RAIL PROFILE SHAPE & RAIL LIFE EXTENSION

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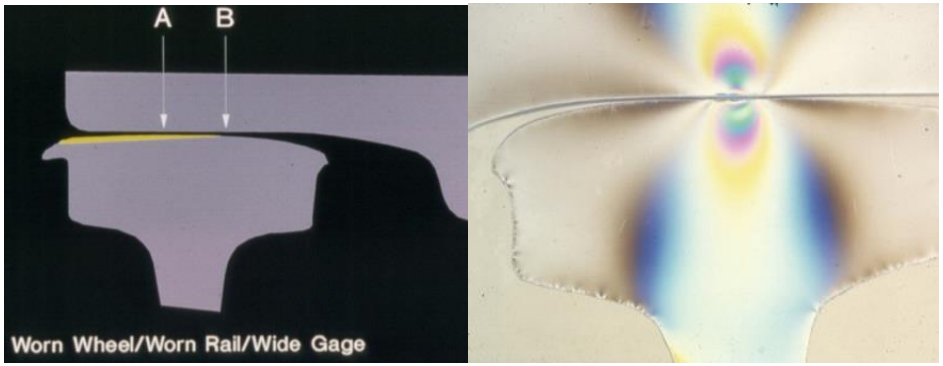
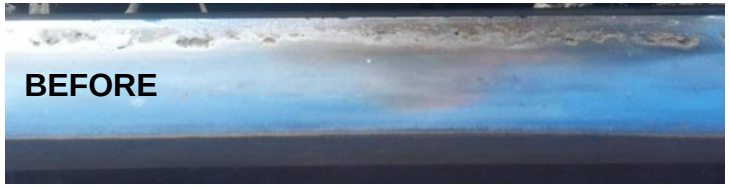
Background: How does Grinding Extend Rail Life?





Why Grind?	Profile Correction	Eliminate Surface Conditions

Benefits:	Optimize Point of Contact
	▪ Less rail wear
	▪ Less rail fatigue
	▪ Prolongs rail life
	▪ Less fuel
	  ▪ Reduced vertical loads
	  ▪ Less vibration
	  ▪ Improved curving of wheel sets
		Minimize Risk
		▪ Allows ultrasonic testing to see internal defects
		▪ Reduces vertical and lateral forces
		▪ Reduces track surfacing cycles (CAT)
		▪ Reduces rail fatigue defects (TD & SD Defects)
		▪ Reduces Rail Service Failures
		▪ Minimizes Derailments

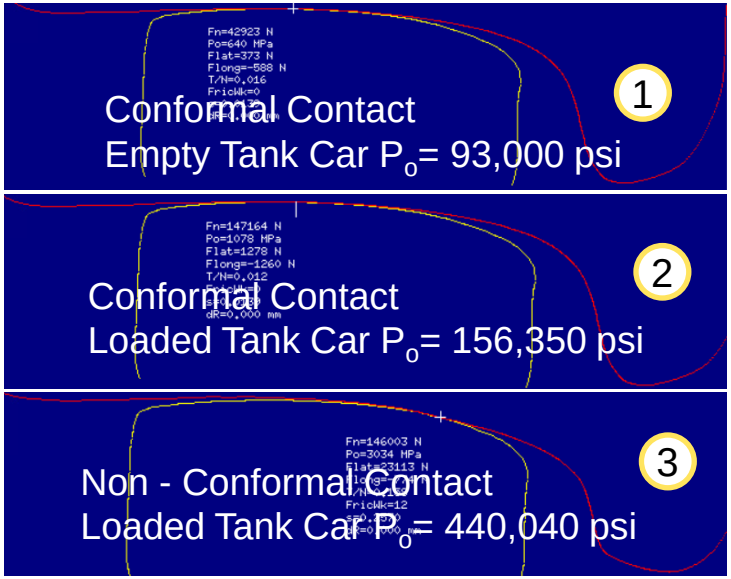
Background: Rail Profiles and RCF

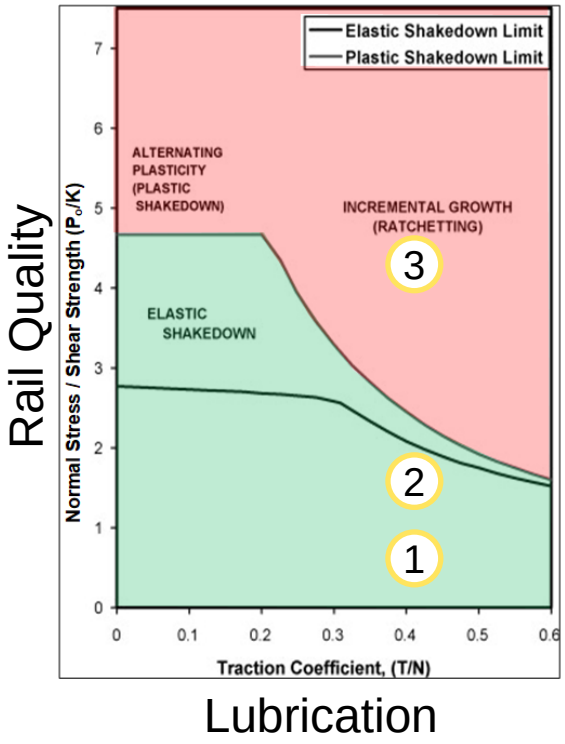
- Rail Profile shape can increase the contact stress 4x greater than an empty vs. loaded car

Fitzgerald MP 654

Measured Hardness: 336 HB

Measured TOR COF: 0.404





Rail Quality

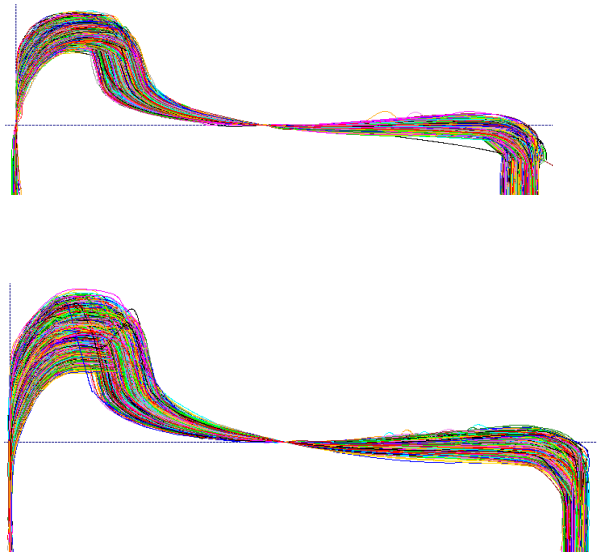
Lubrication

Diagrams & Analysis performed by Canadian National Research Council (CNRC) Alexander Woelfle for CSX

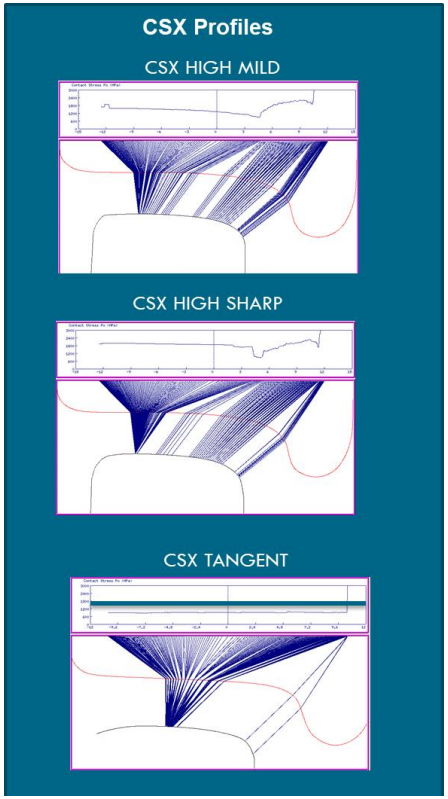
National Research Council NRC·CNRC Canada

Background: Considerations in Profile Design

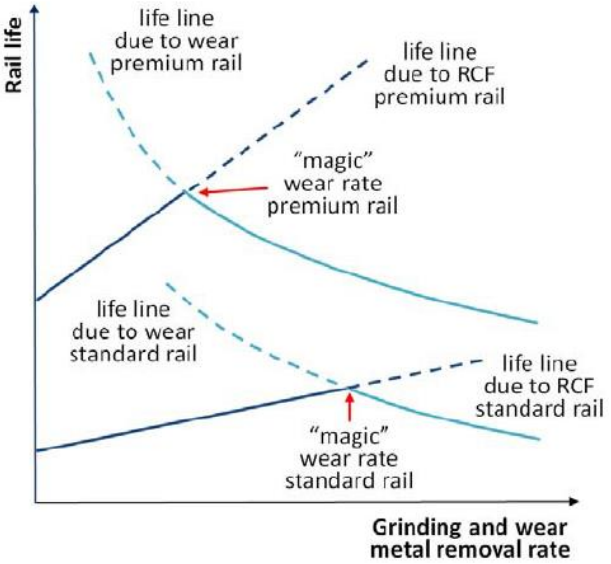
Wheel & Traffic



Curvature



Magic Wear Rate



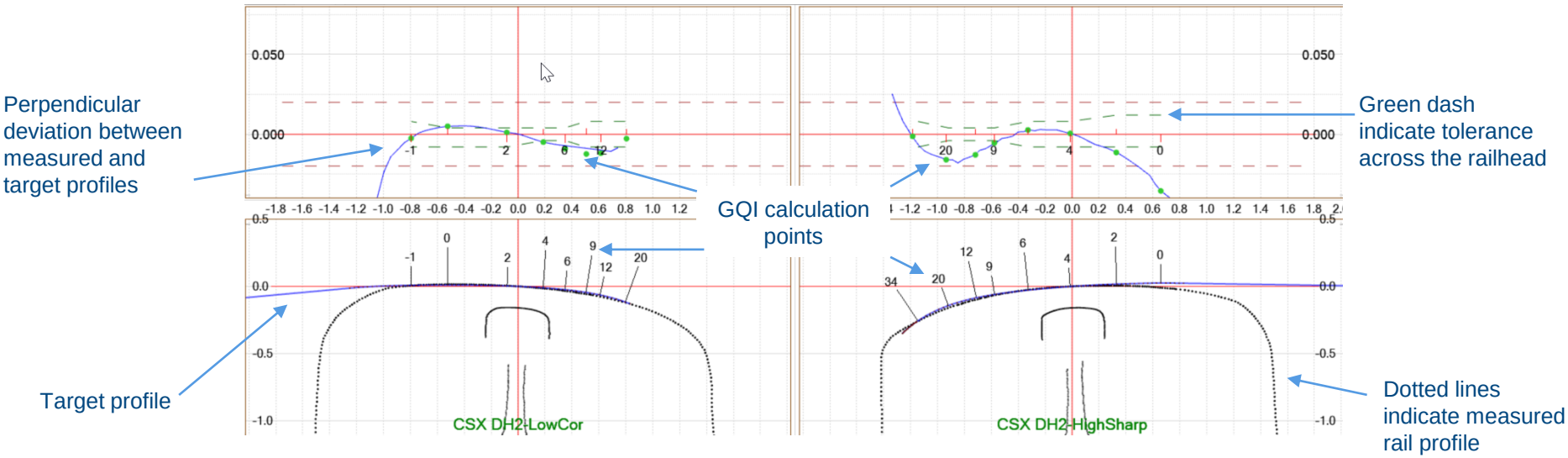
Background: What is Grind Quality Index (GQI)

What is GQI

- GQI is metric to measure post grind results against a specified target profile

GQI Relationship to Rail Life

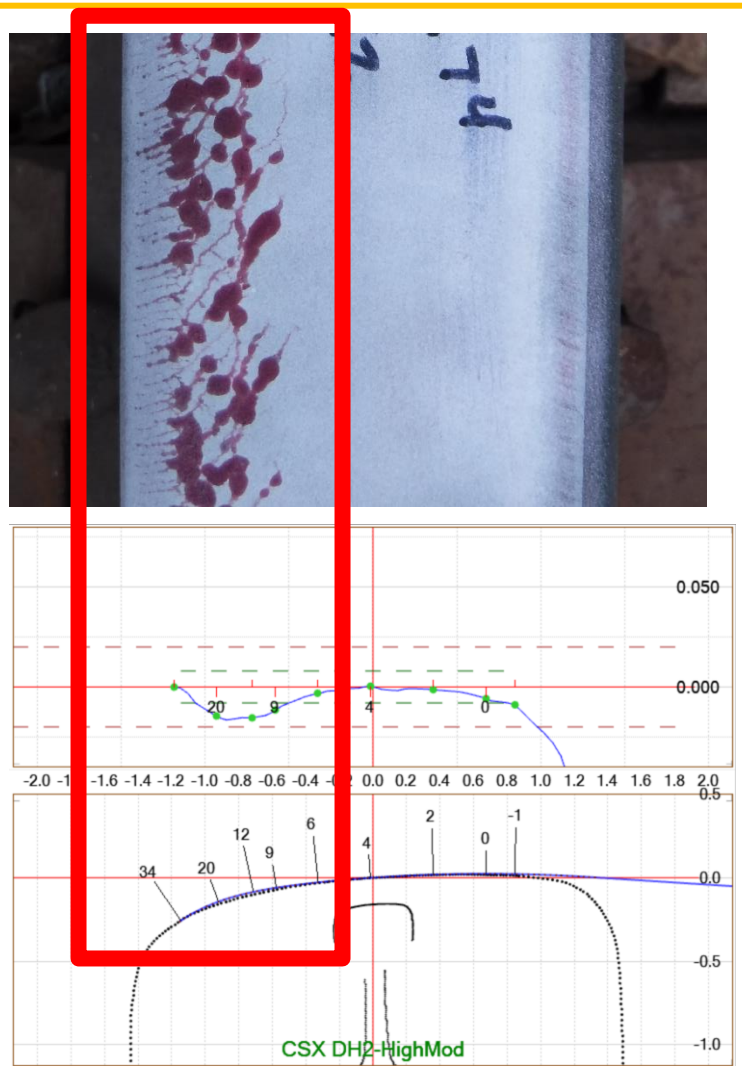
- GQI is not a rail life metric, and higher scores do not always indicate longer rail life particularly if target profile is not optimal.



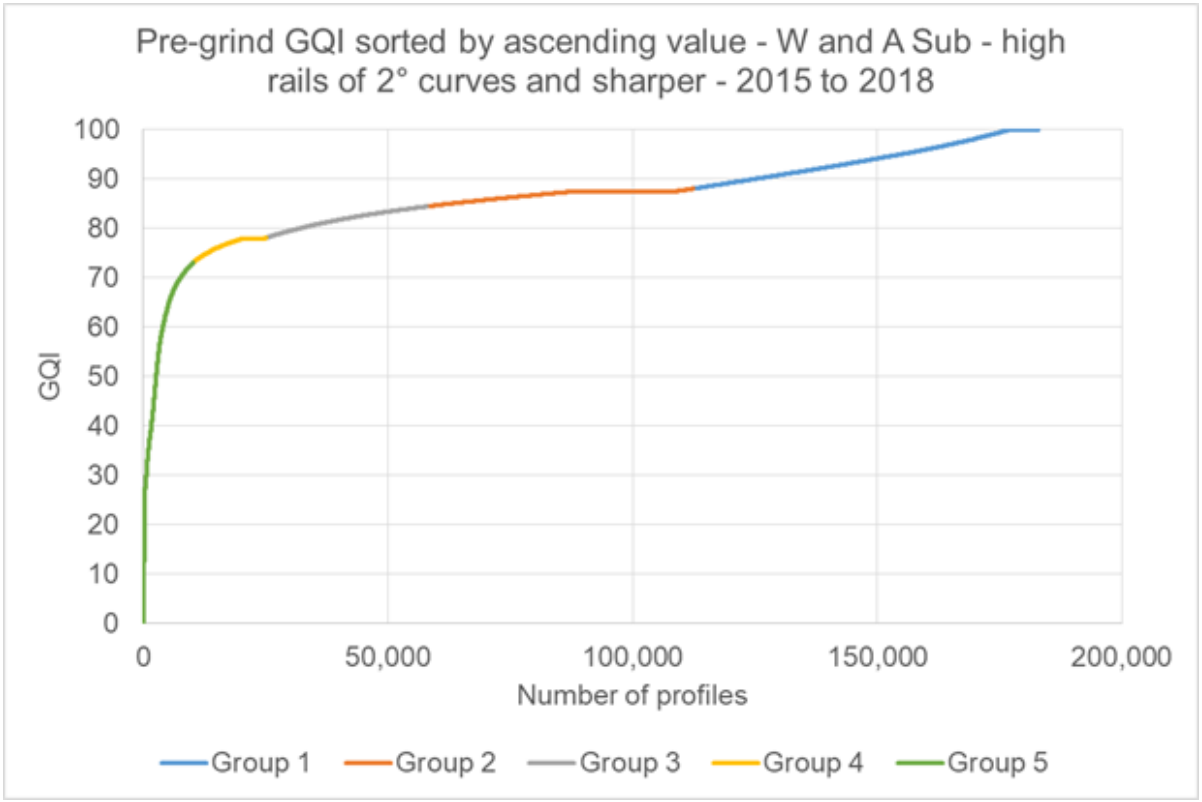
Challenge: Rail Life Extension from Profiles & GQI

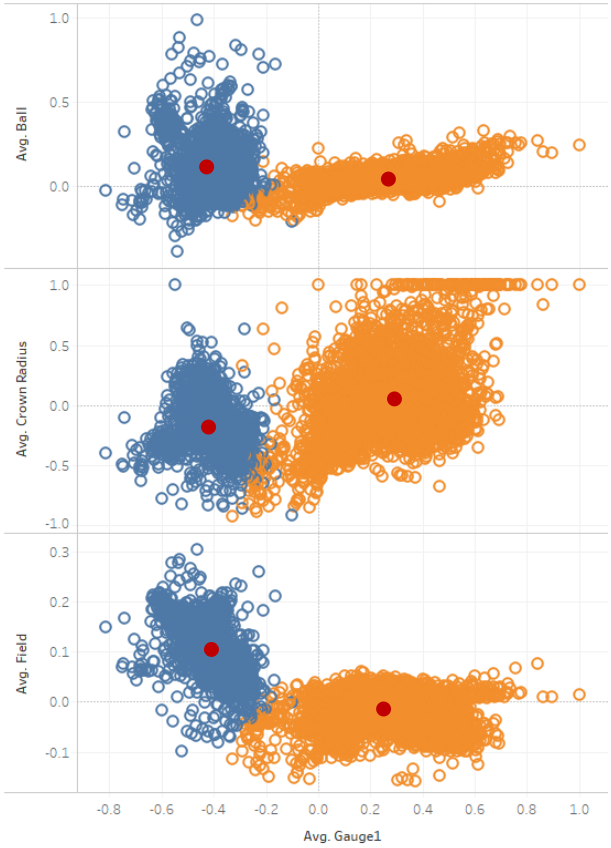
Rail Profile Optimization

- CSX uses GQI score as one of the measures to determine if / when to grind
- Current CSX target rail profiles are not providing the ideal wheel-rail interaction
- Current target profiles would removal metal at the wrong locations



Approach: RIV Data Shows Range of Rail Shapes





Diagrams & Analysis performed by Canadian National Research Council (CNRC) Alexander Woelfle for CSX

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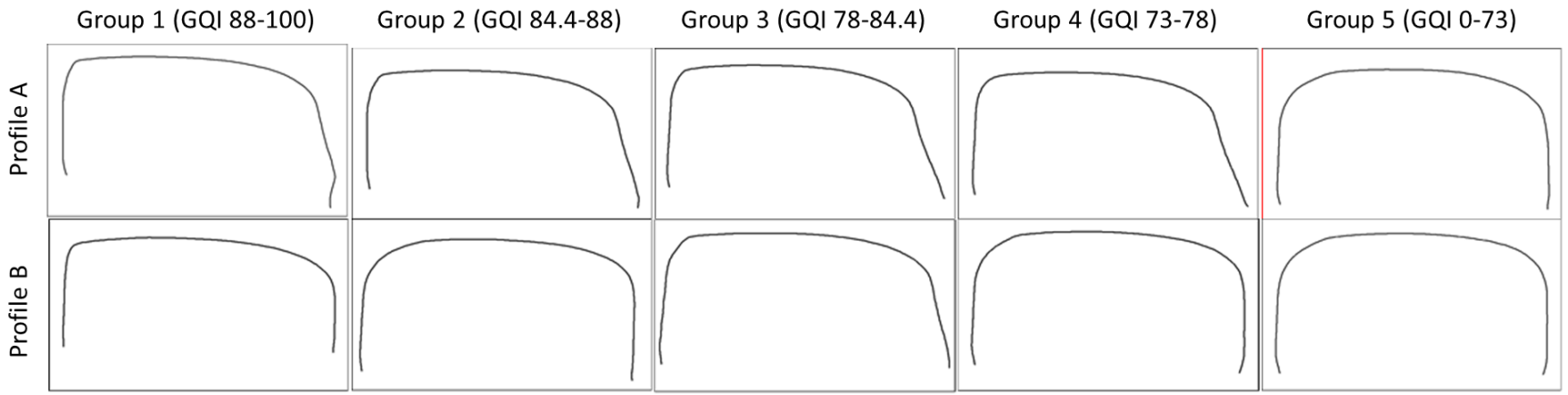
Approach: Compare 10 Rail Profile Shapes



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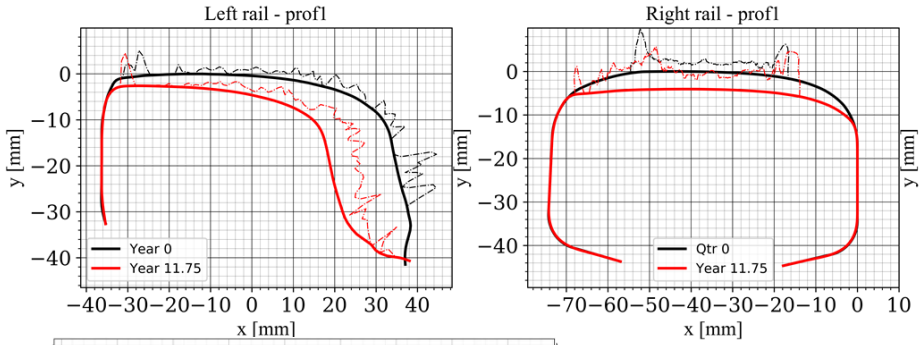
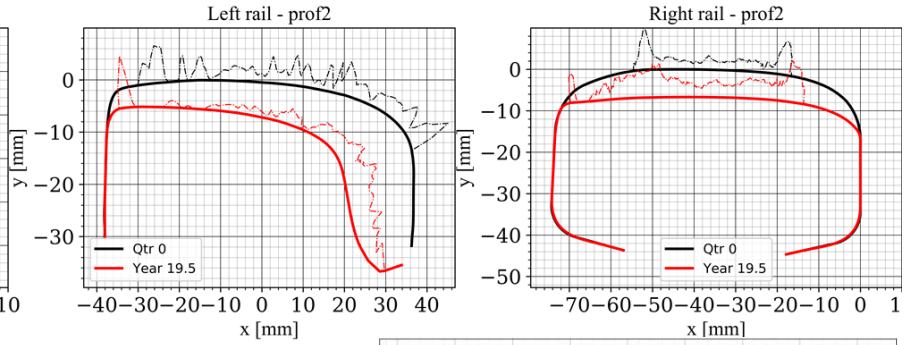
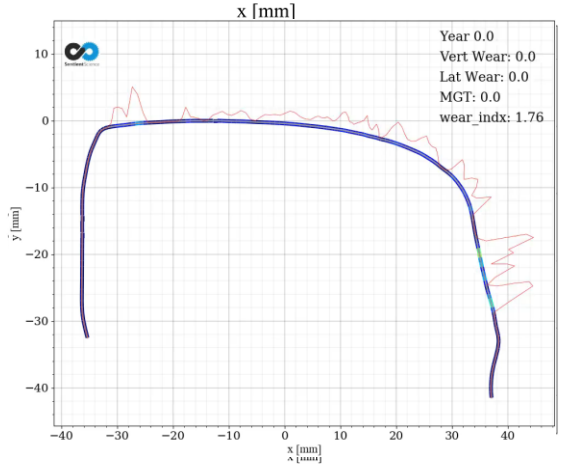
Approach: Life Extension of Higher GQI Profile

Group 1 - Profile A – 89.19 GQI & 615 AMGT Life



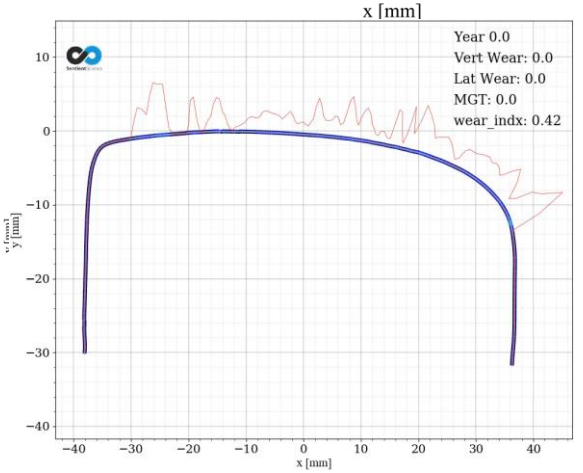
Group 1 - Profile B – 98.54 GQI & 1011 AMGT Life





- 73% Life Extension of Profile B
- 10% Higher GQI of Profile B
- Lateral Wear is Limit in Both Profiles

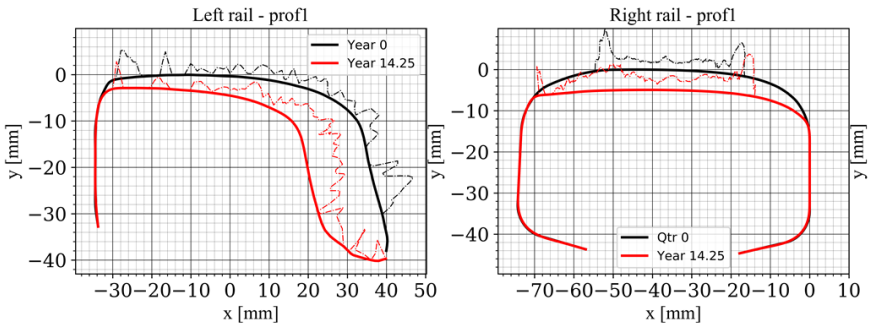
- $45,909 Net Present Value Net Savings
- $5,739 NPV Savings per Year of Life



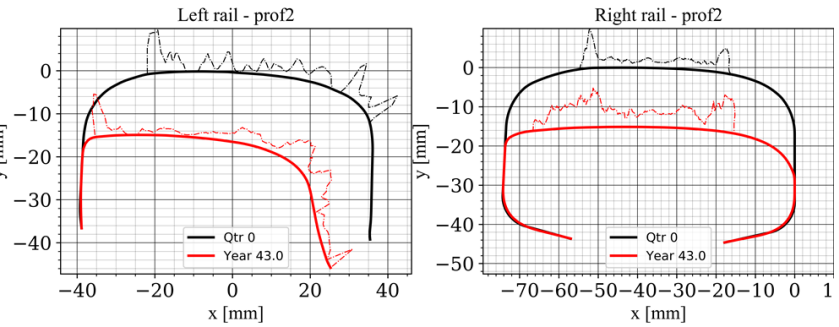
DigitalClone for Rail

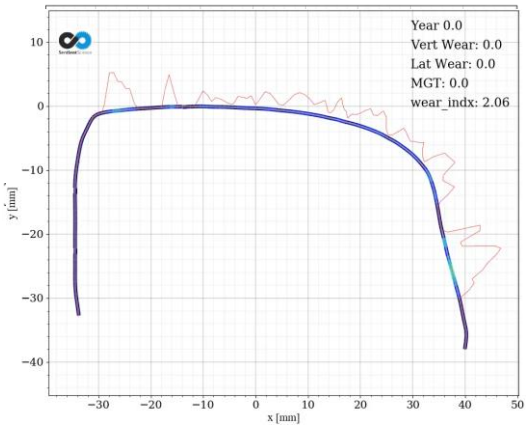
Approach: Significant Life Extension of New Profile

Group 2 - Profile A – 84.7 GQI & 738 AMGT Life



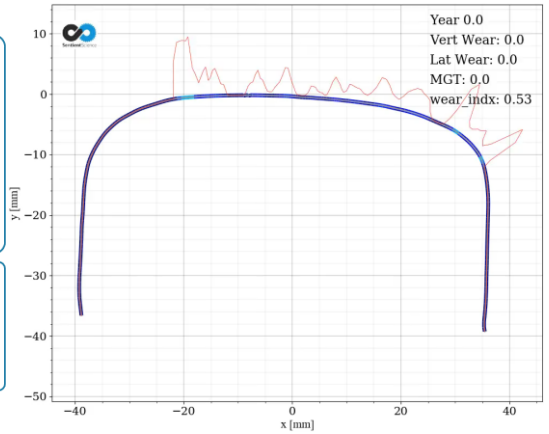
Group 2 - Profile B – 87.78 GQI & 2,235 AMGT Life





- 302% Life Extension of Profile B
- 3.6% Higher GQI of Profile B
- Limit Transfers from Lateral to Vertical

- $76,963 Net Present Value Net Savings
- $2,749 NPV Savings per Year of Life

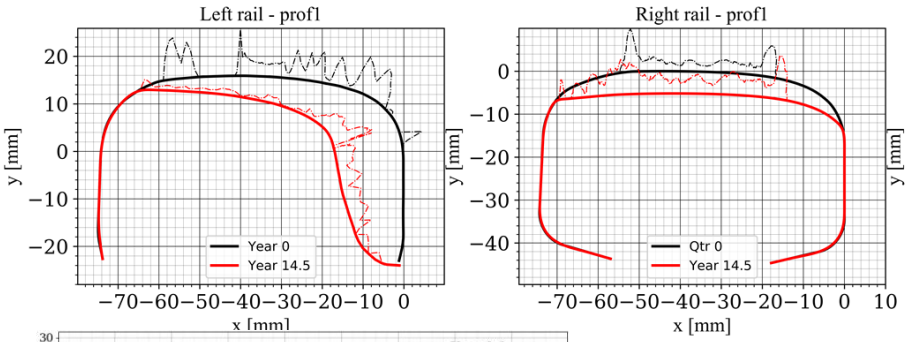


DigitalClone for Rail

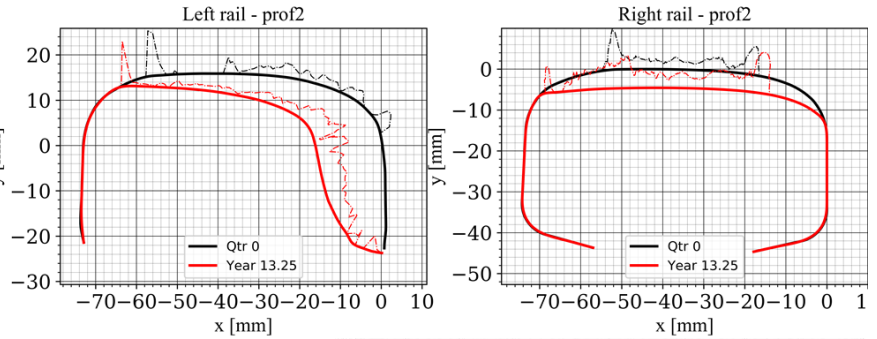
CSX

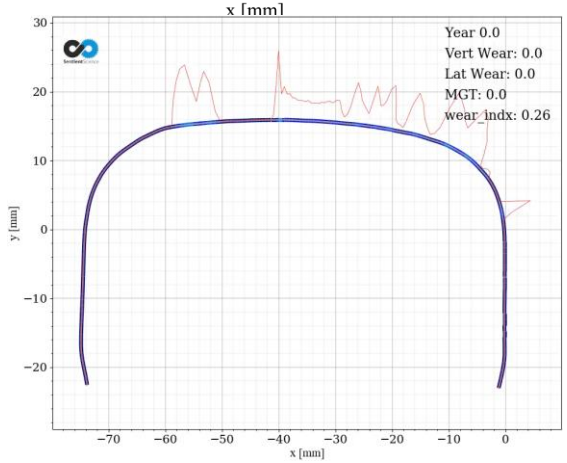
Approach: Reduced Life Extension at Lowest GQI

Group 5 - Profile A – 67.17 GQI & 760 AMGT Life



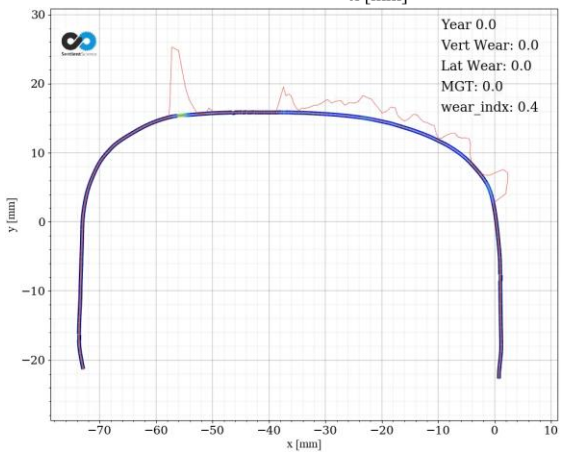
Group 5 - Profile B – 71.28 GQI & 690 AMGT Life





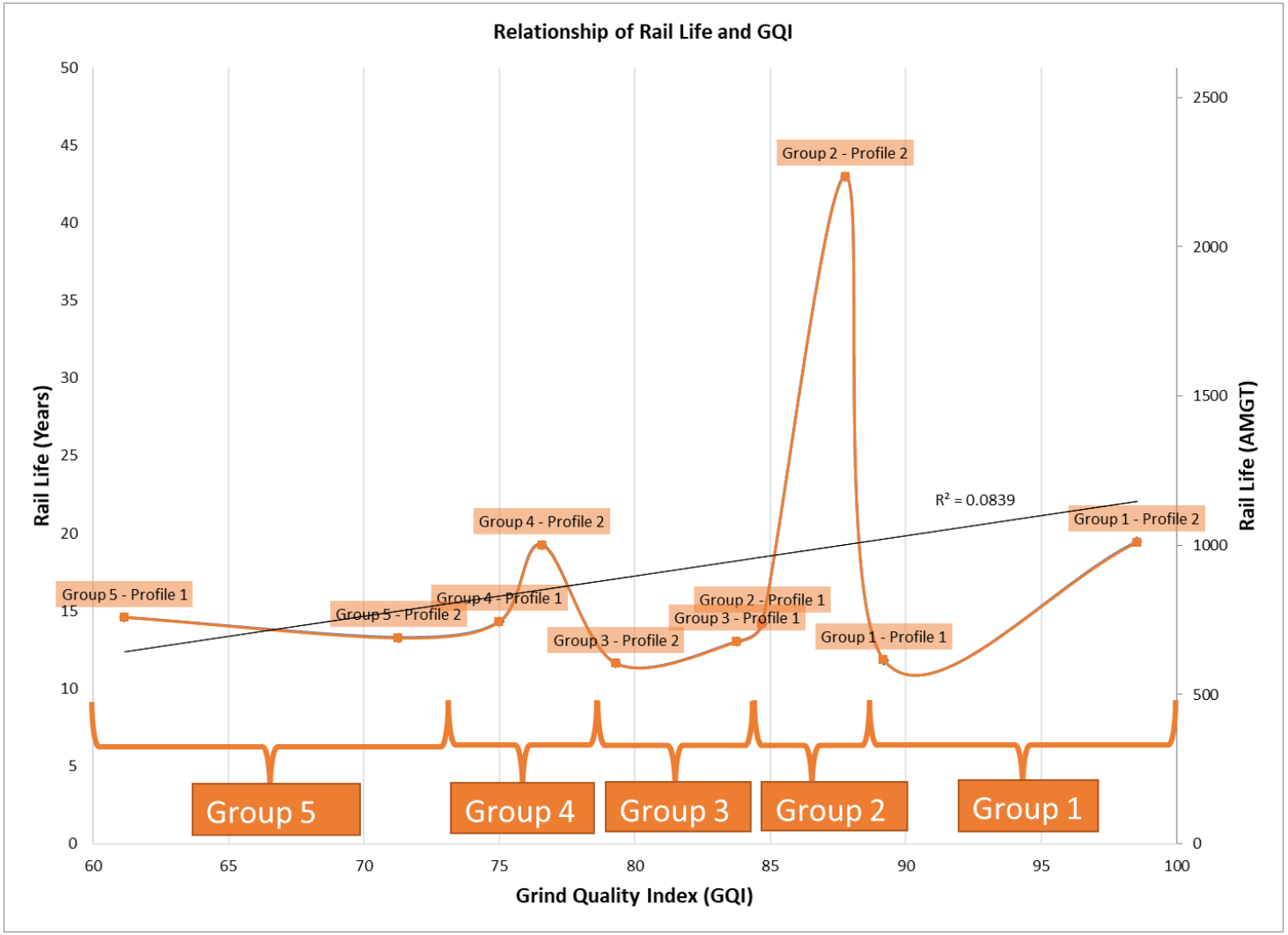
- 9% Life Decrease of Profile B
- 6.1% Higher GQI of Profile B
- Lateral Wear is Limit in Both Profiles

- -$6,268 Net Present Value Net Savings
- -$6,268 NPV Savings per Year of Life



DigitalClone for Rail

Outcome: Trend of GQI Level vs. Rail Life



Key Discussion Topics

- Optimal Profile Increases Rail Life
- Location of Wear on Profile Critical
- High Variance of Profile Shapes
- How to identify the outlier shapes to eliminate the negative rail life?
- Should different types of track geometry (curves) have different scoring techniques?