Managed Lanes
A National Perspective on Practice, Experiences, and Outcomes

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TODAY’S DISCUSSION

→ The Purpose of Managed Lanes
→ Managed Lanes in Practice
→ Problems That Have Occurred with Managed Lanes
WHAT’S THE POINT OF MANAGED LANES?
ECONOMICS OF CONGESTION

Congestion is an imbalance between:

- Supply (highway lanes)
- Demand (highway travel)

Equilibrium where Supply and Demand are in balance
ECONOMICS OF CONGESTION

Congestion is an imbalance between:

→ Supply (highway lanes)
→ Demand (highway travel)

Unlimited demand yields overconsumption of supply

→ Demand limited by fuel consumption, not location and time of use

Outcome is economic scarcity

![Supply and Demand Diagram]

- Price (P*)
- Quantity (Q^s, Q^d)

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DEALING WITH SCARCITY

3 Options for Dealing with Scarcity

- Increase Capacity
- Reduce Demand
- Control Access
DEALING WITH SCARCITY

Build More Lanes
- Congestion relief is temporary
- Does not fix the fundamental imbalance
- Widening costs are expensive

Reduce Demand
- Yields rationing and trip avoidance
- Requires viable alternatives
- Impedes economic productivity

Control Access
- Does nothing for growth
- Shifts more trips to arterials
Avoiding Congestion

¬ Requires a fundamental commitment to manage roadway capacity to avoid traffic flow breakdowns.
CONGESTION IS THE RESULT OF FLOW BREAKDOWN

➔ Predictable conditions
  ▪ Bottlenecks at known locations
    - Ramp merges, grades, weaving points, lane constrictions, bridges, etc.
  ▪ Speed differentials between vehicles

➔ Unpredictable conditions
  ▪ Driver behavior that slows traffic, such as rubber necking or sudden braking
  ▪ Spikes in traffic that yield short periods of high density flow
Flow breaks down at 1800 – 2000 vehicles per hour per lane
EXAMPLE OF FLOW BREAKDOWN
EXAMPLE OF FLOW BREAKDOWN
WHY SHOULD WE USE PRICING?

➔ **Generates Revenue**
  - Afford more than we could otherwise build and maintain

➔ **Meters Traffic**
  - Higher travel speeds accrue in medium and (especially) long term
  - Pricing more efficient than signalization or rationing

*You Don’t Need a Price to Meter: I-70 (Colorado) meters traffic through mainline traffic signals.*
MANAGED LANES MORE EFFICIENT

- Use of pricing meters traffic in order to prevent breakdown into congested conditions.
MANAGED LANES IN PRACTICE
Under Construction
RAPID GROWTH IN PRICED MANAGED LANES

Almost doubling the total lane miles in the next five years

Graphic Source:
Prof. David Levinson, University of Minnesota, June 15, 2015.
## PRICING OF HOV’S

<table>
<thead>
<tr>
<th>HOV-2+ free at all times</th>
<th>HOV-2+ free peak only</th>
<th>HOV-3+ free with limits</th>
<th>HOV-3+ discount</th>
<th>No HOV benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>I-15 (CA)</td>
<td>I-10 (TX)</td>
<td>I-95 (FL)</td>
<td>SR-91*</td>
<td>Loop 375</td>
</tr>
<tr>
<td>I-25</td>
<td>I-45</td>
<td>I-85</td>
<td>I-635</td>
<td>Loop 1</td>
</tr>
<tr>
<td>SR 167</td>
<td></td>
<td>I-495</td>
<td>I-35E (TX)</td>
<td>I-595</td>
</tr>
<tr>
<td>I-35W</td>
<td></td>
<td>SR-91*</td>
<td></td>
<td>I-95 (MD)</td>
</tr>
<tr>
<td>I-394</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I-680</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SR-237 / I-880</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I-15 (UT)</td>
<td></td>
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</tr>
</tbody>
</table>

**I-635, Dallas**
NOT ALL MANAGED LANES ARE THE SAME

Convert HOV Lanes

- Overused HOV
  - I-85 Atlanta

- Underused HOV
  - I-25 Denver
  - I-15 Salt Lake City
  - SR-167 Seattle
  - I-394 Minneapolis

Build New Lanes

- Convert + Build
  - I-15 San Diego
  - I-95 Miami
  - I-495 Virginia
  - I-35W Minneapolis
  - I-10 Houston
  - I-635 Dallas

- Build Only
  - SR-91 Orange County
  - I-595 Ft. Lauderdale
  - North Tarrant Express Dallas
  - DFW Connector Dallas

Anticipate More Benefits

Anticipate Less Benefits
WHEN THINGS DON’T GO RIGHT
## I-394 MINNEAPOLIS

<table>
<thead>
<tr>
<th>Feature</th>
<th>Details</th>
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<tbody>
<tr>
<td>Year Opened</td>
<td>2005</td>
</tr>
<tr>
<td>Length</td>
<td>11 miles</td>
</tr>
<tr>
<td>Directional lanes</td>
<td>1 lane each direction / 2 lane reversible</td>
</tr>
<tr>
<td>Access Type</td>
<td>5 Access Points</td>
</tr>
<tr>
<td>Separation Type</td>
<td>Painted Buffer</td>
</tr>
<tr>
<td>Transit</td>
<td>Moderate Bus Frequency</td>
</tr>
<tr>
<td>Capital Cost</td>
<td>$10M</td>
</tr>
<tr>
<td>Innovations</td>
<td>First use of buffer separation; mobile enforcement; static signage with DMS</td>
</tr>
</tbody>
</table>
What Went Wrong

- Opened with 24 hours operation
- Increase in general purpose lane congestion
  - Observed in off-peak direction
  - Unanticipated outcome
- Increase due to a reduction in GP lane capacity
  - Prior HOV configuration permitted GP traffic in off-peak times / directions
- Legislature began considering a bill to reverse the I-394 Managed Lanes
  - Within first three weeks of operation

What Was Changed

- MnDOT changes operations in response to legislature and public
- Instituted peak hour / peak direction policy
- 6 am – 10 am inbound
- 2 pm – 7 pm outbound

Outcome

- Concerns alleviated
  - Continuously operated since 2005
  - Support for new lanes on I-35W and I-35E
- Mitigation depressed revenue
- Created precedent for all facilities
<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Year Opened</strong></td>
<td>2011</td>
</tr>
<tr>
<td><strong>Length</strong></td>
<td>15.5 miles</td>
</tr>
<tr>
<td><strong>Directional lanes</strong></td>
<td>1 lane each direction</td>
</tr>
<tr>
<td><strong>Access Type</strong></td>
<td>7 Weave Lanes</td>
</tr>
<tr>
<td><strong>Separation Type</strong></td>
<td>Painted Buffer</td>
</tr>
<tr>
<td><strong>Transit</strong></td>
<td>Adjacent to corridor</td>
</tr>
<tr>
<td><strong>Capital Cost</strong></td>
<td>$60M</td>
</tr>
<tr>
<td><strong>Innovations</strong></td>
<td>Registered carpool accounts, Mobile toll app, Mobile enforcement, Virtual barrier system</td>
</tr>
</tbody>
</table>
I-85 ATLANTA

What Went Wrong

→ Restored flow to overused HOV lanes
  ▪ Converted congested HOV-2+ lane to priced managed lane with HOV-3+ toll-free with registration

→ Substantial increase in general purpose lane congestion
  ▪ By design, removing vehicles from managed lanes

→ Dynamic pricing algorithm imposed very high toll rates
  ▪ Algorithm overly considered conditions in general purpose lanes when setting tolls

Measureable Impacts

→ Vehicular Throughput
  ▪ AM Peak: 6.6% decline
  ▪ PM Peak: 2.9% decline

→ Person Throughput
  ▪ AM Peak: 9.9% decline
  ▪ PM Peak: 6.3% decline

→ Vehicle Occupancy
  ▪ HOV-2: 30% (AM) decline
  ▪ AVO: 2.0 → 1.2 person/vehicle

Source: Georgia Tech, College of Engineering
http://transportation.ce.gatech.edu/hov2hot
What Was Changed

→ Governor Deal intervened in the first five days to implement changes
  ▪ Placed cap on tolls
  ▪ Required across-the-board reduction in toll rate
  ▪ Opened additional access points to/from facility with restriping

→ Implemented a “human factor” in toll rate setting
  ▪ Replaced algorithm with human setting of toll rates
  ▪ Algorithm “shadowed” changes and helped inform human operators

→ Changed algorithm
  ▪ No longer over-represented GP congestion in calculations

Outcomes

→ Public, legislative, and media concerns alleviated
  ▪ Changes were institutionalized
  ▪ Express Lanes operate at/near maximum flow rates

→ Expansion of managed lanes concept (under same Governor)
  ▪ Extension of I-85 Express Lanes
  ▪ I-75 / I-575 (Northwest) under construction
  ▪ I-75 (South) also under construction

→ Managed lanes key component of Governor’s 10 year strategic plan
## I-110 LOS ANGELES

<table>
<thead>
<tr>
<th>Year Opened</th>
<th>2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length</td>
<td>10.8 miles</td>
</tr>
<tr>
<td>Directional lanes</td>
<td>1 (4.3 miles); 2 (6.5 miles)</td>
</tr>
<tr>
<td>Access Type</td>
<td>7 intermediate with weave lanes</td>
</tr>
<tr>
<td>Separation Type</td>
<td>Painted Buffer</td>
</tr>
<tr>
<td>Transit</td>
<td>In-line stations (5)</td>
</tr>
<tr>
<td>Capital Cost</td>
<td>Appx. $35M</td>
</tr>
<tr>
<td>Innovations</td>
<td>Switchable transponders, transit incentives for use of express lanes</td>
</tr>
</tbody>
</table>
What Went Wrong

→ **Northern end congestion**
  - Terminus in downtown Los Angeles involves critical bottleneck
  - Although lane split, demand does not follow split
  - Backups occur in both managed lanes and general purpose lanes

→ **Congestion at access points**
  - HOV only facilities on I-105 feed into I-110 Managed Lanes
  - High weaving volumes at junctions

What Went Wrong

→ **HOV violations increased substantially**
  - Change to switchable transponders yielded more willful violators
  - 24 – 29% estimated violation rates in 2013 / 2014 operations
I-110 LOS ANGELES

What Was Changed

→ **Reduce demand at bottlenecks**
  - $16M revenue reinvested for resolving traffic at bottlenecks
  - Changes in dynamic pricing algorithm to adjust to growing traffic volumes

→ **Increased enforcement to reduce “unmetered” violators**
  - Violation rates declined to 10 – 12% when CHP actively patrolling
  - Exploring additional changes
    - Application of automated vehicle occupancy enforcement to aid CHP
    - HOV-2+ to HOV-3+ change

Outcomes

→ **Public support for continuing Express Lanes**
  - Built-in sunset into project
  - Extensive public outreach / hearings yielded 58% support; 25% oppose

→ **Legislative removal of sunset date**
  - Both I-110 and I-10 Express Lanes
  - Indefinite continuation (2015)

→ **L.A. County Metro is developing additional Express Lanes**
  - I-110 Extension (pre-design)
  - I-105 (pre-design)
  - I-405 (pre-design)
LESSONS LEARNED
LESSONS AND TRENDS

→ Managed Lanes are an increasingly mainstream mobility option
  ▪ Adopted managed lanes policies in multiple states
    – Mandate preference for managed lanes as new capacity
    – Shift to managed lane networks
  ▪ Limited general purpose lane widening in urban areas
  ▪ Preservation of options
→ Still recognize that managed lanes are a fundamental change in how we use highway capacity
  ▪ Evolution from “build and forget” to “every day operation”
LESSONS AND TRENDS

→ Big Projects Require Big Revenue
  ▪ $1B+ reconstruction projects increasingly funded with revenue from managed lanes
  ▪ Leverages multiple funding sources
  ▪ Alternative delivery / concession agreements
  ▪ Provides O&M and limited capital coverage

→ Tolling for revenue involves different fundamental decisions than tolling for traffic management
  ▪ Mechanisms still the same
LESSONS AND TRENDS

→ Success driven by planning and policy
  - Invest early in education and outreach

→ Technical, institutional, public acceptance issues can be overcome
  - Don’t oversell the project
  - Create “win” scenarios
  - Listen to constituents
  - Adapt policies to public desires

→ Establish performance measures and key policies early
  - Agreement on what will constitute success or failure
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