AN INTRODUCTION TO INTELLIGENT TRANSPORTATION SYSTEMS

1.212 SPRING 2005

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Mon/Wed 2:30-4:00

BLOCK 2
Lecture 10

ADVANCED TRAVELER INFORMATION SYSTEMS

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FREIGHT RELIABILITY

DRIVEN BY INVENTORY AND STOCK-OUTS
WHAT CAN GO WRONG?

Delays along the way -- service reliability

ISSUE: Stock-outs

Inventory at B

Time

80
40
1 2 3

goods don’t arrive
WHAT CAN GO WRONG?
(CONTINUED)

So, perhaps the customer at B keeps a day's worth of inventory.

Problems: Bigger Inventory, Warehousing Costs, Insurance Costs.
A BIG ISSUE -- STOCK-OUTS

◆ WHAT DOES A STOCK-OUT COST?
  ◆ Examples
    ◆ GM Assembly Plant
    ◆ Retail Store
    ◆ Blood Bank
INVENTORY MINIMIZATION

◆ If one needs a greater amount of inventory because of unreliability in the transportation system or probabilistic use rate, you generate costs as a result of needing larger inventory to avoid stock-outs.

◆ We try to balance the costs of additional inventory with the costs of stock-outs.
TOTAL LOGISTICS COSTS (TLC)

Total Logistics Costs (TLC) =

\( f (\text{travel time distribution, inventory costs, stock-out costs, ordering costs, value of commodity, transportation rate, etc.}) \)
This probability density function defines how reliable a particular mode is.

TLC is a function of the travel time distribution.

As the average travel time and variance grows, larger inventories are needed.
TRAVELER RELIABILITY

NOW IT IS TIME UTILIZATION
AND NOT INVENTORY WE ARE
CONCERNED WITH
How can you deal with uncertainty in travel times?

- Choose time when conditions are stable
- Choose routes with stable conditions
- Choose routes you know
- Build knowledge through experiment
- Minimize consequences through safety margins
- Get better information before the trip or en route

Think we should design unreliable systems for the thrill-seekers?

Yin, Yafeng and Hitoshi Ieda, “Assessing Performance Reliability of Road Networks Under Nonrecurrent Congestion”, *Transportation Research Record 1771*, National Academy Press, Washington, DC.
Desired Arrival Time = 9 am

for departure times from 7:30-8:30am
What is the overall travel time distribution composed of?

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With no traveler information, how would you decide when to leave?

9 am Utility of Arrival

OR

9 am Utility of Arrival
Suppose at 7:30, while still at home, you can find out what kind of a day it is

- Light
- Regular
- Terrible

What do you do, based on that information?
So, do you really save *actual* traffic time?

Maybe a little, but not much.

Does that mean there is no value to ATIS?
ATIS Non-User:
Travel Times Based on Past Experience

Figure ES-1: ATIS Non-User Route Choice and Trip Timing

ATIS User:
Reported Travel Times at 8 am

Figure ES-2: ATIS User Route Choice and Trip Timing

ATIS benefits are *grossly understated* if only travel time savings are included.

The value of improved on-time reliability is not easily nor directly monetized, but it is clear that many types of travelers can benefit from ATIS.

Trucks delivering auto parts in a just-in-time manufacturing process may highly value any improvement in on-time reliability or reduction in early schedule delay.

Commuters face an on-time requirement not only on the home-to-work leg of their daily trip-making, but increasingly on the work-to-home return trip in order to meet daycare pickup requirements and other commitments.

Improved reliability and predictability of travel are also likely good surrogates for reduced commuter stress.

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CONCLUSIONS (2)

◆ Overall, ATIS use proved advantageous in efficiently managing the traveler’s time. Specific quantitative examples selected from the Washington, DC, case study include:

◆ Peak-period commuters who do not use ATIS were three to six times more likely to arrive late compared to counterparts who use ATIS;

◆ Cases where ATIS clearly benefits the user (e.g., ATIS user on-time, non-user late) outweighed cases where ATIS clearly disadvantages the user by five to one;

◆ ATIS users in peak periods are more frequently on-time than conservative non-users, yet they experience only two-thirds as much early schedule delay as non-users;

◆ Late shock, the surprise of arriving late, is reduced by 81% through ATIS use.

Simulation Approach

- 72 drivers
- Ages 18-86
- Equal number of males and females
- Familiarity with actual roads (but this was a *simulation*)
THREE LEVELS OF ATIS

- No ATIS
- Basic ATIS
  - Descriptive information about incidents and congestion
  - Location, type of incident
- Enhanced ATIS
  - Basic plus the following
  - Alternative route
  - Incident details
  - Real-time traffic map
  - Live video traffic images
TWO TRAFFIC LEVELS

- Light
- Moderately Heavy

So, Six Experimental Conditions, Twelve Participants per Condition

Also, incidents built into the simulations
CONCLUSION

◆ ATIS influences en route driver decisionmaking
◆ Drivers will divert
◆ Travel time savings occurred as a function of ATIS features
◆ Some drivers did worse by diverting
◆ Travel level (light vs. moderately heavy) had little effect on driver behavior
◆ Maps work
SOME QUESTIONS

- Can you separate traffic management and traveler information?
- Does it make sense to have one without the other?
- Reporting traffic conditions without doing anything about it.
- Can the for-profit sector compete with people giving away information (radio stations, e.g.)?
- Is there value-added for better information? Do customers act on it?
QUESTIONS/ISSUES

- Value of information -- how to measure?
- Price -- will people pay?
- Costs (and who bears them)
- Quality of information and how to assure
- “Ethics” -- just because you can pay, should you be advantaged in using a public facility?
- Safety -- distraction
- Privacy
- Providing people “wrong” information to enhance overall flows.
- Does ATIS help or hurt congestion -- network operations?
STATIC INFORMATION
(E.G., NETWORK TOPOGRAPHY)

SEMIDYNAMIC INFORMATION
(E.G., CONSTRUCTION)

DYNAMIC INFORMATION
“E”-INFORMATION FROM FIELD IN REAL-TIME
E.G., VOLUMES SPEEDS QUEUES
NON-“E”-INFORMATION E.G., SPOTTER AIRCRAFT STATE POLICE

ATMS

ESTIMATE NETWORK STATE

GENERATE NETWORK STRATEGIES

PREDICTION OF FUTURE NETWORK STATE AS F (STRATEGY) INCLUDING “GUESSES” ABOUT TRAVELER REACTION TO ATIS

ATIS

INFORMATION TO TRAVELERS E.G., DYNAMIC ROUTING INFORMATION TO INDIVIDUAL VEHICLES E.G., VARIABLE MESSAGE SIGNS

ACTUAL CHANGE IN TRAVELER BEHAVIOR?

SELECT AND DEPLOY STRATEGY
WRAP-UP

- ITS provides substantial data gathering capability
  - Static
  - Semi-dynamic
  - Dynamic
- Can this data be translated into information of value?
  - To individual travelers
  - To network operators
- Are there interests of individual travelers and network operators complimentary or antithetic?
- Can we make good (consistent) predictions of the future state of the network if people act on traveler information?
- Can ATIS be a business? Can it create customers? (Peter Drucker)