Traffic Signal Timing:
“What’s Your Priority?”

Transportation Education Series
May 8, 2012
Presentation Outline

• Applications
Why Are We Doing This Project?

• Improve Practice!
Second Edition Vision

- Defining a process
- System includes all users
- Outcome and Performance Measures focused
- Integrating components to make it a system
Who Is The *Primary* Audience?

- Practitioners who operate and manage traffic signals
What Is Included In the Manual?

Adapted from Michael Kyte
What Level of Detail?

- More than in first edition
- Need an understanding load switches and channels
## New Structure and Chapter Modifications

### First Edition

- Chapter 1. Introduction
- Chapter 2. Policy
- Chapter 3. Capacity Concepts
- Chapter 4. Design
- Chapter 5. Basic Timing
- Chapter 6. Coordination
- Chapter 7. Developing Plans
- Chapter 8. Maintenance
- Chapter 9. Advanced Concepts

### Second Edition

- **PART I – Traffic Signal Program**
  - Chapter 1. Introduction
  - Chapter 2. Program Elements
- **PART II – Concepts, Analysis & Design**
  - Chapter 3. Definitions and Concepts
  - Chapter 4. Design
  - Chapter 5. Developing Timing Plans
- **PART III – Basic Signal Timing**
  - Chapter 6. Intersection Timing
  - Chapter 7. System Timing
  - Chapter 8. Operations and Monitoring
- **PART IV – Advanced Timing**
  - Chapter 9. Special Applications
  - Chapter 10. Priority and Preemption
  - Chapter 11. Advanced Systems
The Six Step Outcome Process

- Step 1: Define Operating Environment
- Step 2: Identify Users
- Step 3: Establish Relative Priorities
- Step 4: Characterize Outcomes
- Step 5: Establish Performance Measures
- Step 6: Operate & Monitor
Step 1: Operating Environment

- CBD
- Suburban /Arterial
- High Speed /Rural
- Other?

<table>
<thead>
<tr>
<th>Context</th>
<th>Goals</th>
<th>Performance Measures</th>
<th>Potential Timing Outcomes</th>
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<tbody>
<tr>
<td>Suburban Arterial</td>
<td>Maximize mobility for through vehicles</td>
<td>Corridor travel speed</td>
<td>Long signal cycles</td>
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<td></td>
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<td>Vehicle capacity</td>
<td>High progression speeds</td>
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<td>Number of stops</td>
<td>Infrequent signals</td>
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<tr>
<td>Central Business District</td>
<td>Create a walkable urban core, while allowing commuters to reach downtown destinations</td>
<td>Pedestrian LOS Vehicle capacity</td>
<td>Leading pedestrian intervals</td>
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<td>Exclusive pedestrian phase</td>
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<td>Short cycle lengths</td>
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<td>Slow progression speeds</td>
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<tr>
<td>Neighborhood Street</td>
<td>Increase access to local retail and allow for safe mid-block crossings</td>
<td>Pedestrian LOS Auto travel speed (lower is better)</td>
<td>Slow progression speeds</td>
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<td></td>
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<td>Frequently spaced signals</td>
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<tr>
<td>Priority Transit Corridor</td>
<td>Increase attractiveness of transit</td>
<td>Transit travel speed</td>
<td>Accommodate transit signal priority within timing plan</td>
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<td></td>
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<td>Transit reliability</td>
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</tr>
<tr>
<td>Priority Bike Corridor</td>
<td>Increase attractiveness of cycling as a transportation alternative</td>
<td>Bike LOS Number of stops (for cyclists)</td>
<td>12-15 mph progression speed</td>
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<td>Accommodate bicycle phases at key locations to reduce conflicts</td>
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</tbody>
</table>
Step 2: Identify Users
Step 3: Establish Relative Priorities

- Railroad
- Emergency vehicles
- Transit
- Bikes
- Pedestrians
- Trucks
- SOV
Step 4: Characterize Outcomes

- Outcomes are concrete statements describing what the operation is trying to achieve
- Smooth Flow
- Minimizing and Balancing Vehicle Congestion
- Predictable and Consistent Response
- Versatility
## Step 5: Establish Performance Measures

| Outcome                  | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 |
|--------------------------|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|----|----|    |
| Public Relations Data    |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| 1 Complaint Calls        |   |   |   |   |   |   |   |   |   | X  | X  |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| 2 Throughput             | X |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| 3 Origin-Destination Volume Matrix | X |   |   |   |   |   |   |   | X | X  | X  | X  | X  | X  | X  | X  | X  |    |    |    |    |    |    |    |    |
| 4 Unique ID Match Travel Time | X |   |   |   |   |   |   | X | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  |    |
| 5 GPS Travel Time        | X | X  |   |   |   |   |   | X | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  |    |
| 6 Travel Time Reliability| X | X  |   |   |   |   |   | X | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  |    |
| 7 Speed                  | X | X  |   |   |   |   |   | X | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  |    |
| 8 Congestion Hours       |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| 9 Vehicle Conflicts      | X | X  |   |   |   |   |   | X | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  |    |
| 10 Pedestrian Conflicts  | X | X  |   |   |   |   |   | X | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  |    |
| 11 Bike Conflicts        | X | X  |   |   |   |   |   | X | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  |    |
| 12 Safety Data           |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| 13 Total Accidents       | X | X  |   |   |   |   |   | X | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  |    |
| 14 Vehicle Accidents     | X | X  |   |   |   |   |   | X | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  |    |
| 15 Pedestrian Accidents  | X | X  |   |   |   |   |   | X | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  |    |
| 16 Bike Accidents        | X | X  |   |   |   |   |   | X | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  |    |
| 17 Accident Severity     | X | X  |   |   |   |   |   | X | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  | X  |    |
New Chapter 3: Concepts

• Premise:
  • Need a strong foundation to deal with both differences in terminology and the ability to address complex applications

• User Focus
  • Should consistently flow throughout the Manual
Chapter 4: Design

- Premise:
  - Need the right “pieces” to make timing work well
Chapter 7: System Timing

• Update with latest research
• Include typical values
• Simplify “curves” (Focus group suggestion)
• Need to provide extensive material on pedestrian timing
Chapter 8: Operations & Monitoring

• Premise:
  • Need to understand what makes the system tick

• Closing the loop between operations and maintenance

• Change from a repair/replace approach to an understanding of operational outcomes
Chapter 10: Priority/Preemption

• Premise:
  • If you separate priority from preemption, you miss an opportunity to improve operations
• Need to change thought process
• Challenge: Stuffing into a single chapter
Moving to Priority Based Timing

Scheduling not Cycle Length

Precedence Diagram
Chapter 11: Advanced Systems

• Premise:
  • Get the most out of what you have before looking for a silver bullet
  • When to use traffic responsive
  • When to use adaptive
  • How to select an adaptive system
Examples Applications and Opportunities

- Transit Preferential Treatments (TPT)
  - Signal timing modifications
  - Transit signal priority
  - Queue jump/bypass lane
  - Transit lanes
  - Enhanced/Skip-stop bus service

- Any transportation treatments to improve the reliability and performance of transit vehicles.
Transit Signal Priority: A Little Perspective

• Transit Signal Preemption Began in the 1970’s
  • Not very successful
  • Too disruptive
  • Largely set back TSP
• Second Generation
  • Priority concept developed
  • Addition of conditional priority
  • Largely first-come, first-served
• Third Generation
  • System based
  • Reflects an understanding of traffic signal control
  • Needs transit to establish its priorities
  • Utilizing smarter systems to make smarter decisions
Washington DC / WMATA Example

- Service evaluation
  - On-time performance
  - AVL speed analysis
- Use archived AVL data to understand bus performance at a segment level
- Identify key routes for bus priority treatments
- Demonstrate the need for action
  - Top 10 lists by jurisdiction
  - Highlight impacts of congestion on bus service quality and operating costs
Competing Routes in a Downtown Grid
Basic Methodology

- Combining multiple data sources
- Balanced approach to the investigation
- Ultimately dependent on what the controller can and cannot do
- Develop realistic TSP strategies

Field Data
- Intersection and Approaches
- Controller Cabinet

Signal Timing
- Pedestrian Treatments
- Variable Green Time

Transit Routes
- Time of Day Routing
- Overlapping and Competing Movements

Controller Testing
- Green Extension
- Early Green
Field Data Collection

• Many things needed to be considered for TSP implementation:
  • Existing Conditions
  • Existing Equipment
  • Intersection Operations
• Data was collected both in the field and out of the field in two key areas:
  • Intersection Data
  • Approach Data

Right: 15th Street/Pennsylvania Avenue Intersection
Signal Timing Assessment

- Pedestrian Signal Timing
  - Minimum walk
  - Minimum Flash Don’t Walk (FDW)
  - Pedestrian Clearance Time
- Variable Green Time

Variable Green = (Cycle length) – (minimum pedestrian time) – (minimum vehicle green time)

Above: Pedestrian Signal 16th Street/Q Street Intersection
Transit Route Prioritization

• Challenge: Prioritizing TSP at intersections with overlapping and competing transit routes

• Review Process
  • Time of Day Route
  • Time of Day Inbound
  • Intersection Location Relative to Route
  • Bus Stop Locations
Controller Testing

- Suitcase tester with QuicLoad
- Created test scenarios
- Expected vs. Actual
- Document results

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<thead>
<tr>
<th>Activity/Evaluation</th>
<th>Expected Controller Action (local cycle time)</th>
<th>Actual Controller Action (local cycle time)</th>
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<td>TSP Call at 90 - dropped at 9</td>
<td>2-FO 4W 4VG 4-FO</td>
<td>2-FO 4W 4VG 4-FO</td>
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Normal Operations - Ring Diagram

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<th>Local Clock Time (sec)</th>
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<th>12</th>
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Queue Jump Opportunity

- Similar process to evaluate opportunity
  - Geometrics
  - Transit
  - Signal Timing
Queue Jump Opportunity

- Multiple legs
- Bicycle signal
- On-street parking
- Near capacity during peak hours
- One of highest ridership corridors in region
What Do We Need to Achieve Better Transit Operations?

• Understanding of Signal Operations
  • Can’t have 4-way green
  • Can’t make significant timing adjustments in some environments
  • Green extension is significantly more valuable than early green
  • Near-side bus stops requires significantly more information

• Understanding of Bus Operations
  • Which routes have the biggest challenges and where
  • How do we “tune” bus schedules to capture the value of TSP on a consistent and reliable manner
  • Where can TSP be most effective for transit operations from a system perspective.

• Smarter Decisions (true ITS: Right Information, Right Place, Right Time)
  • What are the desired outcomes
  • What are the data needs
  • How do you know if you are getting better
Challenges

• “Historical” Lessons Learned
• Territorial boundaries
• Skeptical about “vapor-ware”
• Maintenance and Operations
Summary

• Signal Timing Manual v2.0 to be completed in 2013
• Parallel Resource with Other Documents/Manuals
• Integrating Outcomes and Performance Measures
• Context Sensitive Timing for all Users
• Signal Timing is NOT “One Size Fits All”
• Smarter Decisions (True ITS: Right Information, Right Place, Right Time)
Questions?

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