employee
unitbenefit 1.45



Network topological measures



Meshedness: $(m - n + 1) / (2n - 5)$
m: number of links
n: number of vertices
Greater meshedness indicates more grid-like

How to apply them in teaching?

Students fill out background survey

Students finish the assignment and submit a report summarizing the results

Students fill out the evaluation survey

Instructors evaluate the tool's effectiveness

Assignments

[Assignment #1](#) - Transportation Network Planning and Design

Application

[Java plug-in](#) is required on your browser.

Evaluation Survey

[Student Background Survey](#)

[SAND Evaluation Survey](#)

Help

[Online Document](#)

Wikibook: Fundamentals of Transportation

Fundamentals of Transportation



Fundamentals of Transportation is a **featured book** on Wikibooks because it contains substantial content, it is well-formatted, and the Wikibooks community **has decided** to feature it on the **main page** or in other places. Please continue to improve it and thanks for the great work so far! You can edit its **advertisement template**.

Table of contents

Introductory Material

- [About](#)
- [Introduction](#)

Planning

- [Decision Making](#)
- [Modeling](#)
- [Geography and Networks](#)
- [Land Use Forecasting](#)
- [Trip Generation](#)
- [Destination Choice](#)
- [Mode Choice](#)
- [Route Choice](#)
- [Evaluation](#)

Transit



Market Street, San Francisco

Hypotheses

STREET will improve students' understanding of critical concepts in Transportation Engineering and enhance students' learning outcomes.

STREET will improve students' motivation toward transportation engineering and improve students' retention.

Effectiveness (ADAM as an example)

Class: CE 3201 (Introduction to transportation engineering)

Subjects: 37 students in spring 2006
38 students in fall 2006

Method: ADAM in Spring 2006
Traditional teaching in Fall 2006

Data: pre-simulation survey + post-simulation survey of self-evaluation of effectiveness + Students' scores in Quiz I

Findings:

- (1) ADAM effectively improves students' learning outcomes;
- (2) Visual and active learners benefit more from ADAM.

Dissemination

Web-based and open-sourced

Presented at the Minnesota State Fair and UMN Academic Technology Showcase

Faculty members from 17 universities have agreed to incorporate STREET into their curricula

6 research papers have been published or presented at TRB Annual Meetings

List of publications

1. Chen, W. and Levinson, D. (2006) *ASCE Journal of Professional Issues in Engineering Education and Practice*, 132(1):29-41.
2. Liao, C.F., Liu, H., and Levinson, D. (2009) *Transportation Research Record*, 2109:12-21
3. Zhu, S. and Levinson, D. (2011) *ASCE Journal of Professional Issues in Engineering Education and Practice*, 137(1):29-41.
4. King, D., Krizek, K. and Levinson, D. (2008) *Transportation Research Record*, 2046:85-93.
5. Krizek, K. and Levinson, D. (2005) *Journal of Planning Education and Research*, 24:304-316.
6. Liao, C.F., and Levinson, D (2010) Presented at TRB Annual Meetings, Washington, DC.

Future plans

Continue to develop online simulation modules related with ongoing research projects.

Apply the modules or derivatives for other educational purposes, such as educating the general public on traffic and planning and integrating modules into high school extracurricular activities to attract students into the transportation field.

Thank you!
Questions?

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