NEC Auto and Truck Transportation with Emphasis on New Technology

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Quick Facts on North East Corridor

- The Northeast Corridor (NEC) extending from Boston, Mass., to the District of Columbia is the most densely populated region in the United States, with six major metropolitan areas.
Quick Facts on North East Corridor

- Northeast region constitutes approximately 40% of the nation’s disposable income\(^{(1)}\).
- The population of the region was 56.3 million in 2003 (20% of total U.S.)
- In 2006 Port Authority of New York and New Jersey moved 31.2 million metric tons of general cargo, with a 7.9% increase over the previous year
- Overall the port generated $150 billion worth of cargo and $25 billion of economic activity in the region

\(^{(1)}\) Port Authority of New York and New Jersey, 2007
Quick Facts about North East Corridor

• In 2001\(^1\),
  – Over 20% of the U.S. population lived and traveled daily in only 6.2% of the U.S. landmass that stretches from Virginia to Maine.
  – Over 38,000 trucks daily carried nearly two-thirds of all North American trucking tonnage through the New York-Northern New Jersey region - trips that were vital to the economy of the burgeoning corridor and to the nation.
  – The twelve-state northeastern corridor had 13 major airports, more than two dozen rail stations, 11 major seaports, and 30,000 miles of Interstate and primary highways.
  – Within their heavily traveled corridor, the multitude of transportation agencies responsible for highways saw vehicle miles traveled annually totaling 105 billion on Interstates and over 155 billion on principal arterials and expressways/freeways.
  – Northeast region includes nation’s capital and major financial and corporate centers, accounting for more than 20% of the nation’s population and GDP despite including only about 2% of its total land area. The Northeast urban core produces 10 times more GDP per square mile than the national average.

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Quick Facts on North East Corridor – Freight Movements

Maritime Volume of Trade: 2004 - 2020

Increase in domestic freight movements in 2020

Northeast region +58%
Quick Facts on North East Corridor – Truck flows

Truck Movements in highways from 2005 to 2025
Current Transportation Related Problems

- Congestion (Truck + Car)
  - Changing economy
  - Demographics / Land Use
    - Aging population
    - Population increase and urban sprawl
- Safety
- Environmental
  - Pollution
  - Noise
- Energy
  - Increased gasoline cost
- Safety (Highway Accidents)
  - Loss life, productivity, resources
- Aging infrastructure & lack of funds
- Finally, Security!
Future Problems?

- May 7th issue of US World News and Report states that congestion is a growing serious problem in the US. [http://www.usnews.com/usnews/issue/070429/]
Future Problems & Solutions

• More of the same? Can we predict future problems and solutions even if we use most sophisticated system engineering concepts?

• Maybe NOT!

• The World3 model was a computer simulation of interactions between population, industrial growth, food production & limits in the Earth’s ecosystems.

• The model predicted that humanity would run up against the fundamental limits to economic growth about a century after the publication of the book: i.e. 2072, with extremely serious ecological problems only beginning to become obvious in the 2030s and 2040s.

• For example, The Skeptical Environmentalist states: "Limits to Growth showed us that we would have run out of oil before 1992" (page 121). What Limits to Growth actually has is the above table which has the current reserves (that is no new sources of oil are found) for oil running out in 1992 assuming constant exponential growth.
Severely Congested Roads and Cost to Eliminate Them


Do we have the resources to build MORE ROADS?
Future Problems & Solutions

• Some basic assumptions
  – Demand for truck and auto traffic will continue to grow in the future
  – Congestion, safety, environmental, energy problems will also continue to grow as a function of increasing demand
  – Resources for expanding and maintaining the NEC transportation infrastructure will continue to be meager
Demand & Safety?

Increased Demand - Increased Number of Accidents
Technology Solutions: Intelligent Transportation Systems

• What is ITS: ITS defines a new paradigm in Transportation by combining a series of new concepts, technologies & services to integrate:
  – Information
  – Vehicles

• Transportation infrastructure Traditional Classification
  – Advanced Transportation Management Systems / Advanced Traveler Information Systems (ATMIS)
  – Advanced Public Transportation Systems (APTS)
  – Advanced Rural Transportation Systems (ARTS)
  – Advanced Vehicle Control and Safety Systems (AVCSS)
ITS Goals

- Enhance the Mobility, Efficiency, and Safety of U.S. Highway System
- Develop a Technology Base for Intelligent-Vehicle Highway System
- Establish the Capability to Perform Demonstration Experiments
- Reduce Societal, Economic, and Environmental Costs Associated with Traffic Congestion
- Improve safety
Transportation System

- People and Goods
- Vehicles
- Roadway Infrastructure

Information flows between these components.
Current ITS Solutions

• Advanced Technology
  – EZ Pass
    • TRANSMIT (vehicle tracking using EZ Pass for travel time estimation and incident detection)
    • Congestion Pricing
      – Variable Message Signs
• Improved Infrastructure and Safety
  – Truck only lanes
  – Lane departure warning
• Traveler Information Systems
  – In-vehicle sensors & devices
  – GPS & satellite technology
• Real-Time Traffic Control and Management
  – HOV + HOT
  – Adaptive Traffic Signals
ATMIS
LA Automated Traffic Surveillance And Control (ATSAC) Center
DEPLOYMENT
Real-Time Traffic Control

Philadelphia
Ben Franklin Bridge
Walt Whitman Bridge
DIVERSION point
Variable Speed Control
Variable Speed Control

Figure 84. Variable speed limit, England.

Figure 87. Close-up of variable speed limit indication, England. (Note flashing warning lights in corners)

Figure 92. Variable speed limit sign, England.

Figure 93. Variable speed limit ends sign, England.
Safety and Security

- Vehicle based safety technologies
  - Intelligent Cruise Control
  - Advanced Crash Warning Systems

- Infrastructure Based Systems
  - Road Weather Information Systems
Road Weather Information Systems (by RITS)

Proposed ITS Additions On Route 287
Project Site - Wanaque Bridge
NJDOT + Rutgers RWIS Project: Actual Installation of Sensors
Congestion Pricing and Technology

• NJ Turnpike is a 148 mile-toll road with 27 entry-exit points.
• Extends from Delaware Memorial Bridge in South NJ to George Washington Bridge in New York City.
• Since September, 2000, time-of-day pricing has been applied. On January, 2003, toll levels for each period and vehicle type were increased.
• On January 2006 E-ZPass discounts during peak hours were removed
• Peak hour tolls: effective on weekdays: 7:00-9:00am and 4:30 - 6:30pm.
• Only passenger cars with E-ZPass tag are eligible for time-of-day pricing, and cash users’ tolls are higher than E-ZPass users irrespective of time-of-day.

Congestion Pricing and Technology

**New Jersey Turnpike Toll Road**(1,2)

<table>
<thead>
<tr>
<th>Toll</th>
<th>Passenger Cars</th>
<th></th>
<th>Tractor Trailers</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1991</td>
<td>Sep-00</td>
<td>Jan-03</td>
<td>Jan-06</td>
</tr>
<tr>
<td>Cash all day</td>
<td>70%</td>
<td>20%</td>
<td>17%</td>
<td>0%</td>
</tr>
<tr>
<td></td>
<td>($4.60)</td>
<td>($5.50)</td>
<td>($6.45)</td>
<td>($6.45)</td>
</tr>
<tr>
<td>E-ZPass peak</td>
<td>-</td>
<td>8%</td>
<td>10%</td>
<td>18%</td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>($4.95)</td>
<td>($5.45)</td>
<td>($6.45)</td>
</tr>
<tr>
<td>E-ZPass off-peak</td>
<td>-</td>
<td>0%</td>
<td>5%</td>
<td>0%</td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>($4.60)</td>
<td>($4.85)</td>
<td>($4.85)</td>
</tr>
<tr>
<td>E-ZPass (weekend)</td>
<td>-</td>
<td>8%</td>
<td>10%</td>
<td>18%</td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>($4.95)</td>
<td>($5.45)</td>
<td>($6.45)</td>
</tr>
</tbody>
</table>

(1): Resulting toll amount between pairs (1,18W) after the toll increase
(2): Weekends: Only E-ZPass discount is in place, weekday peak hour tolls effective

- E-ZPass users form 63% of the total users
- During peak hours and peak shoulders, more than 90% of the vehicles are passenger cars.
- In 2004, a total of 1,464,077 users have been using E-ZPass.

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Congestion Pricing and Technology

Port Authority of New York and New Jersey

Tunnels & Bridges (Veh / Year)\(^{(1)}\)

- GW Bridge: 55M
- Lincoln Tunnel: 21M
- Holland Tunnel: 16M
- Staten Is. Bridges: 34M

126M

\(^{(1)}\) Ozbay K., Yanmaz-Yuzel O., Holguin-Veras, J., “The Impacts of Time-of-day Pricing Initiative at NY/NJ Port Authority Facilities Car and Truck Movements” Transportation Research Record, 2006, No: 1960, pp. 48-56
## Congestion Pricing and Technology

### Port Authority of New York and New Jersey\(^{(1,2)}\)

<table>
<thead>
<tr>
<th>Type of Vehicle</th>
<th>Before Value Pricing (Before March 2001)</th>
<th>After Value Pricing (After March 2001)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cars</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cash Peak</td>
<td>$4.00</td>
<td>$6.00</td>
</tr>
<tr>
<td>Cash Off-Peak</td>
<td>$4.00</td>
<td>$6.00</td>
</tr>
<tr>
<td>E-ZPass Peak</td>
<td>$3.60</td>
<td>$5.00</td>
</tr>
<tr>
<td>E-ZPass Off-Peak</td>
<td>$3.60</td>
<td>$4.00</td>
</tr>
<tr>
<td><strong>Trucks (per axle)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cash Peak</td>
<td>$4.00</td>
<td>$6.00</td>
</tr>
<tr>
<td>Cash Off-Peak</td>
<td>$4.00</td>
<td>$6.00</td>
</tr>
<tr>
<td>E-ZPass Peak</td>
<td>$3.60</td>
<td>$6.00</td>
</tr>
<tr>
<td>E-ZPass Off-Peak</td>
<td>$3.60</td>
<td>$5.00</td>
</tr>
<tr>
<td>E-ZPass night</td>
<td>$3.60</td>
<td>$3.50</td>
</tr>
</tbody>
</table>

- Peak hours: Weekdays: 6 AM – 9 AM, 4 PM – 7 PM
  Weekends: 12 PM – 8 PM
- Overnight: Weekdays: Midnight – 6 AM

- E-ZPass users form around 70% of the total users during peak and peak shoulders\(^{(1,2)}\)

\(^{(1)}\) Ozbay K., Yanmaz-Yuzel O., Holguin-Veras, J., “The Impacts of Time-of-day Pricing Initiative at NY/NJ Port Authority Facilities Car and Truck Movements” Transportation Research Record, 2006, No: 1960, pp. 48-56

Congestion Pricing and Technology

Value of Travel Time for NJ Turnpike Users\(^{(1,2)}\)

<table>
<thead>
<tr>
<th>trip purpose</th>
<th>period</th>
<th>Mean VOTT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Work</td>
<td>Pre-peak</td>
<td>$16.72/hr</td>
</tr>
<tr>
<td></td>
<td>Peak</td>
<td>$19.72/hr</td>
</tr>
<tr>
<td></td>
<td>Post-peak</td>
<td>$17.35/hr</td>
</tr>
<tr>
<td>Leisure</td>
<td>Pre-peak</td>
<td>$17.03/hr</td>
</tr>
<tr>
<td></td>
<td>Peak</td>
<td>$17.16/hr</td>
</tr>
<tr>
<td></td>
<td>Post-peak</td>
<td>$15.33/hr</td>
</tr>
</tbody>
</table>

- Mean VOTT values of the NJ Turnpike users are higher than most of the other toll facilities in U.S. Possible reasons could be:
  - No flexibility of users to shift other periods or routes
  - High income levels
  - Avoiding congestion and being on time are more important than saving on toll


### Value of Time of NJ Turnpike EZ Pass Users

<table>
<thead>
<tr>
<th>trip purpose</th>
<th>period</th>
<th>VOTT Function</th>
<th>Mean VOTT</th>
<th>St. dev. VOTT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Work (1)</td>
<td>pre (1)</td>
<td>( \frac{\partial V_{1j}}{\partial t_{1j}} = -0.106 p_{1j} - 0.9 t_{1j} - 0.15 R_{1j} - 0.22 )</td>
<td>$16.72/hr</td>
<td>$2.77/hr</td>
</tr>
<tr>
<td></td>
<td>peak (2)</td>
<td>( \frac{\partial V_{12}}{\partial t_{12}} = -0.2 p_{12} - 0.88 t_{12} - 0.3 t_{22} - 0.14 R_{12} - 0.48 )</td>
<td>$19.72/hr</td>
<td>$2.89/hr</td>
</tr>
<tr>
<td></td>
<td>post (3)</td>
<td>( \frac{\partial V_{13}}{\partial t_{13}} = -0.26 p_{13} - 0.62 t_{13} - 0.139 R_{13} - 0.34 )</td>
<td>$17.35/hr</td>
<td>$2.16/hr</td>
</tr>
<tr>
<td>Leisure (2)</td>
<td>pre (1)</td>
<td>( \frac{\partial V_{21}}{\partial t_{21}} = -0.1 p_{21} - 0.5 t_{21} - 0.18 R_{21} - 0.44 )</td>
<td>$17.03/hr</td>
<td>$2.17/hr</td>
</tr>
<tr>
<td></td>
<td>peak (2)</td>
<td>( \frac{\partial V_{22}}{\partial t_{22}} = -0.15 p_{22} - 1.08 t_{22} - 0.15 R_{22} - 0.7 )</td>
<td>$17.16/hr</td>
<td>$2.03/hr</td>
</tr>
<tr>
<td></td>
<td>post (3)</td>
<td>( \frac{\partial V_{23}}{\partial t_{23}} = -0.18 p_{23} - 0.92 t_{23} - 0.15 R_{23} - 0.43 t_{23} - 0.53 )</td>
<td>$15.33/hr</td>
<td>$2.09/hr</td>
</tr>
</tbody>
</table>

What is in the Future?
New ITS Initiatives

- Intelligent Vehicle Initiative (2005)
  [http://www.its.dot.gov/ivi/ivi.htm](http://www.its.dot.gov/ivi/ivi.htm)
- Lessons learned from IVI led to development of 3 Federal ITS initiatives:
  Vehicle Infrastructure Integration, Cooperative Intersection Collision Avoidance Systems and Integrated Vehicle Based Safety Systems.
How is NEC Corridor Doing?

CVAS Member States

www.path.berkeley.edu/path-at-20/Presentations/AVCSS3.pdf
More Advanced Technologies

http://www.path.berkeley.edu(PATH/Publications/Videos/)

- Collision warning systems
- Automated snow blower
- Smart parking
More Futuristic Solutions

Advanced Large Vehicle Control

1. Lane Following (Lateral Control)
2. Platooning (Longitudinal Control with Coordination)
3. Curbside Docking (Longitudinal/Lateral Control)
4. Collision Avoidance (Longitudinal/Lateral Control with Sensory Recognition)
Automated Trucks

• According to Bishop (2000)
  ivsource.net/archives/ppt/IV2000_IVoverview.ppt
  – Roughly 50,000 heavy trucks equipped with Eaton-Vorad radar-based system
    • covers forward zone and right blind spot
    • selling “thousands” per year
    • accident reductions of 50% or greater reported for some fleets
  – Lane departure warning entered heavy truck market in 1999
    • based on image processing
    • first on Mercedes trucks (Europe), followed by Freightliner (Iteris system)
    • now a factory option from Kenworth (SafeTRAC)
    • suitable for automotive aftermarket

• More to Come!!!
New Issues on Security

- Large concentration of population
- Beyond traditional use of the transportation infrastructure
  - Emergency evacuation before and after of a natural or man-made event
- Need for inter-modal evacuation plans
  - Cape May evacuation plan and contra-flow
- Identification and protection of key Infrastructure
- Issues of Preparedness
Conclusions

• Auto and Truck Traffic on the NE Corridor will continue to grow

• Demand for **BIGGER & HEAVIER** trucks continues to increase

• NE Corridor is densely populated and it is very expensive to build new infrastructure

• Long and mid term planning should be improved
  - New methodologies
  - Incorporate operational solutions into the planning tools Advanced technologies such as ITS can be part of the future solutions

http://faculty.washington.edu/jbs/itrans/bishopahs.htm
Conclusions

- Safety has become a major focus area
  - Intersection safety
  - Collision avoidance
- Demand management through congestion pricing is the major policy advocated by many agencies
- Information technology solutions continue to be popular (ATIS)
- More tested solutions such as incident management, ramp metering, and adaptive signal control should be implemented
- Public transit is still not popular
- However, it might not be possible to completely avoid building new roads!!!