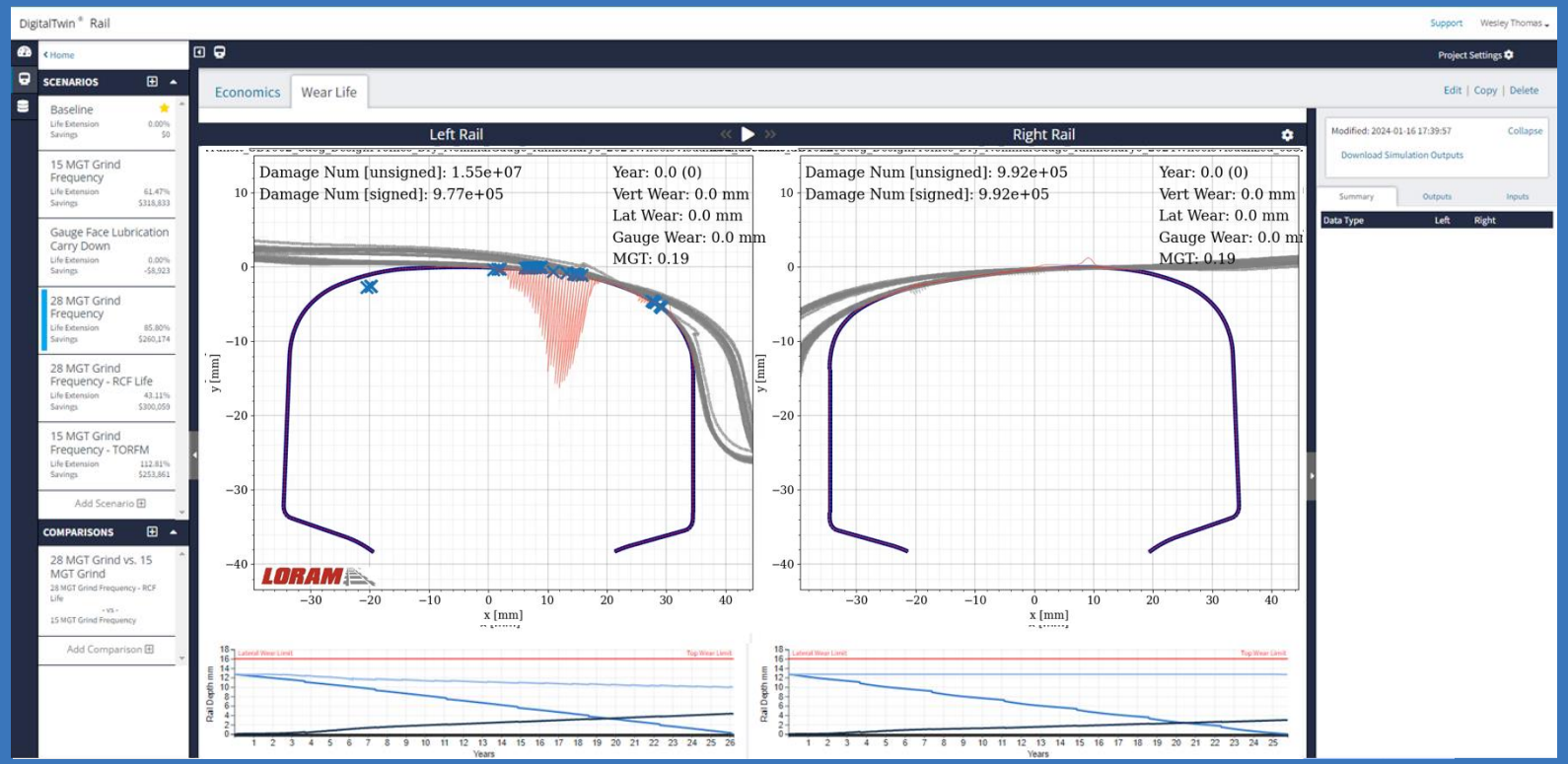
Digital Twins to Support Track Maintenance Decisions for Sound Transit



RAIL TRANSIT SEMINAR

August 26-28, 2025

SEATTLE, WA

WRI2025RT

Background – Challenges to Solve

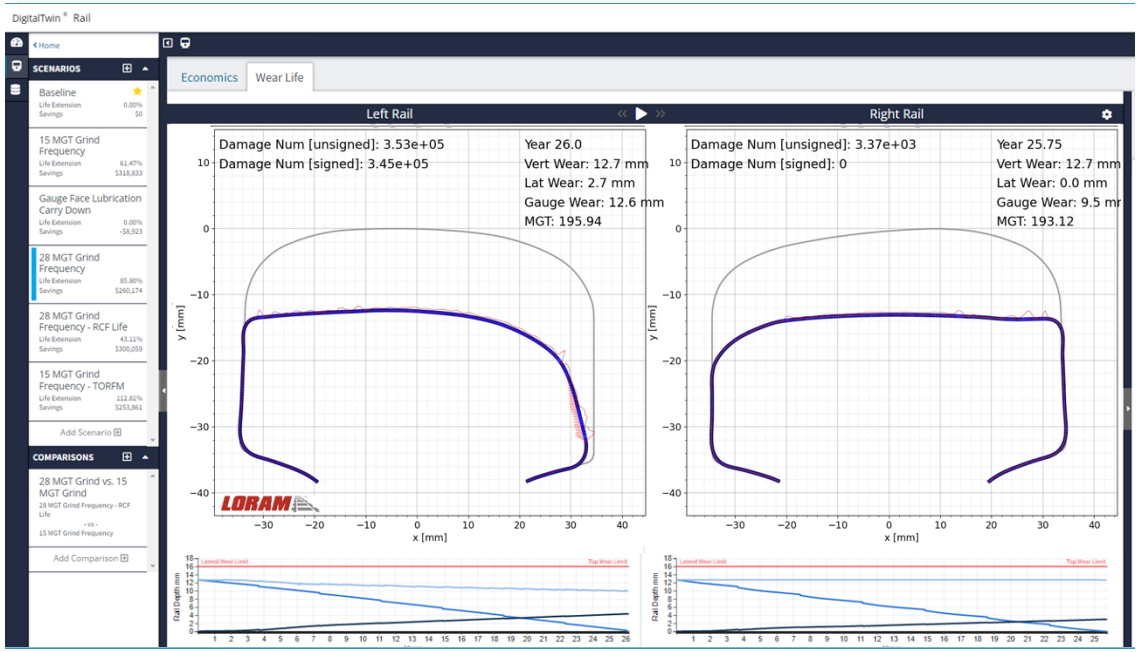
Noise, Vibration, and Gradual Preventive Grinding

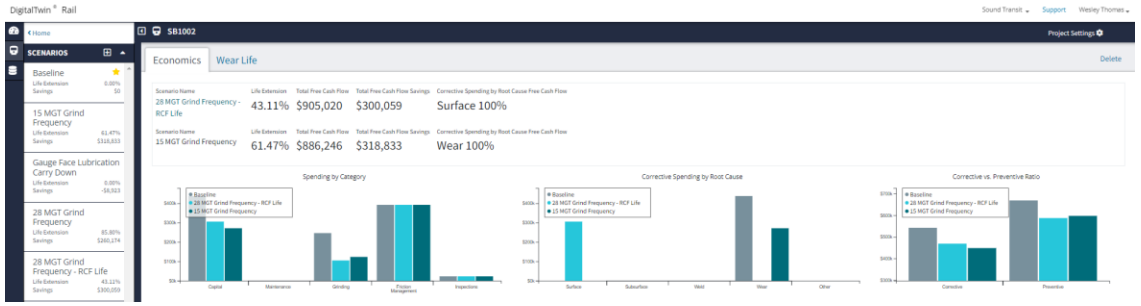
Sound Transit experienced vibration, noise, and stud defects during periods before preventive grinding. These challenges have been improved with corrective work, but how can we optimize the frequency and schedule?

Life Extension from Network Build Focus to O&M Focus

Sound Transit has been rapidly expanding its network with significant funding. However, the capital investment will reduce and budgets will tighten. How do we help plan for the upcoming maintenance needs and be good stewards of taxpayer funding?

Year 1 – Grind Strategy in Digital Twin



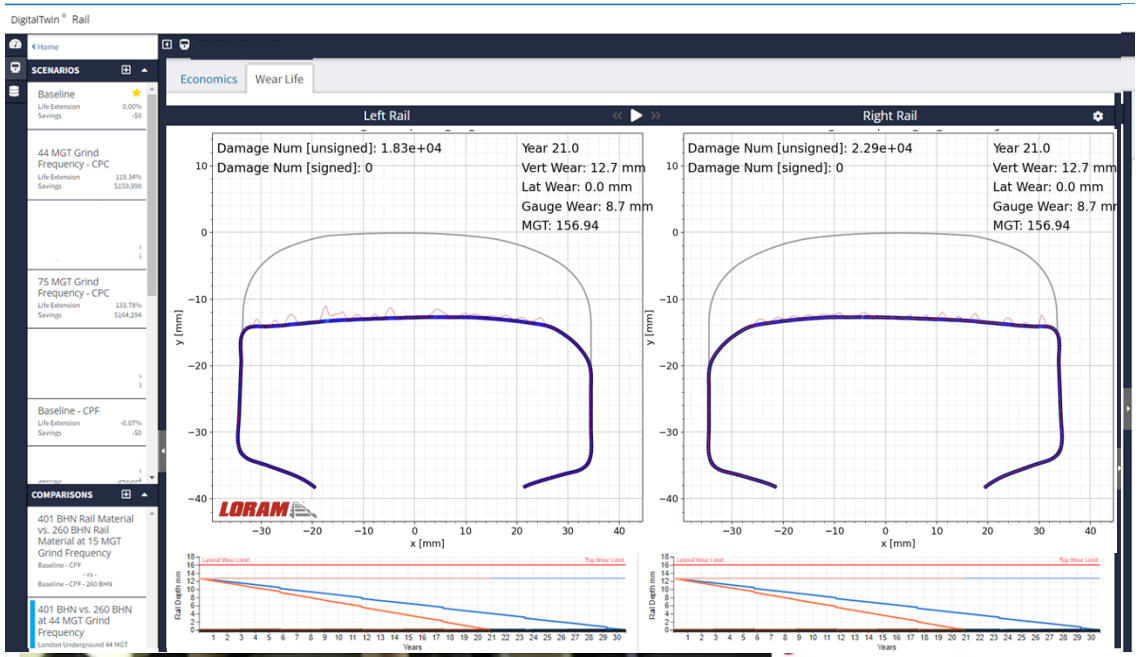


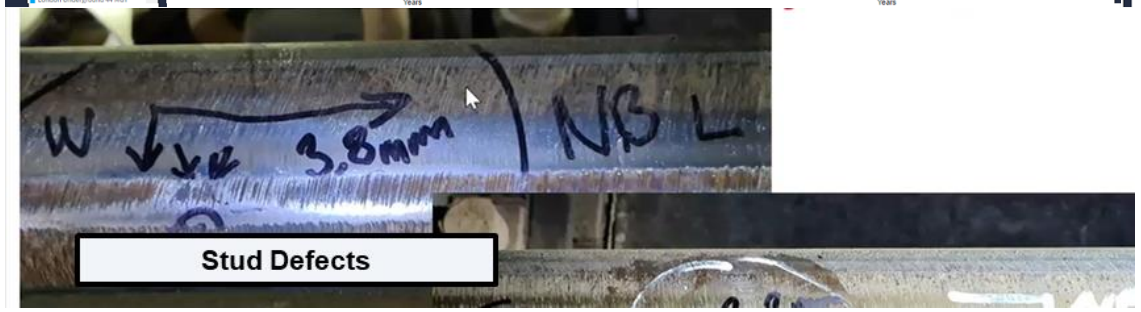
Grind Plan

Grind frequency was inconsistent across network.

Recommended grind strategy for long-term scheduling

Year 1 – Rail Material to Address Studs



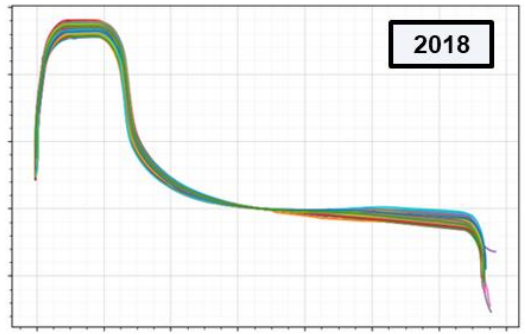


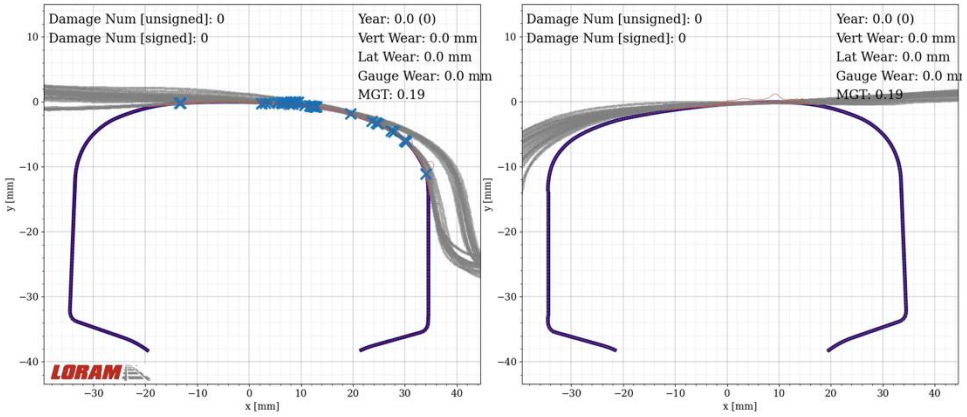
Stud Remedy

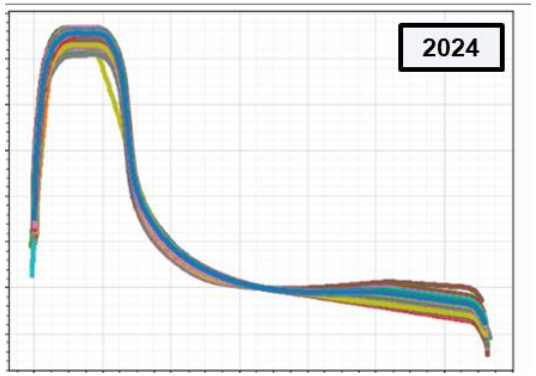
Stud defects were persistent before grinding

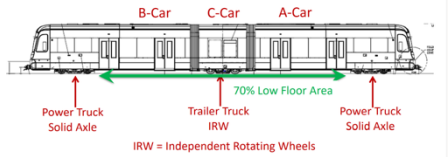
Did not recommend reduce rail hardness to prevent based on ROI

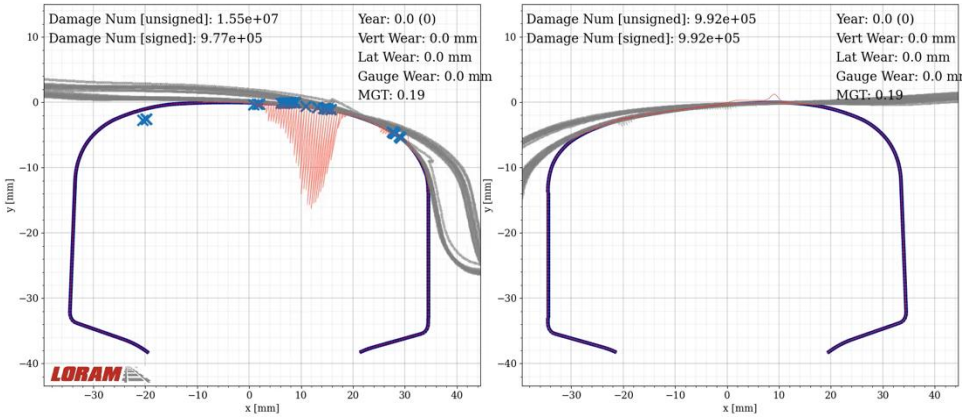
Year 2 – Verify with Actual Vehicles/Wheels











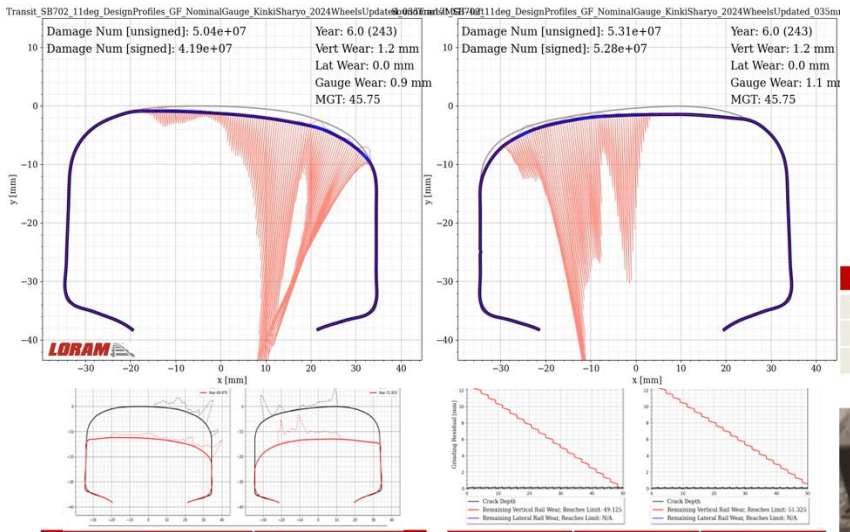
Wheel-Rail Interaction

Updates to the wheel profiles and vehicle model to represent Sound Transit rolling stock replicated wheel-rail interaction

Year 2 – Verify with Actual Rail Condition

Order.	Loc.	Start	End	Sect	Start MP	End MP	Name	Slice	Curve Radius	Curve (deg)	Gauge (mm)	Super EL (in)	Min Speed	Max Speed	Cant Def	HR Target	LR Target	Traffic MGT/Y	Wheel Data	Rail Wght.	Rail Mat	Grind Freq.	Grind Depth	Fric. Level	Wear Limit
10	MT Baker Station	BHS	MBS	SOUTH	1.25	1.325	SB702	1.28	500'	11.54	1435.26	3	17	20	0.22	HRC	LOW	7.5	MiniProf 2024	115	Premium 400	17.25	[0.36,0.42]	GF BHS MBS 1.2	12.7 / 12.7

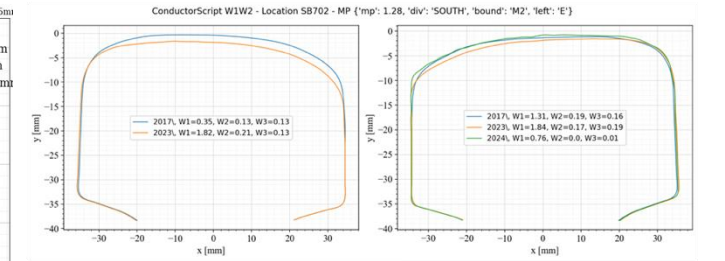
Left Rail **Right Rail**



Output Parameter	[Left, Right]
Vertical Wear Rate [W1] [% Art.]	[0.25, 0.24] [58%, 60%]
Lateral Wear Rate [W2]	[0.00, 0.00]
Gauge Wear Rate [W3]	[0.21, 0.21]
Damage Number per 100MGT [E6]	[54.72, 79.58]

Output Parameter	Years [Left,Right]	MGT [Left,Right]
Rail Life	[50.0, 51.9]	[374.8, 389.4]
Wear Life	[50.0, 51.9]	[374.8, 389.4]
RCF Life	[-999, -999]	[-999, -999]

Left Rail **Right Rail**



Output Parameter	[Left, Right]
Vertical Wear Rate [W1] [%]	[0.29, 0.12 to 0.38]
Lateral Wear Rate [W2]	[0.00, 0.00]
Gauge Wear Rate [W3]	[N/A, N/A]

Output	Years [L,R]	MGT [L,R]
Rail Life	[44+, 45+]	[330+. 338+.]
Wear Life	[44+, 45+]	[330+. 338+.]
RCF Life	No Data	No Data

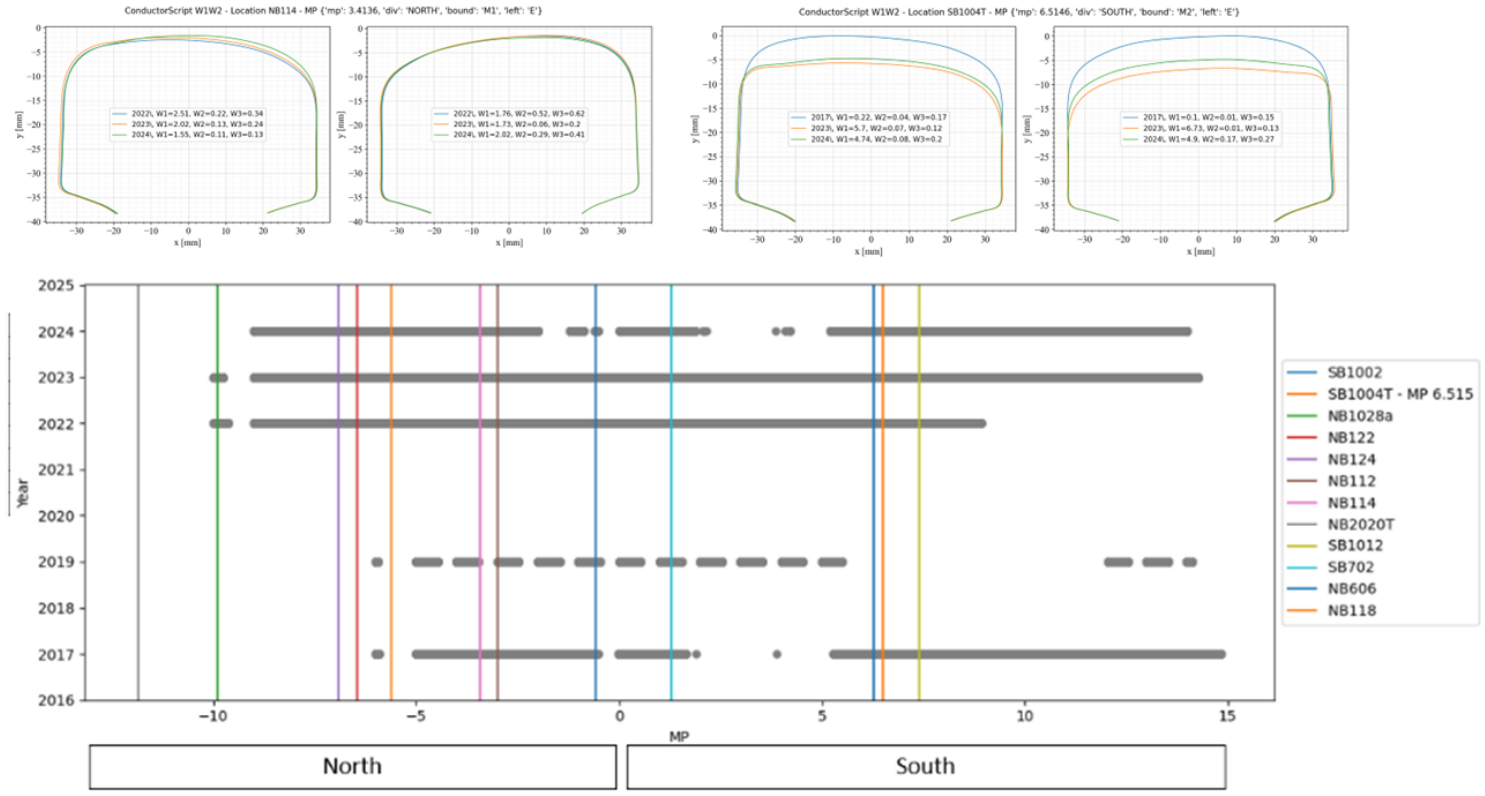
Left Rail **Right Rail**

Category	[Left]	[Right]
Contact Band Assessment	Two Point – Gauge and Field	Three Point – Gauge and Field
Surface Damage Assessment	No Surface Damage Observed	Corrugation

Rail Condition

Twelve virtual test sites were established on Sound Transit showing similar wheel-rail interaction, wear, and surface damage as observed

Challenge – Consistency of Rail Profile Data



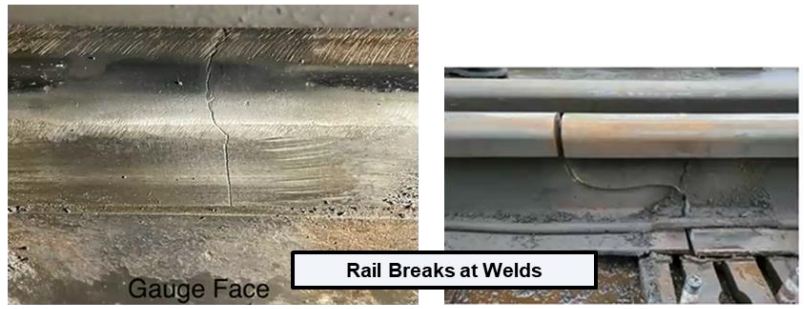
Rail Profile Data

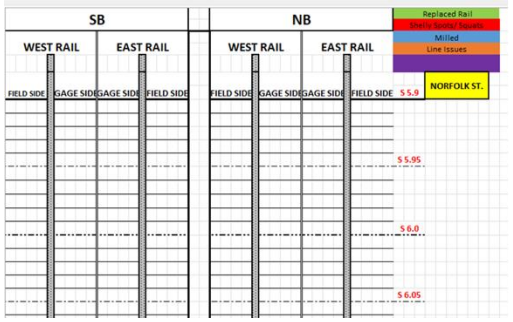
Rail profiles stored for network

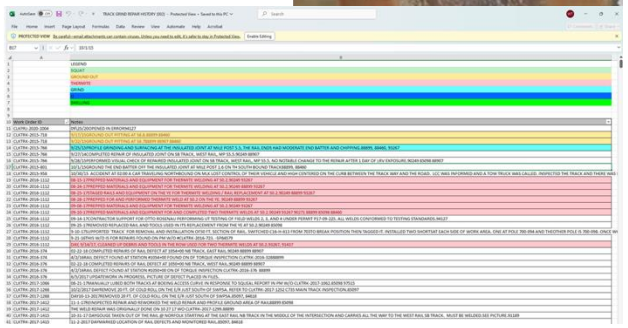
Quality and consistency improvements

Connect to OnTrack for RSL

Challenge – Rail Surface Condition



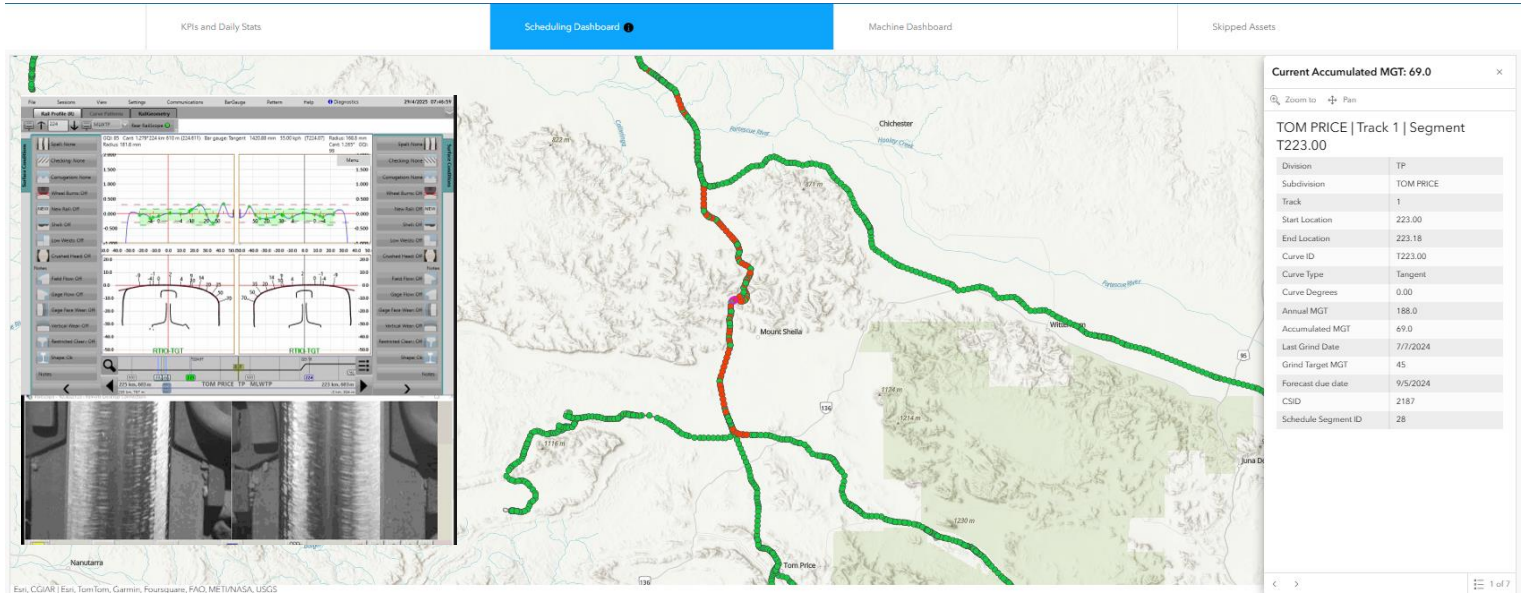


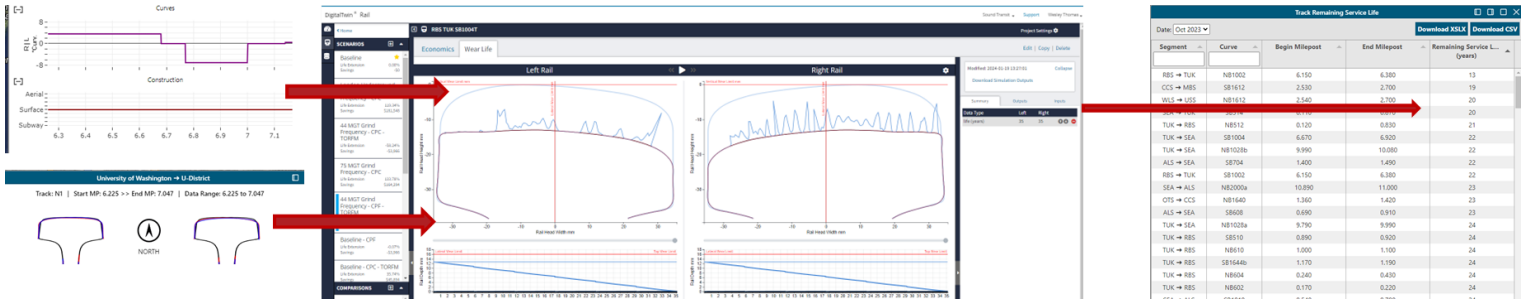


Rail Condition Data

Rail conditions limited to photos and Excel tracking manually or as export from EAM work orders.

Future - Implementing the Strategy





Tools to Implement

Rail conditions limited to photos and Excel tracking manually or as export from EAM work orders.