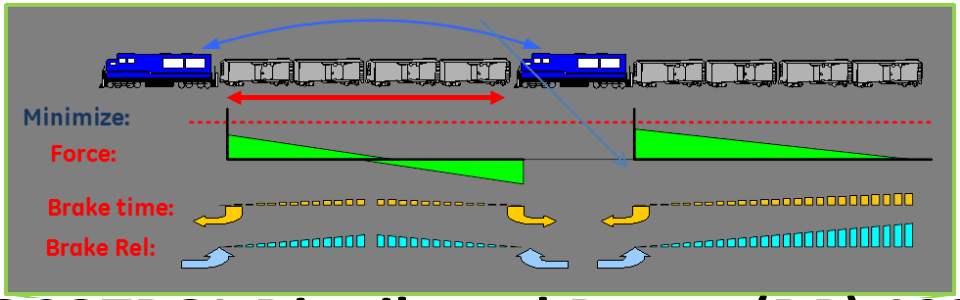
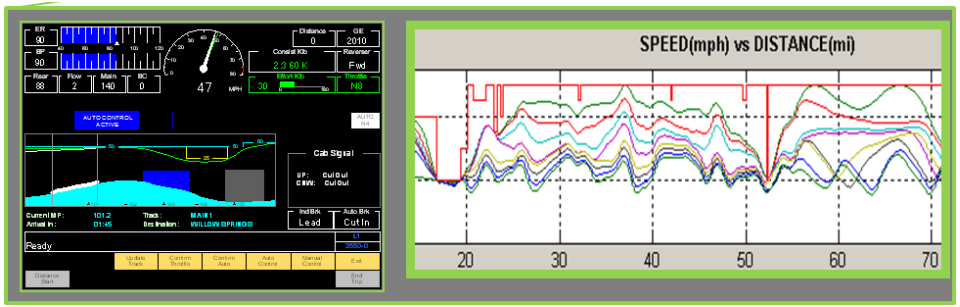

Running Longer Trains more Productively and Less Destructively

The Braun and the Brains…

Two Complimentary Technologies for Long Trains:



LOCOTROL Distributed Power (DP) 1985



Trip Optimizer (TO) Train Control System 2005

More Productively: Distributed Power Capacity

99,732 tons, 682 ore cars
2x168x2x168x2x168x1x178x1
BP segments: 5,800'

~42,000 tons, 342 ore cars
EDDx114XDDEx114xDDDDx114xDD
BP segments 3,740'

~45,000 tons, 336 ore cars
2x112x2x112x2x112
BP segments 3,608'

~10,000 tons, 179 wells
5x170x1 typ.
BP segment 10,000'

~16,000 tons, 306 wells
3x102x2x102x2x102x2
BP segment 6,000'

15,000 tons, 130 cars
1x74x1x74x1
BP segments 6000'

More Productively: Distributed Power Throughput

Benefits of going from 1.5 Mile long trains to 2.2 Mile DP trains:

Trains reduced: 52/year

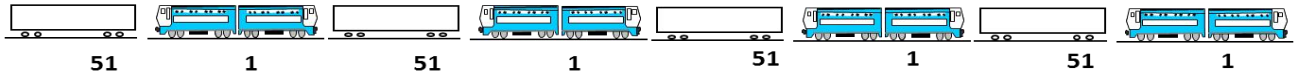
Crews reduced: 520/year

More Productively: Distributed Power Throughput

Original Operation:

5,000 tn = 150,000,000 / yr

Current with DP: 4x Capacity, 90 trains daily



Same braking distance
Same safe train interval
No changes needed to signaling!

20,000 tn = ***450,000,000*** t / yr

Total Program ROI: just over 2 years

LOCOTROL ROI: ~ 3-4 months

More Productively: Distributed Power Stopping Dist.

Train Design

Date : 12 October 2006
Project Number : 050105.01TDN
Reference : / RS – 2006 / 141

EVALUATION OF *THIRD* 342 (30T/AXLE) WAGON ORE TRAIN USING AUTHENTIC LOCOTROL DISTRIBUTED POWER EQUIPMENT

Teams: Technology Management (Train Design)
Technology Management (Signals & Telecommunications)
Traction Department (Electrical Test)

DP: With 3 remotes equals ECP Brake performance

Approved
Principal Engineer (Train Design)

More Productively: Distributed Power Fuel Savings

322 Out of Macon:

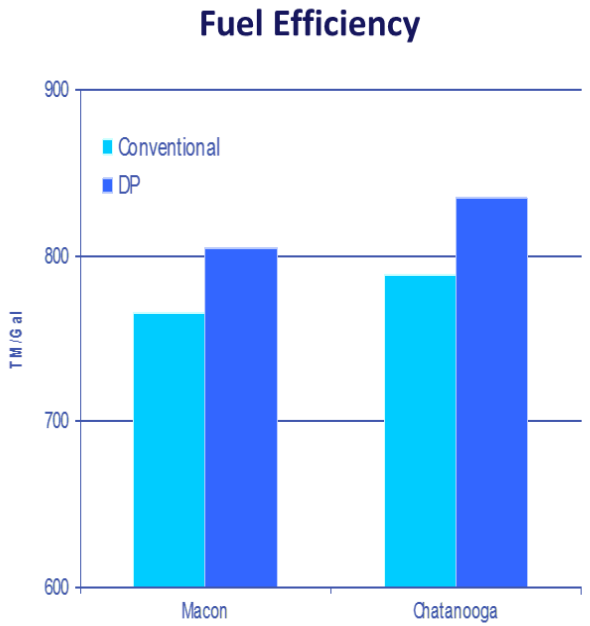
- DP Avg: 342 GTK/Litre (805 GTM/Gal)
- Conventional Avg: 326 GTK/Litre (766 GTM/Gal)

5.2% Difference

361 Out of Chattanooga:

- DP Avg: 355 GTK/Litre (835 GTM/Gal)
- Conventional Avg: 335 GTK/Litre (788 GTM/Gal)

6.0% Difference



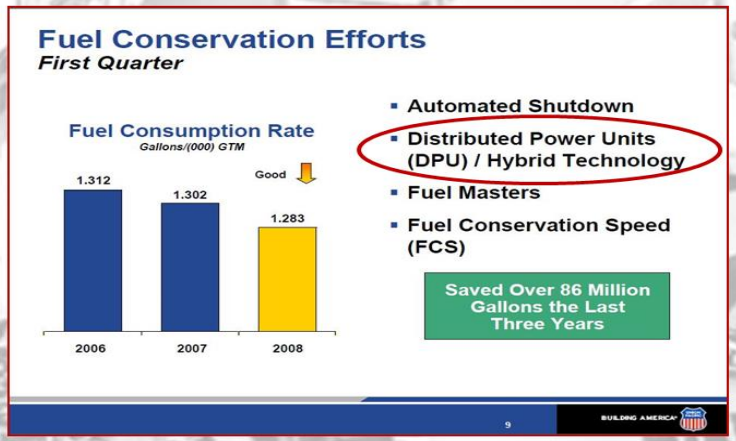
More Productively: Distributed Power Fuel Savings

CPRR:

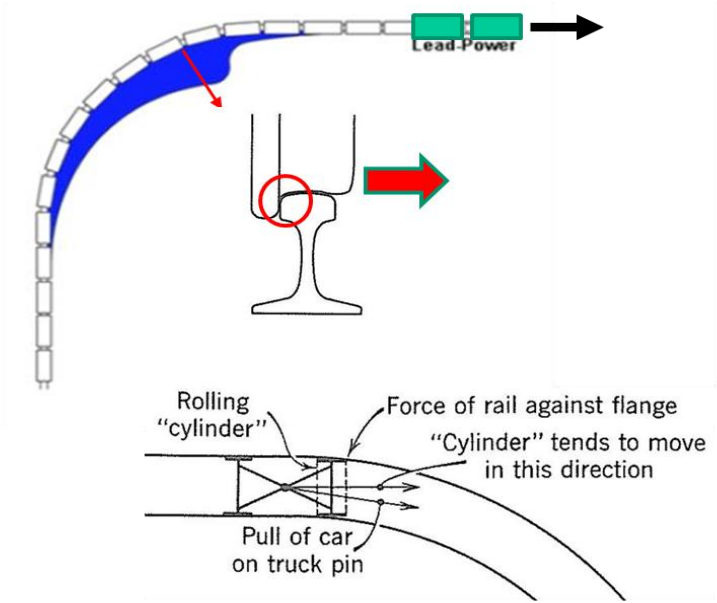
- 6% Fuel Savings
- 10% Improvement in overall tonnage
- 11% Improvement in fewer train starts

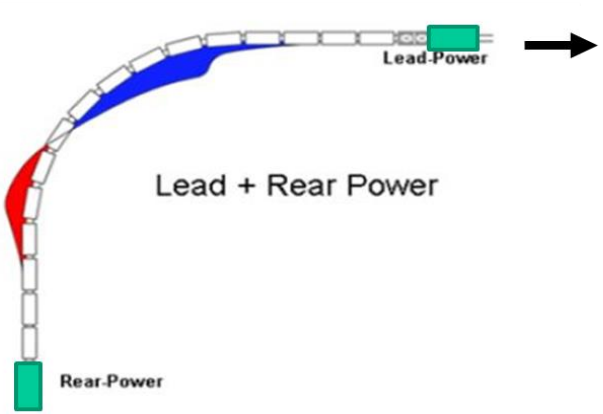
Union Pacific:

- 5% Fuel Savings across the fleet due to LOCOTROL



More Productively: Distributed Power Fuel Savings

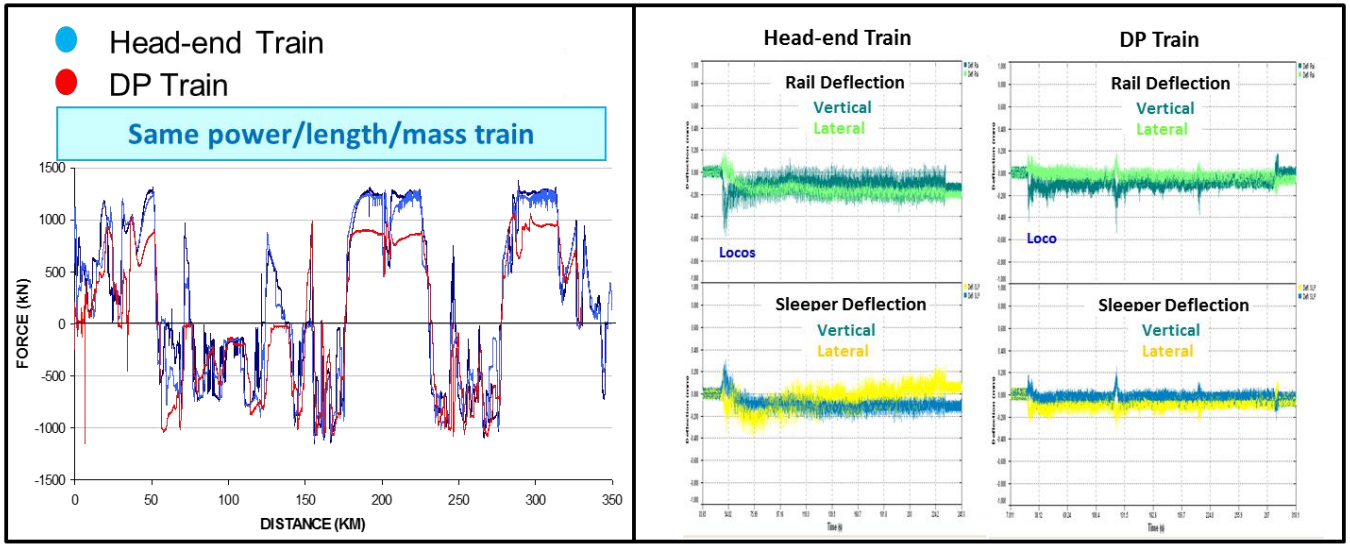


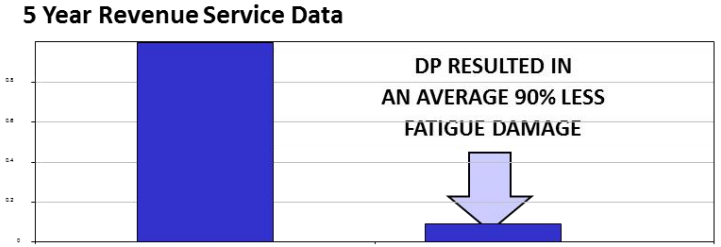


Union Pacific RR: **5% fuel savings over 5 years**

Canadian Pacific RR: **6% fuel savings over 4 years**

Less Destructively: Distributed Power





Less Destructively: Distributed Power Control of Lateral Force

Before

The rail installed in Oct. 2004 and replaced in May 2005.

- The extreme rail wear was seen after only 7 months.

After

After installation in May of 2005, which is 7 months, the curve rail wear was between 1/32 to 2/32.

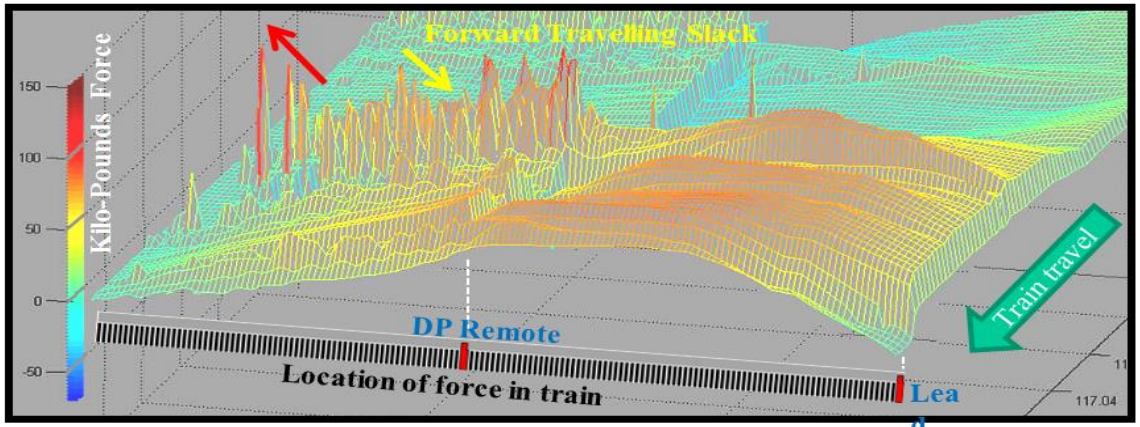
- This is a major improvement.
- Rail Life extended from one year to five years.

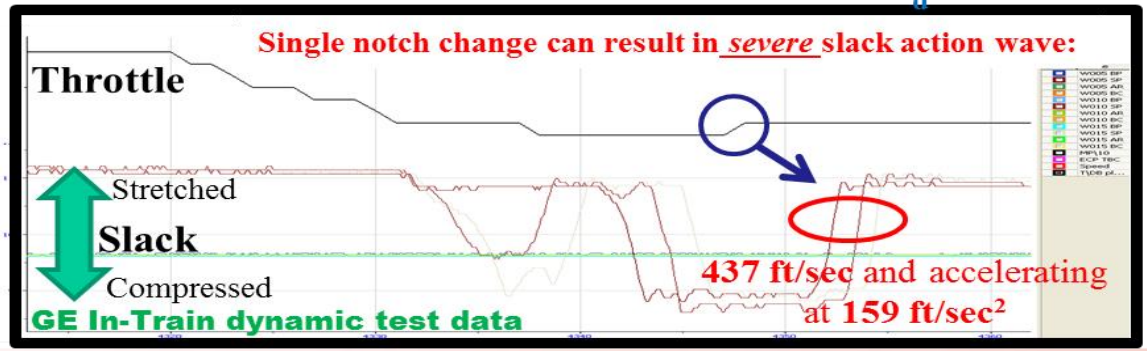
DP RESULTED IN AN AVERAGE

80% LESS Rail Wear!

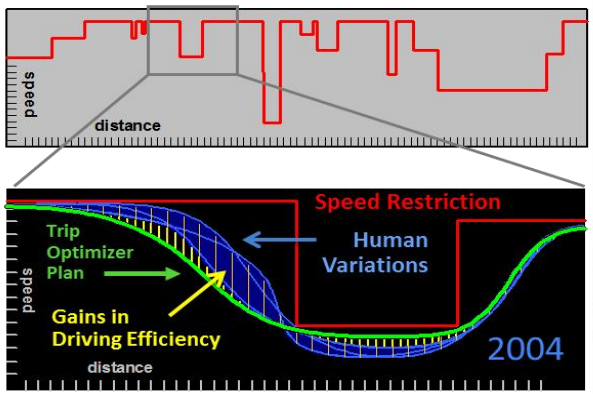
- Less friction wear = less Fuel
- Longer Wheel Life
- Less Track grinding/replacement Downtime
- Less Sleeper/Wheel Maintenance

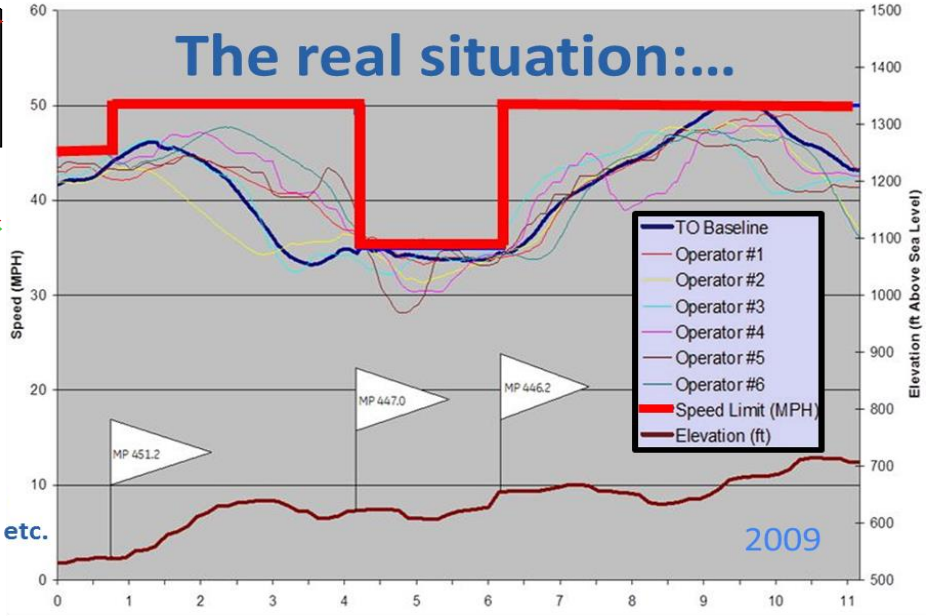
Less Destructively: Distributed Power Slack Action Control





More Productively: Trip Optimizer





Human Variations Due to:
Variations in train mass, Rolling resistance, Locomotive capability/de-rating, Wind, Train length, Mass distribution, Driver experience, etc.

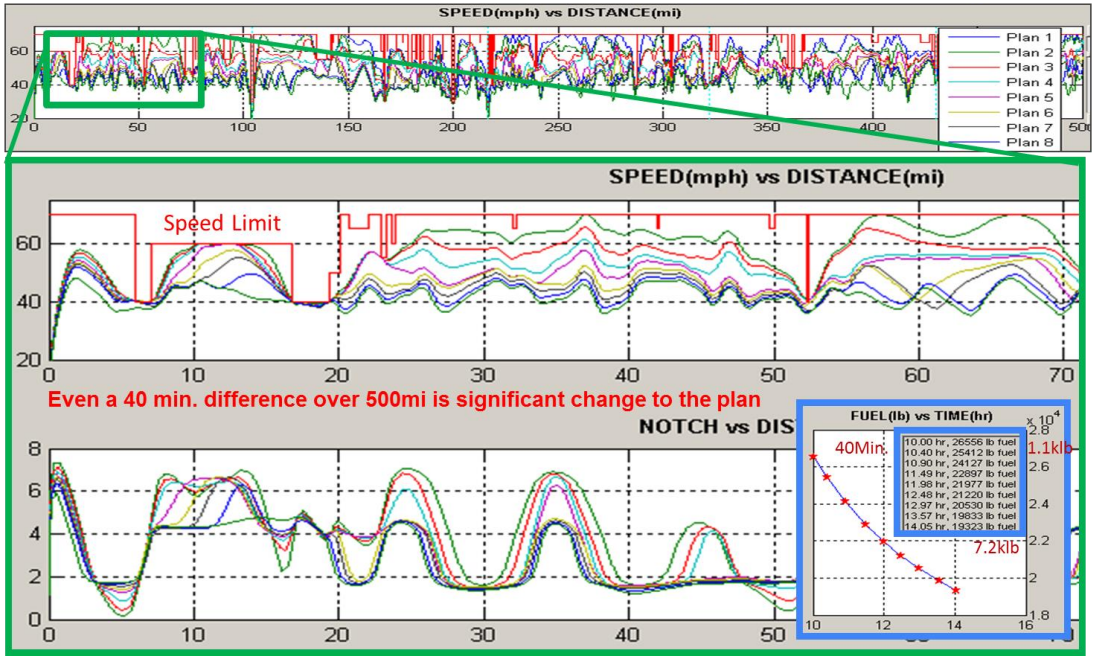
Trip Optimizer

- **Plans the most efficient (Optimum) way to Drive for whatever is being Optimized** (fuel, time, handling...)
- **Automatically Drives to the plan**

More Productively: Trip Optimizer

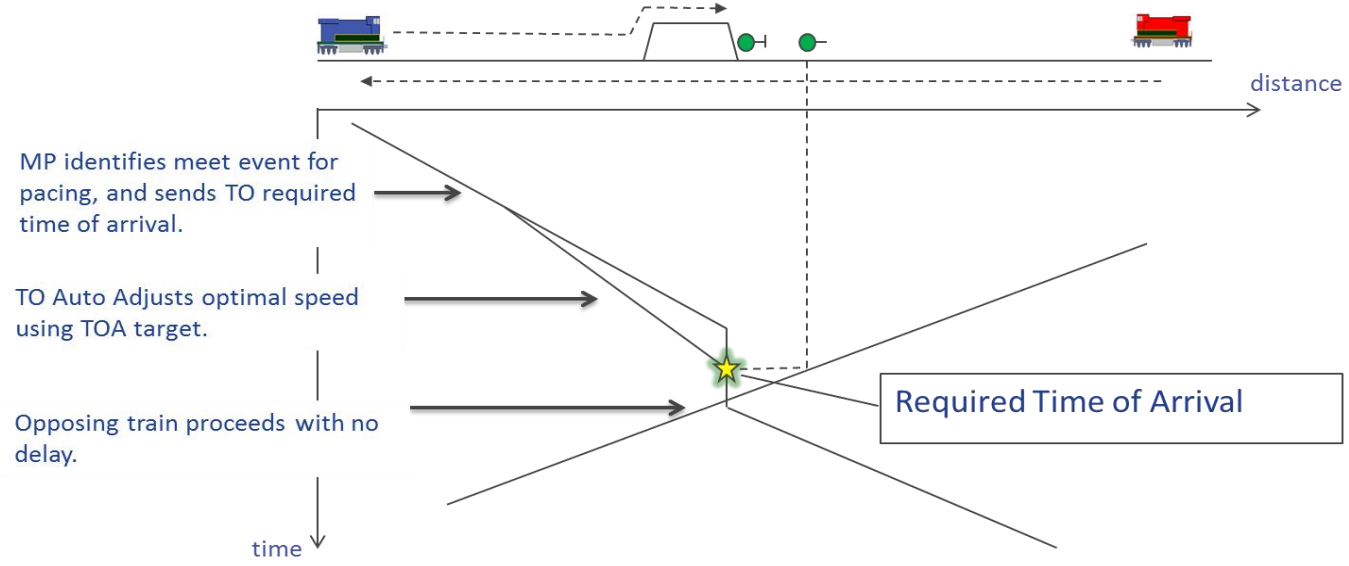
TO Optimization/Plan – Complex Physics Based

- **Full parametric optimization:** For a given set of parameters and constraints (speed restrictions, train mass, HP, train resistance, in-train force, time, etc.), there is ***only one*** optimum solution. Upon on *new or learned* data TO can rapidly Calculate the change



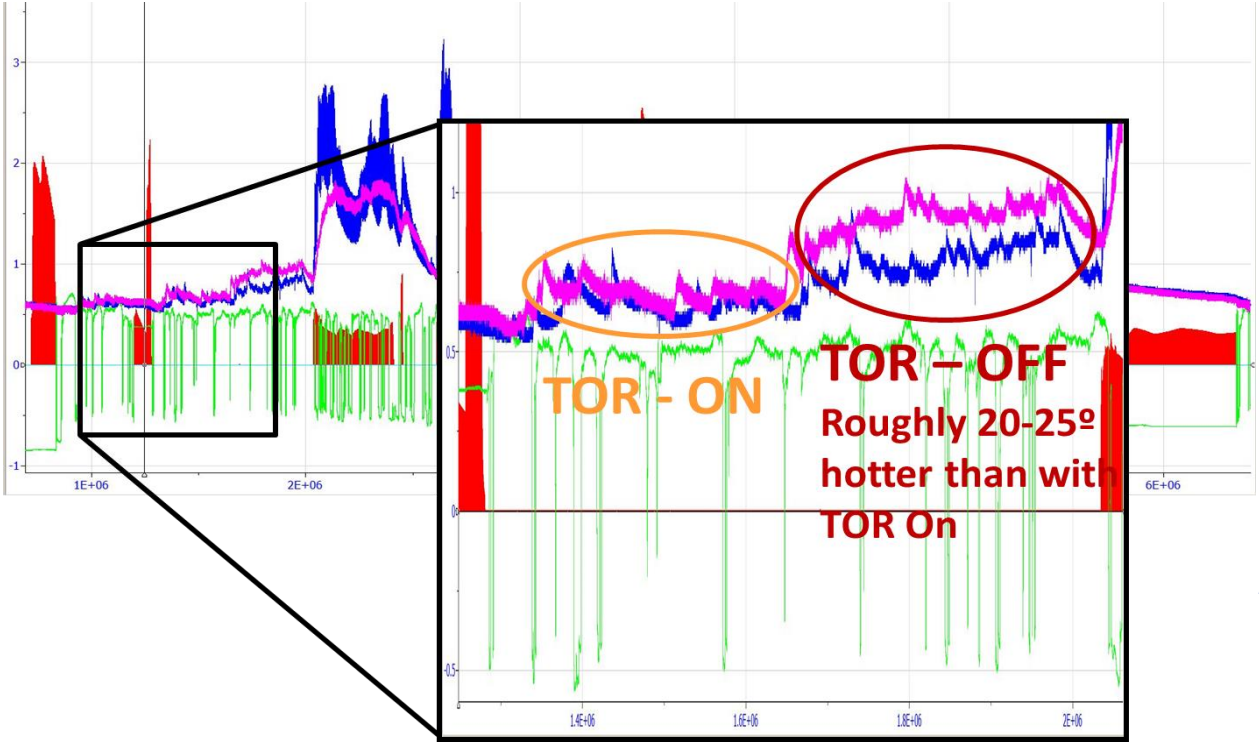
More Productively: Trip Optimizer

Energy Efficient Train Meet



Delayed train saves fuel by pacing approach to meet

Less Destructively: Trip Optimizer Friction Modifier Control*



* Tested, under evaluation

Less Destructively: Trip Optimizer/DP Computer Controlled Slack Action Control

Relative speed control

Concept

Regulate difference between crucial car speeds along the trip

Multiple interacting speed control loops

- relative speeds between consists
- planned speed deviation
- remote loco to tail speed

Impact

Real-time train-handling

Run-in avoidance