2015 FRA
Rail Program Delivery

Operations Simulation for Railroad Capital Project Development

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What is Railroad Operations Simulation?

- **Tool for analyzing railroad operating performance**
  - **Predefined set of trains**
  - **Predefined infrastructure configuration**
  - **Does NOT provide the solutions to problems**
- **Consists of three basic elements**
  1. **1st Input – Train Traffic**
  2. **2nd Input – Infrastructure**
  3. **Simulation Methodology - the model software**

Why do Operations Simulation?

- **Planning on changes to train traffic?**
  - **What infrastructure is needed to meet performance goals?**
- **Planning on changes to infrastructure?**
  - **What will it do to train performance?**
- **Relationship between operational requirements and physical resources**
- **<u>For railroad capital projects</u>**
  - **Simulation links operational objectives to scope and design (and environmental impacts)**

What Kind of Projects Should Involve Operations Simulation?

- **Changes to line-haul railroad operations**
- **Rail lines with emphasis on unscheduled or highly-variable operations**
- **Simulation less useful for:**
  - **Highly scheduled operations**
  - **Complex operations within terminals or at major junctions**
  - **Other operations analysis tools are available**

When during a project's development is operating simulation done?

- **Beginning during the Planning Phase**
  - **Key input for Service Development Planning and Service NEPA**
- **Continues through finalized Preliminary Engineering**
- **Iterative process with other elements of Service Planning**
  - **Effects of operationally relevant design refinements**
  - **Requirements for refinements in service plan**
  - **Changes in forecasts and assumptions for background traffic**
- **For passenger projects, ultimately used to support Service Outcomes Agreement**

Who participates in operations simulation, and in what roles?

Party	Preferred Roles	Secondary Roles
Project Sponsor	*Guides overall work; Coordinates with other service planning elements; Coordinates between all parties; Helps establish inputs and assumptions*	
FRA	*Monitors development of model methodology, assumptions, inputs; Assesses conclusions; Reviews reports; Requests necessary changes*	
Planning/Design Consultant	*Works for Project Sponsor; Proposes methodology; Performs simulations work; Authors reports*	
Host Railroads	*Contributes input data; Helps verify and calibrate base case; Suggests possible infrastructure changes*	*Performs role of planning consultant*
Amtrak	*Contributes input data*	

The Simulation Process

The Simulation Tool

- **Two basic elements**
  1. **Train Performance Calculator (TPC) – Pure (Ideal) Running Time for a train**
     - **No meets or overtakes**
     - **No restrictive signals**
     - **Try to operate at exactly the speed limit**
  2. **Dispatching Simulator**
     - **Optimization algorithm for mimicking decision-making of actual dispatcher**
     - **Coordinate meets and overtakes to minimize delay**
     - **All delay not created equal – varies based on priority assigned by train type**

The Simulation Process

Assembling Input Data

Train Traffic

- "Schedules"
- Consists
- Train Types (with priorities)

Infrastructure

- Track Configuration
- Signal Design
- Grades
- Speed Limits

- Begin by developing for the existing conditions, then use as basis for alternative scenarios

The Simulation Process

Scenario Development and Scenario Control

- **Base Case**
  - **Existing conditions**
  - **Used for calibration (or setting performance targets)**
- **Do-Minimum (No Build)**
  - **Committed changes to infrastructure and train traffic**
  - **Forecasted changes to freight traffic and necessary improvments**
- **Do-Something (Build)**
  - **Project's intended operating changes**
  - **Use to identify infrastructure improvements to achieve desired performance**
- **Need to control for changes individually**

The Simulation Process

Variability and Resiliency Testing

- **Real-world operations not consistent or always predictable**
  - **Model thinks they are, unless you tell it otherwise**
  - **Need to demonstrate infrastructure can accommodate variability while maintaining performance**
- **“Normal” Variability**
  - **Unscheduled/loosely-scheduled freight trains, varied consists**
  - **Varied passenger timetables**
- **Irregular variability**
  - **En-route failures, maintenance-of-way events**
- **Tools for reflecting variability and testing resiliency**
  1. **Multi-day simulation**
  2. **Randomized train traffic input**

The Simulation Process

Measuring Performance and Interpreting Results

- **Major performance metrics**
  - **Minutes of Delay (per 10k train-miles)**
  - **Velocity**
  - **On-time performance**
- **Stringline diagrams**
- **TPC Plots (logarithmic speed scale)**
- **Pitfalls in interpreting results**
  - **Statistical significance of differences in results**
  - **Delay metrics accounting for changes in Pure Running Time**

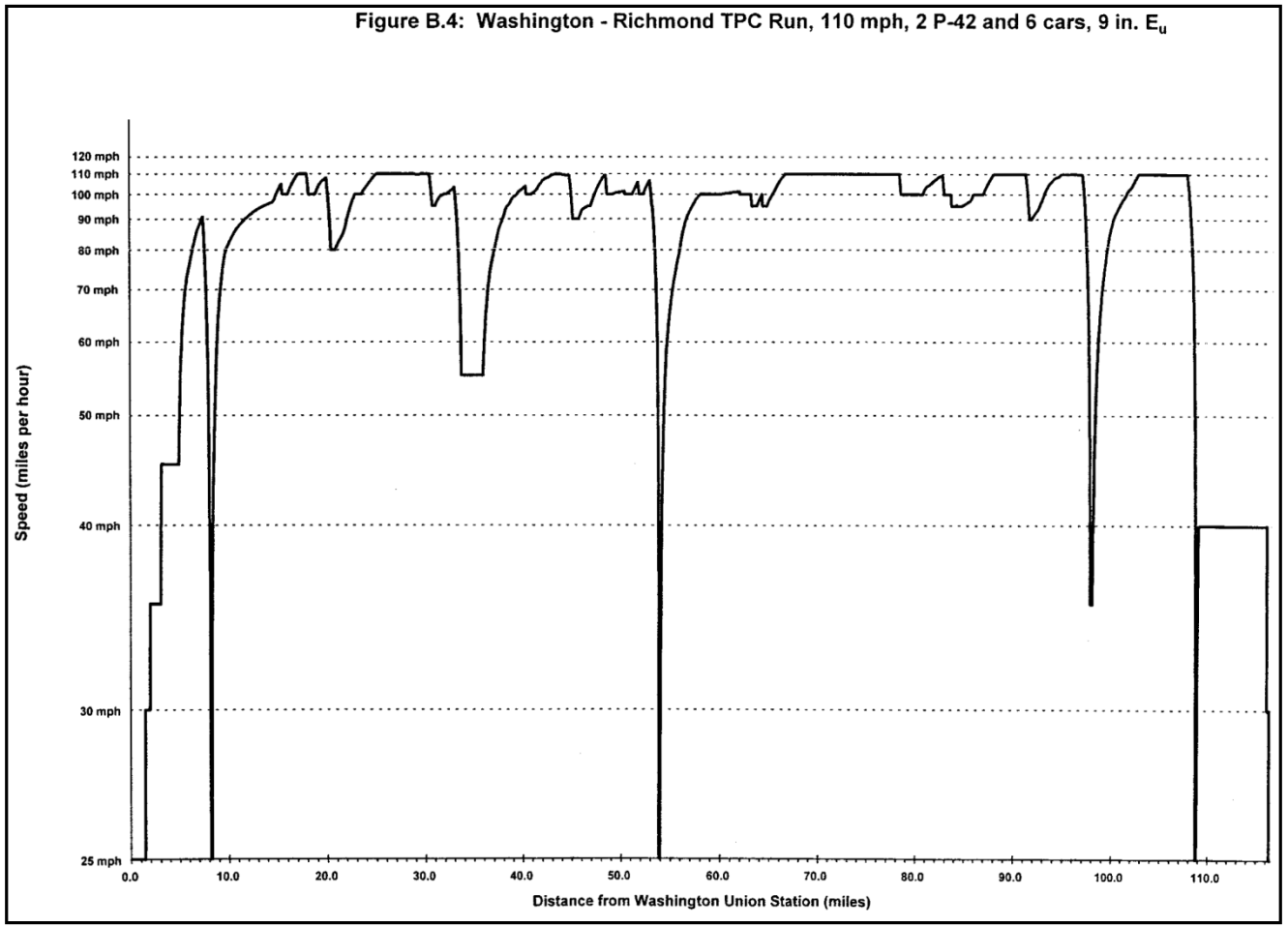
Figure B.4: Washington - Richmond TPC Run, 110 mph, 2 P-42 and 6 cars, 9 in. E_u
Speed (miles per hour)
120 mph
110 mph
100 mph
90 mph
80 mph
70 mph
60 mph
50 mph
40 mph
30 mph
25 mph
0.0
10.0
20.0
30.0
40.0
50.0
60.0
70.0
80.0
90.0
100.0
110.0
Distance from Washington Union Station (miles)

The Simulation Process

Stringline Diagrams