

Precision Scheduled Railroading - An OR Practitioner's Perspective

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Disclaimer: the opinions expressed here are the author's own and don't reflect the view of author's employer

Outline

- Introduction to Precision Scheduled Railroading (PSR)
- PSR at Norfolk Southern
- Operations Research Methodology & Tools
- Conclusions

About NORFOLK SOUTHERN



19,500 ROUTE MILES
across **22 STATES & D.C.**



↔ GATEWAY CITIES TO WESTERN CARRIERS

MAKING CONNECTIONS

Norfolk Southern (NYSE: NSC) has served the freight transportation needs of America for nearly two centuries, connecting businesses and communities to the marketplaces of the world — creating jobs, supporting economies, and transporting goods on safe, environmentally friendly rail.



43 PORTS SERVED



61 AUTOMOTIVE FACILITIES SERVED



55 INTERMODAL TERMINALS



154 TUNNELS



62,700 FREIGHT CARS



250 SHORT LINE CONNECTIONS
Adds 20,000+ miles to NS network



CONNECTS
with Western rail carriers



4,155 LOCOMOTIVES



9,706 BRIDGES



41 RAIL-TRUCK TRANSFER FACILITIES

Economic Impact



27,100 EMPLOYEES

\$2.2 BILLION
PAYROLL



\$121,000
ANNUAL AVERAGE EMPLOYEE WAGE & BENEFITS



\$5.2 BILLION
PURCHASES & PAYMENTS



\$930 MILLION
LOCAL, STATE & FEDERAL TAXES PAID

\$1.7 BILLION

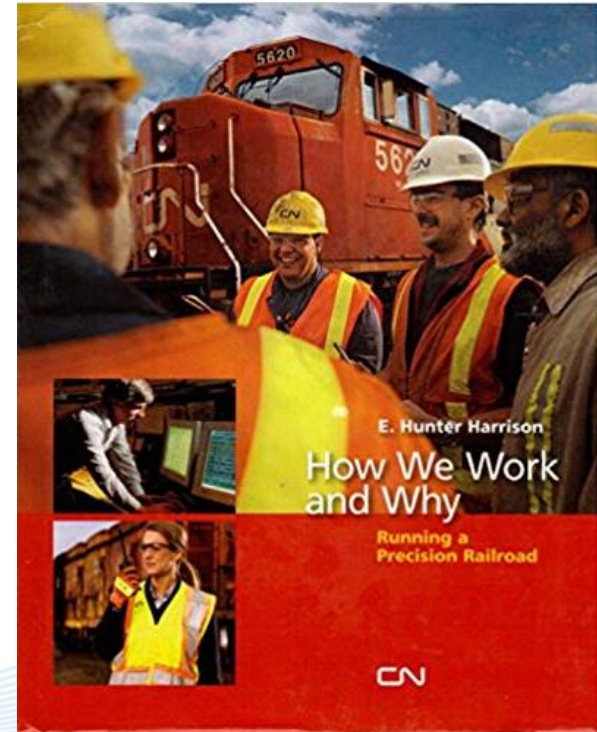
NS-FUNDED CAPITAL INVESTMENTS
(locomotives, freight cars, tracks and bridges)



What is Precision Scheduled Railroading (PSR)

PSR is a railroad strategy to optimize key assets and maintain a strict operating plan to improve operating efficiency and achieve low operating ratios

Operating Ratio Before and After Hunter Harrison's Tenure



Current Trend with PSR

- Adopted by Almost All Class I's in North America:
 - CN, CP, CSX, KCS, NS, and UP
- PSR at Norfolk Southern
 - Entitled TOP21 Plan
 - Improve network fluidity and velocity
 - Reduce circuitry and train miles
 - Create capacity for growth
 - Started in 2018
 - Phase 1 rolled out on July 1, 2019

PSR: What It Is and Isn't

What It Is:

- “A way of thinking”
- End-to-end car velocity
- Static plan to reduce variance
- Manage by exception
- Network optimization
- Asset utilization
- Involving all departments

What It Isn't

- “A tidy set of rules”
- Scheduled railroad only
- Point-to-point delivery
- Cost cutting

PSR Guiding Principles

PSR

1. Service
2. Cost control
3. Asset utilization
4. Safety
5. People

Norfolk Southern's Five Pillars

1. Serving customers
2. Controlling cost
3. Managing assets
4. Working safely
5. Developing people

PSR Service Design Principles

PSR

1. Minimize car dwell time in yards
2. Minimize car classifications
3. Use multiple traffic outlets
4. Run general-purpose trains
5. Balance train movements by direction
6. Minimize power requirements
7. Strive for steady workload flow

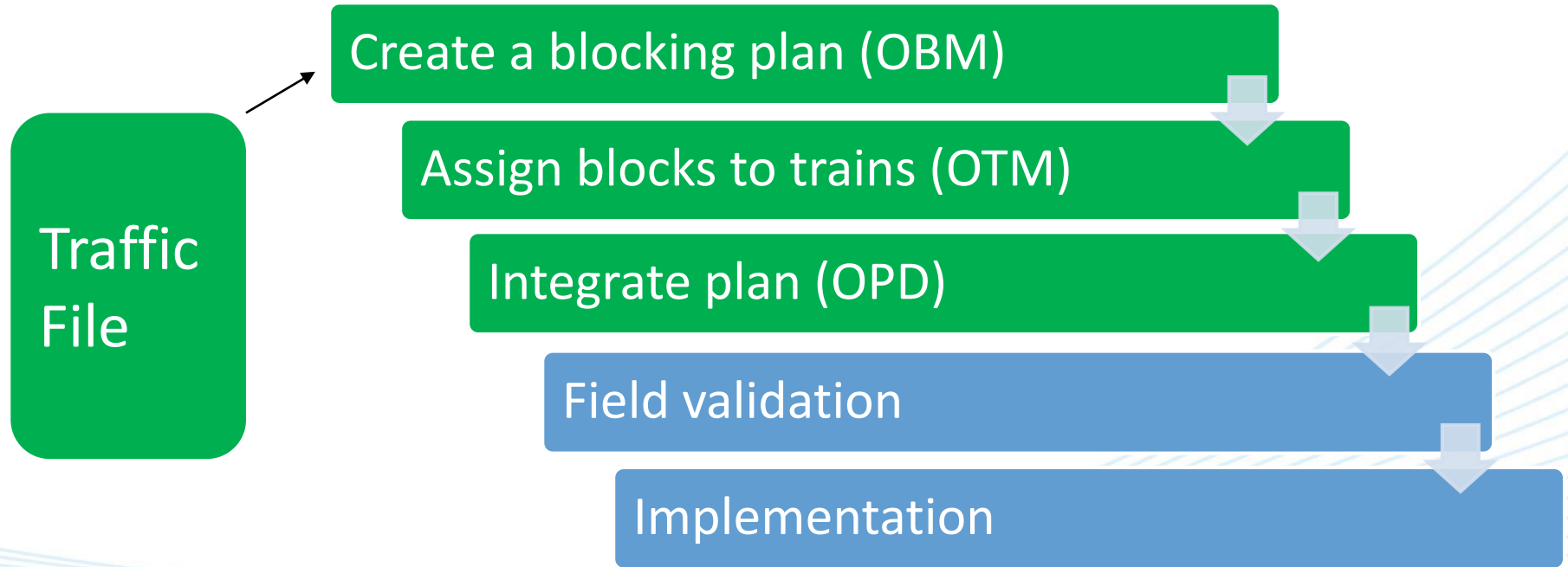
Norfolk Southern TOP21 Plan

1. Clean Sheeting at major yards
2. By-pass blocks and block swaps
3. Multi-rides for large blocks
4. Merging unit, automotive, intermodal and manifest trains into *one network*
5. Building balanced blocking plan to achieve balanced train movements
6. Running longer trains to reduce train starts
7. Running trains 7 days a week and optimizing yard clock

How NS Implementation Differs from Others

- Clean Sheeting for 18 months prior to TOP21 plan
- Organizational change to focus on new plan
- Customer collaboration
- Phased rollout
- Continuous improvement
- Leverage in-house OR tools

NS Uses OR Tools to Design TOP21 Plan



OBM - Blocking Plan Strategies

- Optimal Blocking Model (OBM) is an internal NS blocking plan optimization model to determine best blocking plan while adhering to various operational constraints
- With more locations allowed to block, traffic can flow and is not “forced”
- Blocking capacities matched to static clean sheet capacities
- Car circuitry and car handling are reduced

OTM - Train Plan Strategies

- Optimal Train Model (OTM) is an internal NS train schedule optimization model that minimize train starts and car dwells. It has 2 main modes, route optimizer and schedule optimizer.
- Train flows are balanced to the extent possible
 - Helped by integration of separate lines of business
 - Balance power and crew
- Add block swaps
 - Road block swaps where sensible to avoid congestion and recrews
 - Limited swaps at hump yards

OBM & OTM Usage

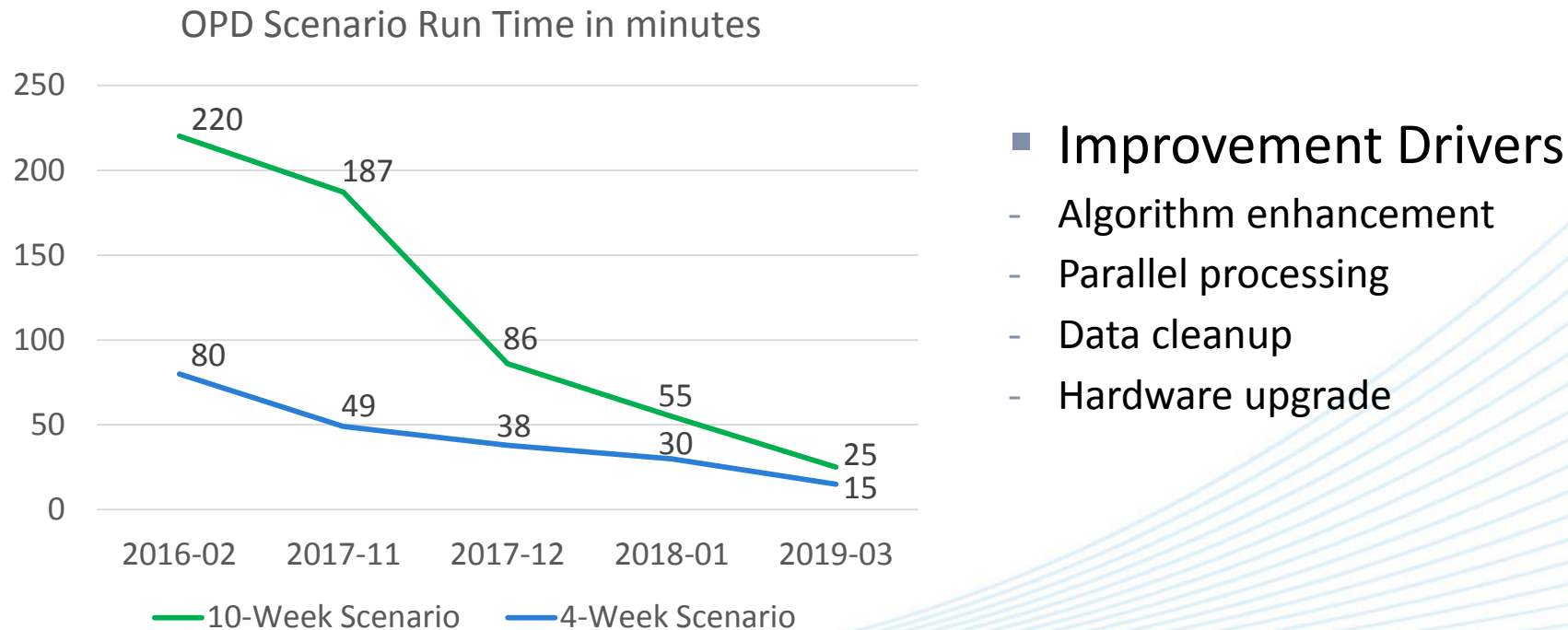
- Total number of iterations

	Optimized Blocking Plan	Optimized Train Plan
TOP21	77	87

OPD - Integration with the local plan

- Operating Plan Developer (OPD) is an offline network planning and service design tool used to simulate railroad operations according to NS real time production system.
- Road train plan merged with local operating plan
- 1 million+ waybills were used in each simulation run
- 300+ scenarios
- Analyzed customer impacts at local level

OPD Scenario Run Time Reduced by 80%



Conclusions

- PSR changes our culture
 - All departments involved in the planning process
- Optimize asset utilization
 - Less cars online
 - Less locomotives
 - Less crews
 - Less network congestion
- Continuous improvement