A Capacity Analysis of Class I Railroad Cooperation in the Columbia Gorge

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Outline

• Intro
• Background
• Geography
• Model Development
• Analysis & Results
• Conclusions
• Opportunities
Introduction
Did You Know?

• Track gauge, flanged wheel
• B&O Railroad – 1827
• Signaling
• Transcontinental railroad
• US line mileage peaked – 1916
• 142,000 miles of track today
• UP’s Bailey Yard
Genesis

• PSU MSCE Project
• Port of Portland Study – 2005
  – Interviews
  – Previous studies, background
  – Rail simulation selection
  – OpenTrack
  – Scope development
Background
Columbia River Corridor

• North bank - Washington
  – Spokane, Portland and Seattle RR - 1907-08
  – Fallbridge subdivision: Vancouver-Pasco
  – Now owned by BNSF Railway

• South bank - Oregon
  – Oregon Steam Navigation Company - 1863
  – Oregon Railway and Navigation Co. - 1880-82
  – Portland subdivision: Portland-Hinkle
  – Now owned by Union Pacific
Pacific Northwest Economy

• Heavily dependant on trade/transportation
• Agriculture and natural resource intensive
• Ports and railroads important for goods movement
• Growing population and employment
Increase in Railroad Demand

- 60% overall growth from 2006-2035
- Intermodal fastest growing ~3.5%
- Bulk (agriculture, mineral) ~2.5%
- General merchandise ~2.5%
- Autos ~3.5%
- Passengers ~5%
Current Network Constraints

- **Washington**
  - Stevens Pass ~ 123% capacity
  - Stampede Tunnel ~ 60% capacity
  - Vancouver Yard
  - Columbia Gorge ~ 70% capacity

- **Oregon**
  - Portland Terminal
  - Columbia Gorge ~ 65% capacity
Solutions Proposed

- Vancouver Yard bypass
- Longer sidings
- Double track
- New connections
- Improve speeds
- Directional operations
Directional Operations Challenges

- Competitive differences
- Terminal, network capacities
- Infrastructure and communications
- Day-to-day management
- New bridge near Boardman, OR
- Regulatory approval
Geography
Portland-Vancouver Terminals
Union Pacific - Portland

- Albina, Barnes Yards
- Kenton/Graham Lines
- Peninsula Junction
- North Portland Junction
- Rivergate industrial area
- Port of Portland terminals
- Trackage rights to Seattle
BNSF Portland-Vancouver

- Seattle to Vancouver Yard
- Port of Vancouver
- Columbia River Bridge
- North Portland Junction
- Port of Portland Terminals 1, 2 and 6
- St. John’s “cut”
- Guilds Lake Yard
Union Pacific - Network

• 150 mile long corridor
• 0.016% average grade
• 48% zero grade track - 130 ft elevation difference
• 42% curved track - 0° 08’ to 6° 36’
• 13 sidings (6,360 to 12,695 feet)
• 21.6 miles double track near The Dalles
• Boardman, OR milepost 165
BNSF Network

- 167 mile long corridor
- 0.028% average grade
- 79% zero grade track - 250 ft elevation gain
- 39% curved track - 0° 20’ to 5° 26’
- 12 sidings (7,092 to 11,115 feet)
- 4.6 miles double track in Vancouver
- Whitcomb, WA milepost 174
Model Development
OpenTrack

• First developed in mid-1990s at Swiss Federal Institute of Technology, Zurich
• 3 types of data: infrastructure, rolling stock & timetable
• Windows interface
• Deterministic routing
• Animation
• Multiple data outputs
Measures of Effectiveness

- Line capacity
- Delay ratio
- Stopped delay & total delay
- Total run time
- Average delay per train
- Average train speed
- Train throughput
Track Data

- UP and BNSF track charts
- Metric conversions
- Milepost
- Track curvature
- Speed limits
- Grades
- Signal locations and types
- Siding/double track locations and lengths
Infrastructure Data

- Worksheet
- Tool palette
- Vertex
- Edges
- Signals
- Stations
- Plot objects
- Graphical elements
OpenTrack Worksheet

Union Pacific

MP 94.95 (KP 152.307)

Double Track 34.279 km

MP 99.65 (KP 160.371)

--- West => East --->

MP 89.95 (KP 144.760)

--- East => West --->

Graham Line

MP 12.9 (KP 20.761)

Portland Subdivision --->

Sandy

MP 18.02 (KP 29.000)

Sandy Siding: 3200m

Kenton Line

MP 19.85 (KP 31.945)

MP 21.55 (KP 34.681)
Routing Data

- Routes
- Paths
- Itineraries
Rolling Stock - Locomotives

- GE Evolution Series ES44AC
- 207-ton, 4400 HP, 73 feet long
- Top speed 75 mph, fuel capacity 5,000 gal.
- Tractive effort/speed diagram
- 35% adhesion
- Engines menu
Rolling Stock – Trains

• Train categories
  – Intermodal, passenger, loaded, empty

• Trains menu
  – Attribute data entry
  – Acceleration and braking rates
  – Air resistance equations
  – Rolling resistance
# Rolling Stock - Consists

<table>
<thead>
<tr>
<th></th>
<th>Intermodal</th>
<th>Auto</th>
<th>Merchandise</th>
<th>Grain/bulk</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>EB WB</td>
<td>EB</td>
<td>WB</td>
<td>EB WB</td>
<td>EB</td>
</tr>
<tr>
<td>Train category</td>
<td>I I</td>
<td>I I</td>
<td>I I</td>
<td>P L</td>
<td>E L</td>
</tr>
<tr>
<td>Percent full</td>
<td>90% 70%</td>
<td>90%</td>
<td>70%</td>
<td>Full 90%</td>
<td>70% Empty 80%</td>
</tr>
<tr>
<td>Number of cars</td>
<td>28 26</td>
<td>40</td>
<td>40</td>
<td>7 100</td>
<td>100 110 110 70</td>
</tr>
<tr>
<td>Car length (ft)</td>
<td>265 265</td>
<td>145</td>
<td>145</td>
<td>85 60</td>
<td>60 60 60 60</td>
</tr>
<tr>
<td>Train length (ft)</td>
<td>7,420 6,890</td>
<td>5,800</td>
<td>5,800</td>
<td>595 6,000</td>
<td>6,000 6,600 4,200</td>
</tr>
<tr>
<td>Number of empty cars</td>
<td>3 8</td>
<td>4 12</td>
<td>0 10 30</td>
<td>0 0</td>
<td>0 14</td>
</tr>
<tr>
<td>Number of full cars</td>
<td>25 18</td>
<td>36</td>
<td>28 70 90</td>
<td>110 110</td>
<td>110 56</td>
</tr>
<tr>
<td>Empty weight (tons)</td>
<td>89 89</td>
<td>74</td>
<td>74 75 40</td>
<td>40 31 31</td>
<td>31 31</td>
</tr>
<tr>
<td>Loaded weight (tons)</td>
<td>400 400</td>
<td>130</td>
<td>130 75 114</td>
<td>114 31 143</td>
<td>114</td>
</tr>
<tr>
<td>Train weight (tons)</td>
<td>10,272 7,913</td>
<td>4,976 4,528</td>
<td>525</td>
<td>10,699 9,216</td>
<td>3,383 15,730 6,837</td>
</tr>
<tr>
<td>Number locomotives</td>
<td>4 3</td>
<td>2</td>
<td>2 1 3</td>
<td>3 1 4</td>
<td>2</td>
</tr>
<tr>
<td>HP/TT ratio</td>
<td>1.7 1.7</td>
<td>1.8</td>
<td>1.9 8.4</td>
<td>1.2 1.4</td>
<td>1.3 1.1</td>
</tr>
</tbody>
</table>

Categories: I-Intermodal, P-Passenger, L-Loaded, E-Empty

foamersnw.brinkster.net/Scottshots.htm
Scheduling Data

• Courses
  – Relates train type to itineraries
  – Speed limit type & entry speeds
  – Itinerary priorities

• Timetables
  – Dispatching & scheduling
  – Arrival & departure times
Calibration

- Amtrak’s Empire Builder
  - Scheduled vs. Simulated
  - -1.3% difference (3 minutes)
- Comparison between BNSF & UP
- HP/ton ratio
- Free flow speed: 41 mph
- Trains per day (2004):
  - BNSF 30, UP 26
Future Train Forecasts

• Extrapolation based on growth rates
• Estimates from previous studies
• Maintain east/west balance
• Trains per day (2020):
  – BNSF 48, UP 42
  ~ 60% growth
Key Assumptions

• Train dispatching:
  – Evenly throughout the day, both directions
  – All trains to complete route in 24 hours
  – Reasonable interactions between trains

• No service disruptions

• Crews and EOT devices always available

• Adjoining tracks and terminals assumed to accommodate all traffic
Analysis & Results
Existing Conditions Analysis

- BNSF and UP simulated independently
- 9 runs total (4 BNSF, 5 UP)
- Train order and scheduling differences
- Adhesion and acceleration profiles
- Results averaged
Existing Condition Results

• Total delay ratio
  – BNSF 11.2%, UP 8.0%
• Total run time
  – BNSF 125 hrs, UP 99 hrs
• Average delay per train
  – BNSF 28 minutes, UP 18 minutes
• Average train speed
  – BNSF 41.1 mph, UP 41.3 mph
BNSF Train Diagram, Existing

BNSF - 2004 Existing Conditions Train Diagram

Legend:
- Green: Passenger
- Pink: Intermodal
- Red: Loads
- Blue: Empties
2020 Volumes, Existing Operations

- Total delay ratio
  - BNSF 14.4% (11.2%), UP 17.2% (8.0%)
- Total run time
  - BNSF 220 hrs, up 77%, UP 178 hrs, up 80%
- Average delay per train
  - BNSF 40 min, up 42%, UP 44 min, up 139%
- Average train speed
  - BNSF 37 mph, decrease of 10%,
  - UP 36 mph, decrease of 12%
BNSF Train Diagram, No Build
2020 Volumes, Directional Strategies

• Total delay
  – BNSF 5.0% (14.4%), UP 2.3% (17.2%)

• Total run time
  – BNSF 165 hrs, down 25%, UP 149 hrs, down 16%

• Average delay per train
  – BNSF 10 min, down 74%, UP 44 min, down 89%

• Average train speed
  – BNSF 46.0 mph, increase of 24%
  – UP 46.4 mph, increase of 28%
2020 Volumes, Directional Strategies

Directional Running - 2020 Clockwise Build Train Diagram

Location
Heppner
Arlington
Bialock
Quinton
Goff
Mosier
Menlo
Wyeth
Cascade Locks
Dodson
Bridal Veil
Sandy
Champ
Vancouver
Washougal
Skamania
Stevenson
Cook
Bingen
North Dalles
Avery
Maryhill
Towal
Bates
Roosevelt
McCredie
Castle

Legend
- Intermodal Loads
- Empties
- Passenger

Time
00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Conclusions
Directional Strategy Conclusions

- Similar performance clockwise/CCW
- Clockwise strategy better near new bridge
- Significant delay and capacity improvements
- UP appears to benefit more than BNSF
- BNSF may be less interested in cooperation
- Congestion at terminals possible
- Significant competitive hurdles to overcome
Opportunities
Possible Next Steps

• Improve model
  – Portland-Vancouver terminal area
  – Pasco/Hinkle terminals
  – Include more trains in network
  – Realistic dispatching

• Individual mainline analysis

• Test line improvements
  – Sidings
  – Double track areas
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Questions?

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