Running Time Analysis for Better Service and a Balanced Budget

Lok Kwan
CTA Rail Scheduling
lkwan@transitchicago.com
### Impacts of Schedule Running Time

#### Table: Schedule Running Time Impacts

<table>
<thead>
<tr>
<th>Route</th>
<th>Start Time</th>
<th>End Time</th>
<th>Impact Description</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>06:00</td>
<td>23:00</td>
<td>Delayed departure</td>
<td>$100</td>
</tr>
<tr>
<td>B</td>
<td>07:00</td>
<td>00:00</td>
<td>Increased waiting</td>
<td>$200</td>
</tr>
<tr>
<td>C</td>
<td>08:00</td>
<td>01:00</td>
<td>Reduced capacity</td>
<td>$300</td>
</tr>
</tbody>
</table>

#### Budget

- **Total Impact Cost:** $600
- **Funding Source:** Government grants

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*Note: This table is a simplified representation of schedule running time impacts and associated costs. Actual data may vary.*

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*Image: CTA train and station platform.*
Revenue hour is one of the basic elements for forming an operating budget in the transit industry.
Budget and Efficiency

4 minutes travel time reduction (One direction) from the Dan Ryan project.

Running time reduction from the Dan Ryan Reconstruction have achieved revenue hour savings despite revenue mileage (service) had gone up.
Data Collection

Quictrak

Supervisory control and data acquisition (SCADA)
**Methodology**

**Data Transformation Model**

1. Eliminate garbage data (Example: faulty track circuit)
2. Format timestamp and datatype
3. “Line-up” data rows (Oracle Analytical Functions: Lead/Lag)
4. Relate tables to organize train data by route, direction, and sequence
Running Time Analysis

GIRO Hastus ATP Tool (From French: Analyse des Temps de Parcours)
CTA Red Line NB (95th to Howard)
Orange Line: Midway to 35th/Archer

Length: Approx. 28,748 Linear Trk ft
### Orange Line: Midway to 35th/Archer

<table>
<thead>
<tr>
<th>Orange Line</th>
<th>Baseline</th>
<th>Benchmark</th>
<th>Schedule (Fall 2015)</th>
<th>Schedule (Spring 2016)</th>
</tr>
</thead>
</table>

#### Increased Runtime?
- **AM Peak** (0600-0900)
  - 7 Org-Brn trains
  - Ridership
  - Dwell Time
- **AM Peak Late Shoulder** (0900-1230)
  - Construction
  - Track Inspection
  - Signal Maintenance
  - Lunch Break at noon
Orange Line: 17th Junction to Tower 12

Length: Approx. 6,994 Linear Trk
The Orange Line and the Green Line share the same tracks from 17th Junction to Tower 12. Interestingly, the Orange Line requires more travel time than the Green Line.
At Tower 12, the NB Orange Line has five “conflicting moves” whereas the NB Green Line will only conflict with the Brown Line. The Orange Line also requires a cross-over move while the Green Line will simply get a straight line-up.
Compared to the Green Line, Junction travel time data clearly indicated the Orange Line requires more travel time to enter and clear at Tower 12.
• CTA rail running time has high “variability” during the late AM peak shoulder due to personnel on the Right-of-way and terminal congestion from yard moves.
• PM peak of the peak running time is generally the greatest due to excessive dwell time and loop congestion.
Orange Line PM peak service is less reliable than AM peak provided that PM headway distribution fluctuate more than the AM distribution.

- Excessive concentration of ridership at 1700
- Excessive PM Peak dwell time
- Loop Congestion
- Direction of flow (AM Inbound, PM Outbound)
Simulation

So far all the analysis is based on historical data. What about potential or anticipated changes in the future?

What if we completely eliminate all the slow zones on the Blue Line Congress branch?
In this Speed & Distance graph, the Yellow Line represents the speed of a simulated train operating on the Congress branch without any Slow Zone. The Blue Line represents the speed of a simulated train operating on the current Congress Branch with 30,233 ft of Slow Zones.
The simulated train under the “Slow Zone free” Congress branch achieved much faster operating speeds when compared to the simulated train under the current Congress branch with 30,233 ft of Slow Zones.
**Simulation**

**Blue Line Congress Branch**

<table>
<thead>
<tr>
<th>Direction</th>
<th>Scenario</th>
<th>Blue-Congress Branch Station (NB)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>DESP-CNC HAR-CNC OAK-CNC AUS-CNC</td>
<td></td>
</tr>
<tr>
<td>NB</td>
<td>Perfect</td>
<td>2:59:44 3:01:21 3:03:02 3:04:40</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Current</td>
<td>2:59:44 3:01:22 3:03:08 3:05:17</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Time Saving</td>
<td>0:00:01 0:00:05 0:00:31   0:00:31</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Direction</th>
<th>Scenario</th>
<th>Blue-Congress Branch Station (SB)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>HAL-CND RAC-CND MEDC-CND WST-CND</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Time Saving</td>
<td>0:00:04 0:00:00 0:00:11   0:01:20</td>
<td></td>
</tr>
</tbody>
</table>

Blue Line Congress Branch NB: 0:02:53 travel time savings
Blue Line Congress Branch SB: 0:04:15 travel time savings
Greatest travel time reduction between Western SB – Kedzie SB and Cicero SB – Austin SB

A robust data model and simulation allow CTA to evaluate different scenarios to prioritize track work and capital investments.
Simulation
Blue Line Forest Park Terminal

Southbound Late Arrival (minutes) at Forest Park Sunday Schedule Simulation

The blue dots represent Southbound terminal delays under current track condition and the yellow dots illustrate terminal delays if the Congress branch is Slow Zone free. Forest Park terminal will be more resilient to random delays if we eliminate all the Slow Zones on the Blue Line Congress branch.
O’Hare terminal achieved less significant improvements due to less Northbound travel time reduction.
Red Line 95th Station is known for having terminal congestion between 0900 and 1000 because of an imbalanced inbound and outbound headway. Given that 95th Station has two pockets for stub operation, the theoretical maximum train recovery time would be five minutes and thirty seconds with a three minutes headway. These limitations and random delays pose significant challenges for train crews to move trains in and out of 95th terminal.
**Optional Discussion - Terminal Congestion**

**Red Line 95th Terminal**

Red Line SB  
63rd Station - 95th Station

<table>
<thead>
<tr>
<th>Baseline</th>
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<th>Schedule (Fall 2015)</th>
<th>Schedule (Spring 2016)</th>
</tr>
</thead>
</table>

Crews removing 14 in-service trains after AM peak causing runtime variability.
CTA Train crews must perform the following to lay-up trains:

- Prepares cars for storage
- Check all cars of trains to ensure no customers remain on board
- Close doors and windows
- Secures all Safety chains and springs
- Trims Motorcabs
- Turn off interior/exterior lights
- Leaves A/C turned on
- Secures trains against rolling

In this situation, adding more schedule running time would not mitigate terminal congestion but worsen the problem by inserting more trains to the terminal.

**Potential Solution #1**
Utilize Service Restoration technique(s). Example: Gapping – When a train has been delayed approaching a terminal, a supervisor or another certified employee can operate a train to a predetermined station to “trade” train with the delayed operator.

**Potential Solution #2**
Space out the layups by adjusting the inbound and outbound headway

**Potential Solution #3**
Infrastructure improvement
Optional Discussion - Terminal Congestion

Excessive dwell time at 87th Station:
SB trains waiting for an open pocket at 95th terminal
Summary

• Running time is central to the formation of service and operating budget in the transit industry.

• Running time analysis is the combination of arts and science base on data analysis, operation knowledge, and scheduling concepts.

• A robust data model can collect and summarize service performance, running time, dwell time, vehicle mileage, and junction performance. These data is useful in monitoring service quality and operation cost.

• Simulation is an important tool to quantify what-if-scenarios for providing recommendations in corrective procedures and capital investments.
Appendix I
Scheduling Basics

\[
\frac{\text{Running Time} + \text{Recovery Time}}{\text{Headway}} = \text{Number of Vehicles/Train Cars}
\]

*Formula by TCRP report 30

Example: Red Line

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Running Time</td>
<td>120</td>
<td>121</td>
</tr>
<tr>
<td>Recovery Time</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>Cycle Time</td>
<td>132</td>
<td>133</td>
</tr>
<tr>
<td>Headway</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Number of trains</td>
<td>44</td>
<td>44.3</td>
</tr>
<tr>
<td>Number of cars</td>
<td>352</td>
<td>360</td>
</tr>
</tbody>
</table>

Running time is critical to the formation of service and operating budget in the transit industry. Insufficient running time might lead to the underestimation of vehicle requirement, causing headway irregularity and unreliable service. Too much running time will lead to the overestimation of fleet size and crew requirement, resulting train bunching and an inefficient operating budget.
Appendix II
Factors affecting Rail Running Time

- Slow Zones
- Personnel on the Right-of-way
  - Construction Activities
  - Track Inspection
  - Signal Maintenance
- Ridership/Dwell Time
- Loop/Terminal Congestion
- Rail car Series
- Car Length
- Operator Experience
- Operation Philosophy
- Service Restoration Techniques