Efficient and Effective Grinding through Infinite Pattern Control

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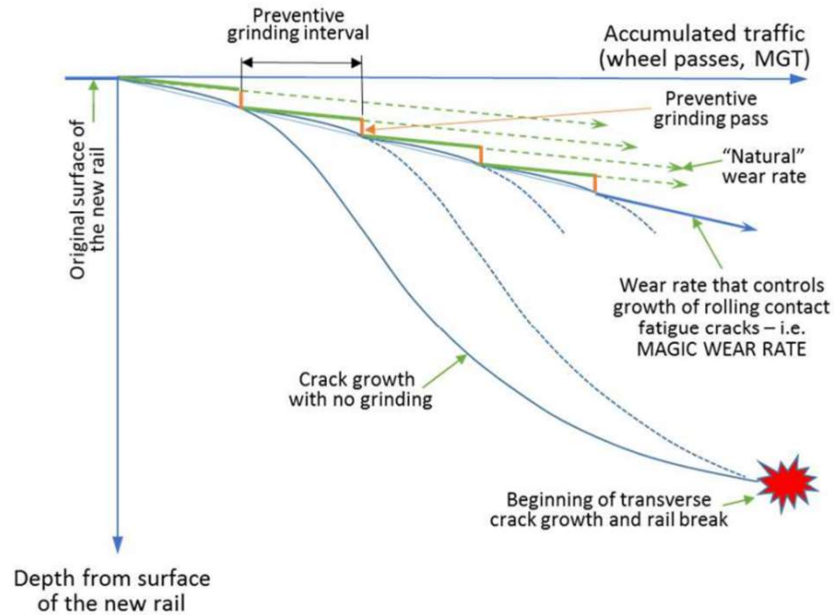
Why Grind

Rail grinding leads to an extension of rail life by

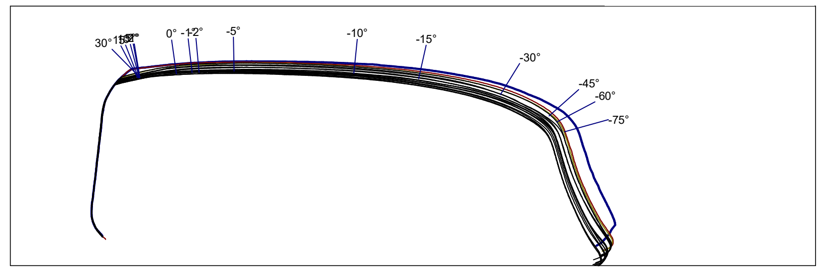
- Removing rolling contact fatigue (RCF) on the surface of the rail
- Maintaining the optimal rail profile

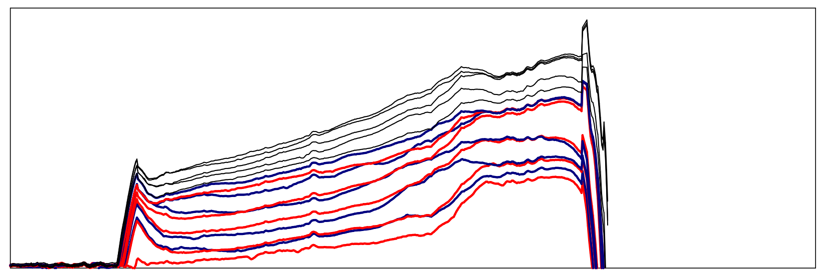


E. Magel, J. Kalousek, P. Sroba, "Chasing the Magic Wear Rate", in J. Pombo, (Editor), "Proceedings of the Second International Conference on Railway Technology: Research, Development and Maintenance", Civil-Com p Press, Stirlingshire, UK, Paper 116, 2014. doi: 10.4203/ ccp.104.116

Optimized Rail Profile (AREMA Best Practices)

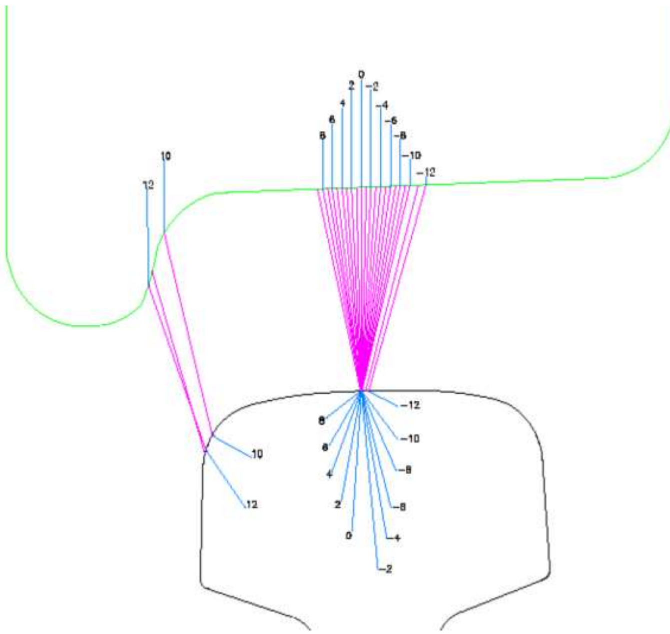
Rail wear due to tonnage causes rail-surface plastic flow and surface fatigue (spalling, shelling, and head checks) and increases the internal stresses in the rail that initiate rail defects, including transverse defects in the railhead





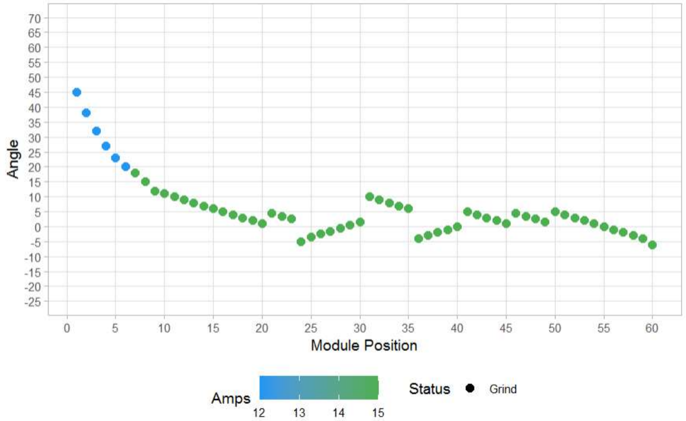
Optimized Rail Profile (AREMA Best Practices)

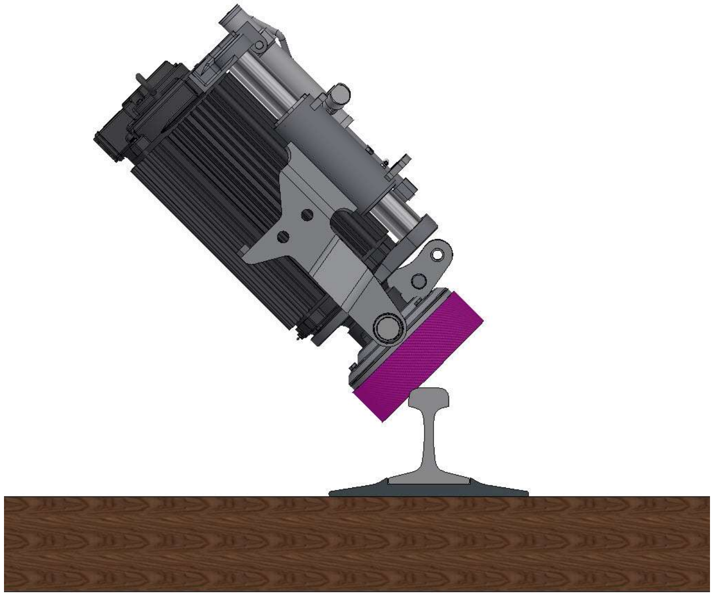
Maintaining designed transverse rail profiles (templates) optimized over expected wheel profiles through rail grinding leads to reduced contact stress, improved vehicle stability in tangent track, and improved wheelset curving

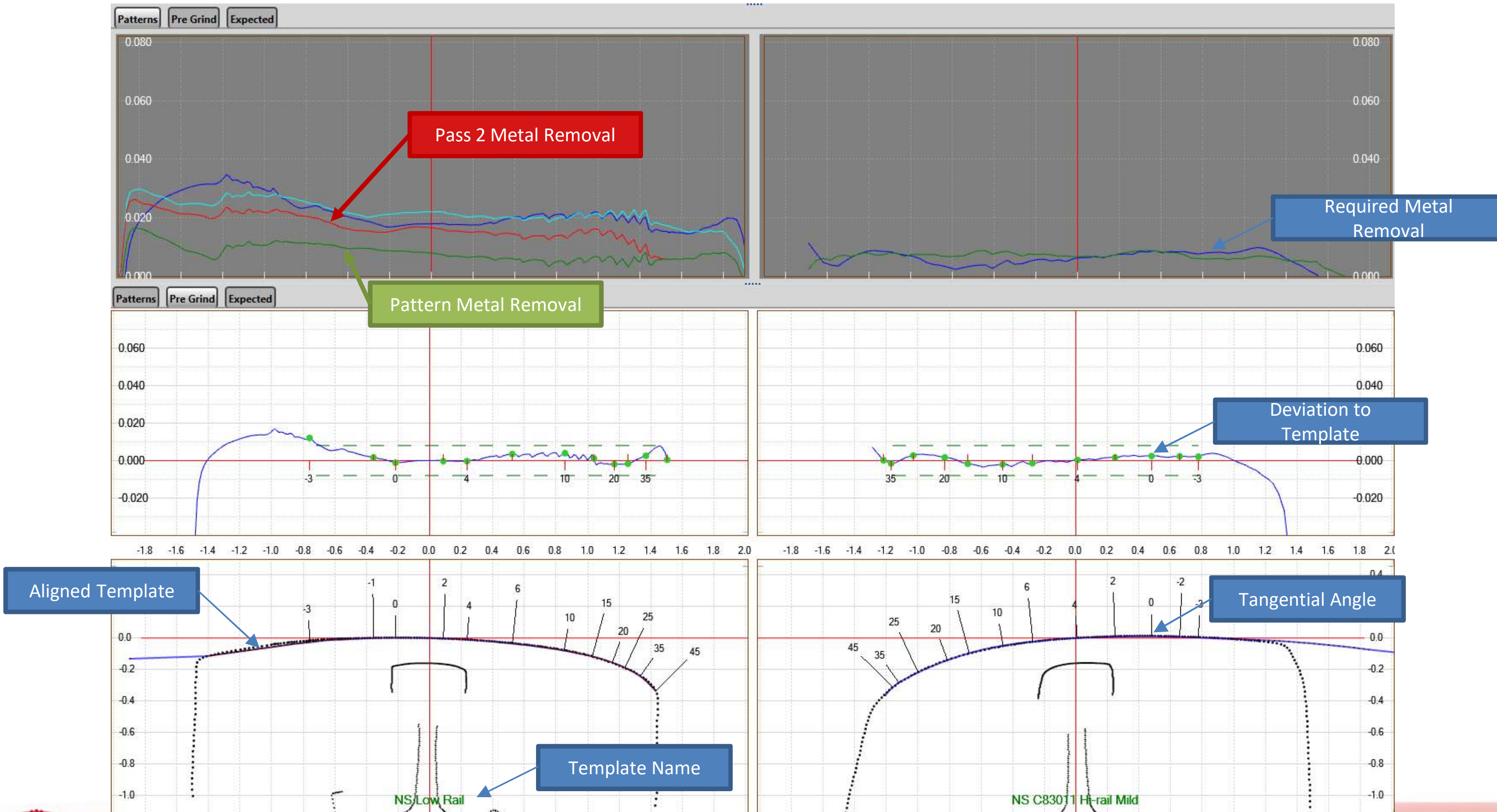


Grind Patterns

A grind pattern is a distribution of grind modules at specific angles and amps throughout a rail grinder used to grind to a template

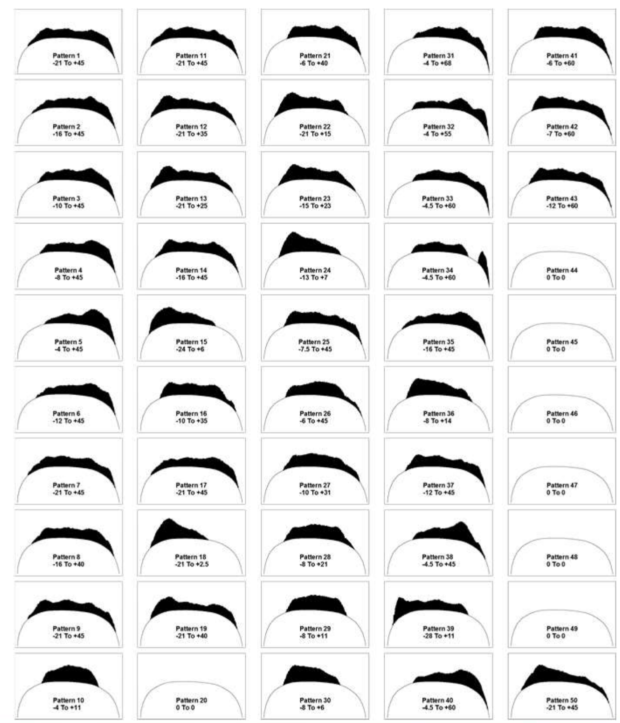





Patterns
Pre Grind
Expected
Pass 2 Metal Removal
Pattern Metal Removal
Required Metal Removal
Deviation to Template
Aligned Template
Tangential Angle
Template Name
NS Low Rail
NS C83011 Hi-rail Mild

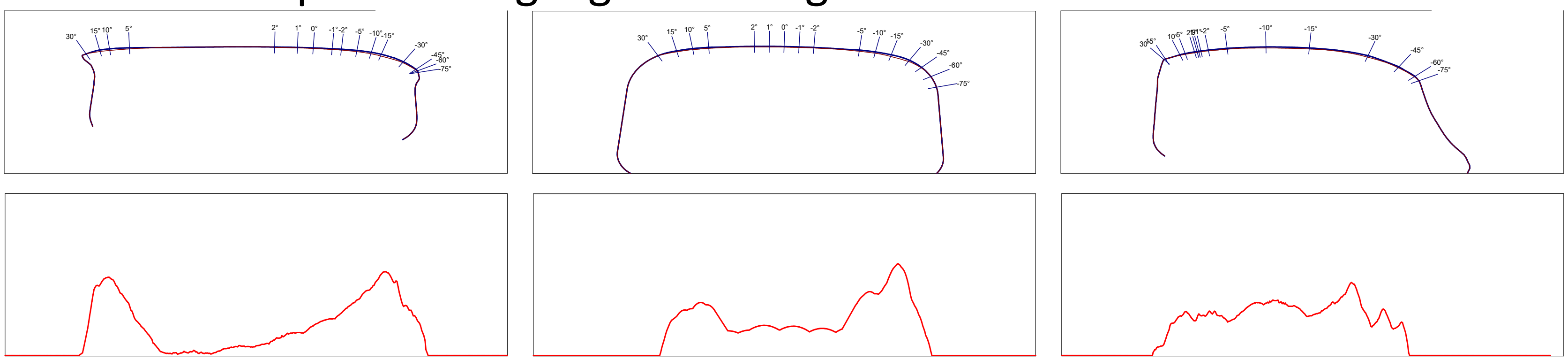
Pattern Selection (Static)

- Up to 50 patterns
- Grind speeds called at 1 mph increments
- Patterns chosen to “fit” required metal removal
- Ensure minimum depth of cut is achieved



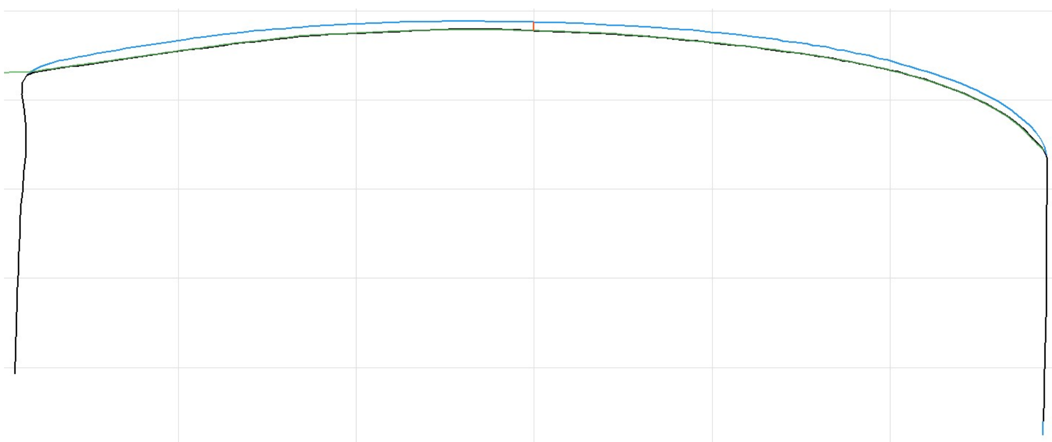
Pattern-Rail Interaction

- A pattern does not give consistent metal removal depending on the rail shape
- The same pattern can yield completely different metal removal for a flat, low rail compared to a gauge-worn high rail



Pattern Creation (Dynamic)

- Practical infinite number of patterns
- Grind speeds called at 0.1 mph increments
- Patterns systematically created to match desired finish rail profile
- Targets exact required depth of cut



Testing on the Norfolk Southern

NORFOLK SOUTHERN®

- Pattern creation in production on RG417 since 3/31/2019
- 640+ shifts
- 24,000+ finished track miles

Testing on the Norfolk Southern

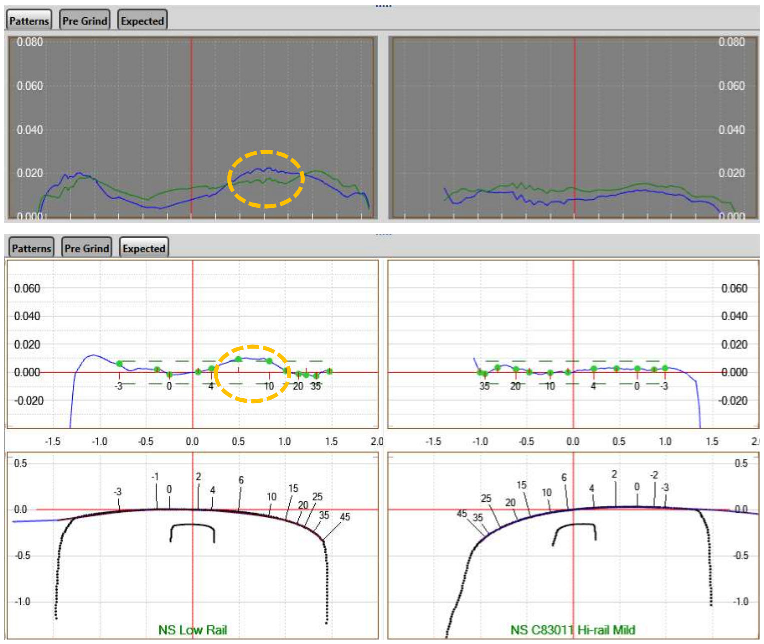
Historical production stats

	Selection	Creation
Timeframe	7/16/2018- 3/30/2019	3/31/2019 - present
PM/Shift	36.35	43.32
TM/Shift	27.78	37.32
Speed	11.74	12.79
OT%	25.6%	28.0%

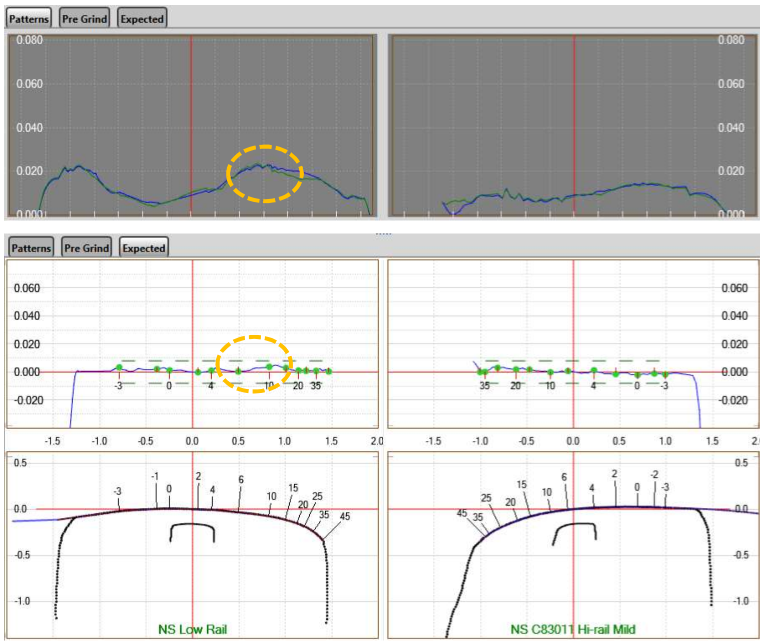
Theoretical coverage over 24 shifts

Red line indicates coverage with Pattern Selection over 24 shifts.
Green line indicates ***additional*** coverage with Pattern Creation over the same number of shifts.

Exact Match to the Template

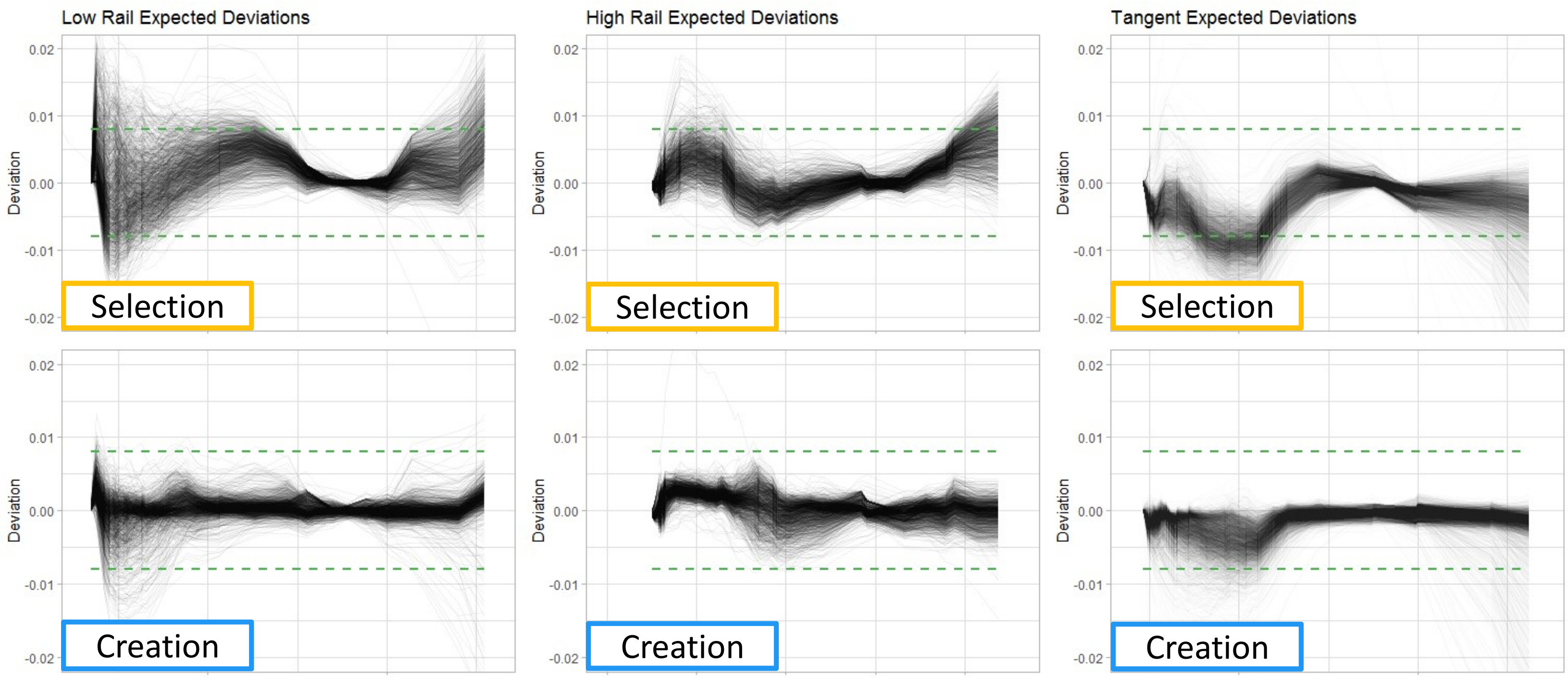


Pattern Selection



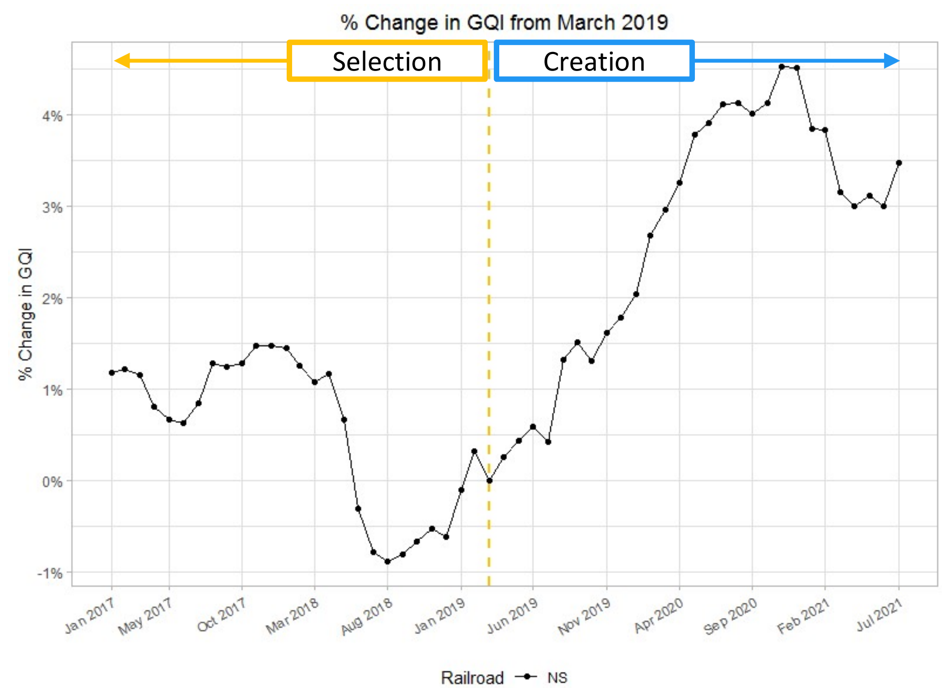
Pattern Creation

Expected Deviations from Template



System Wide GQI

GQI is up by 3.5% since the start of pattern creation and was up as high as 4.5%



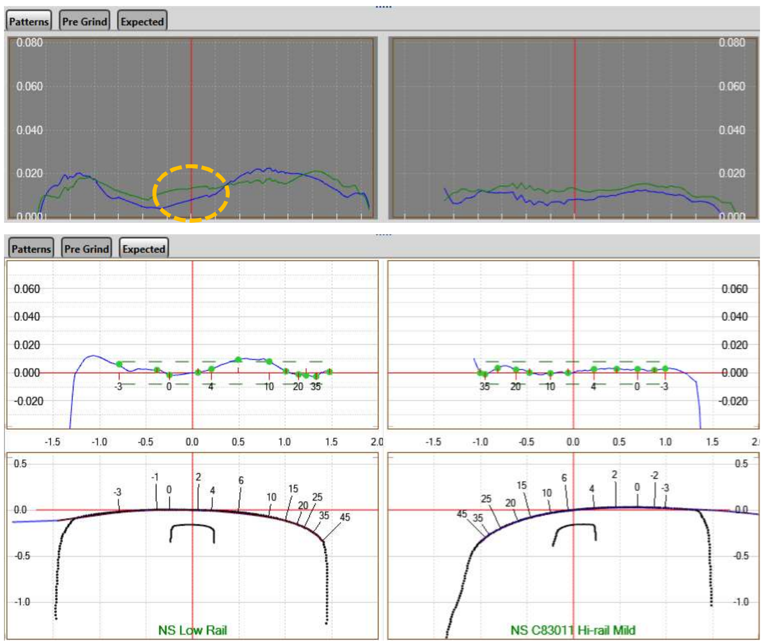
Surface Condition Improvement

- Lower required depths of cut (DOC) indicate less severe RCF on the rail
- Subsequent cycles after pattern creation show a reduction of 4% required DOC on high rails and 6% on low rails

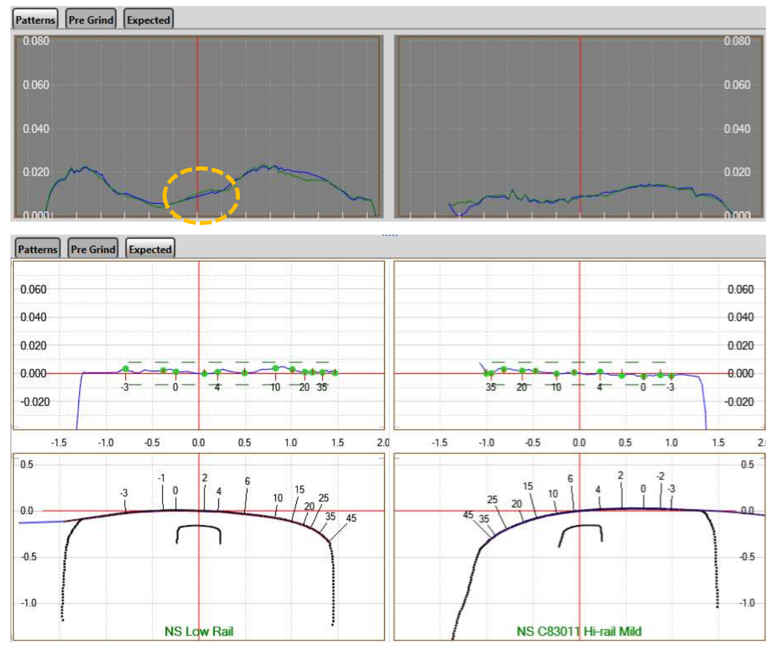
			Required Area		Required DOC		Pregrind GQI	
Subdivision	**LS**	**Rail Side**	**Selection**	**Creation**	**Selection**	**Creation**	**Selection**	**Creation**
ATLANTA SOUTH	H_s	High	0.0288	0.0252	0.0082	0.0084	93.3	97.8
BLUE RIDGE	N_p	High	0.0238	0.0243	0.0069	0.0070	95.8	97.8
CHARLOTTE-GREENVILLE	0_n	High	0.0344	0.0294	0.0098	0.0092	91.0	94.2
CHRISTIANSBURG	N_p	High	0.0251	0.0259	0.0070	0.0073	94.8	93.9
GREENVILLE-ATLANTA	0_n	High	0.0349	0.0307	0.0100	0.0096	91.5	95.3
KENOVA	N_p	High	0.0242	0.0219	0.0072	0.0071	95.5	98.3
KENOVA	NA_p	High	0.0233	0.0205	0.0070	0.0065	95.6	97.8
NORCROSS	0_n	High	0.0352	0.0278	0.0095	0.0084	89.7	95.5
Average			**0.0287**	**0.0257**	**0.0082**	**0.0079**	**93.4**	**96.3**

			Required Area		Required DOC		Pregrind GQI	
Subdivision	**LS**	**Rail Side**	**Selection**	**Creation**	**Selection**	**Creation**	**Selection**	**Creation**
ATLANTA SOUTH	H_s	Low	0.0392	0.0376	0.0080	0.0097	90.4	94.4
BLUE RIDGE	N_p	Low	0.0316	0.0306	0.0075	0.0073	93.8	94.2
CHARLOTTE-GREENVILLE	0_n	Low	0.0555	0.0392	0.0113	0.0098	84.1	93.0
CHRISTIANSBURG	N_p	Low	0.0406	0.0407	0.0082	0.0077	86.4	80.9
GREENVILLE-ATLANTA	0_n	Low	0.0560	0.0417	0.0121	0.0104	84.5	91.9
KENOVA	N_p	Low	0.0290	0.0259	0.0072	0.0066	93.5	94.8
KENOVA	NA_p	Low	0.0268	0.0247	0.0071	0.0065	95.6	95.9
NORCROSS	0_n	Low	0.0553	0.0426	0.0104	0.0100	77.3	90.0
Average			**0.0418**	**0.0354**	**0.0090**	**0.0085**	**88.2**	**91.9**

Exact Required Depth of Cut



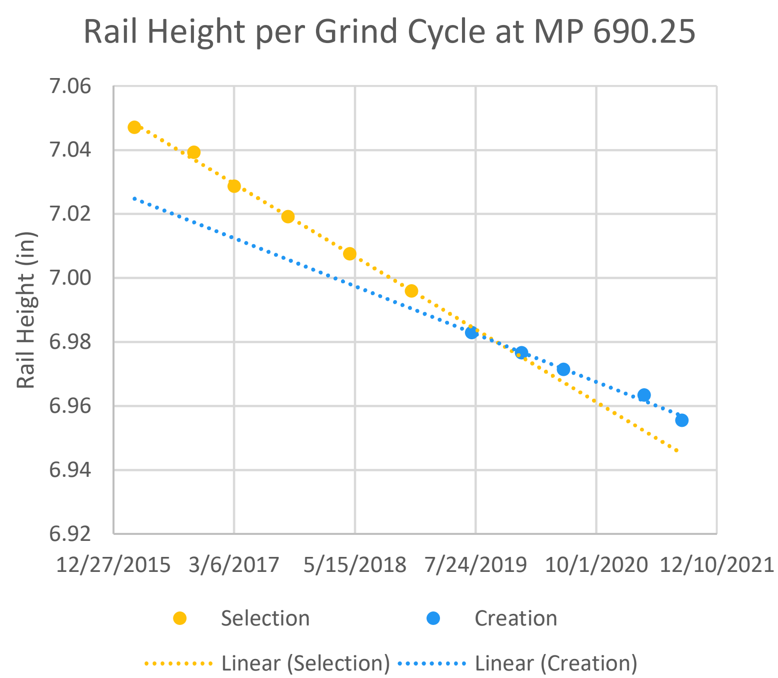
Pattern Selection



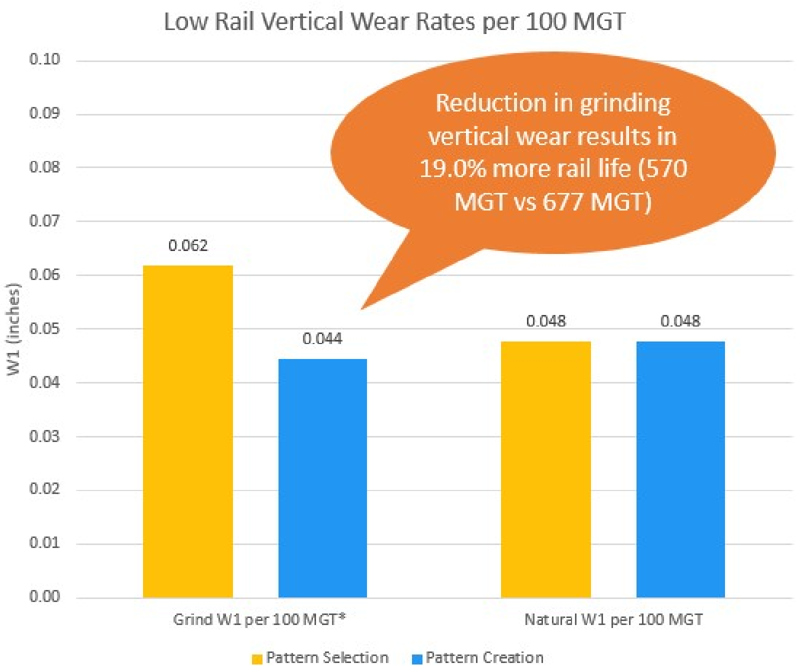
Pattern Creation

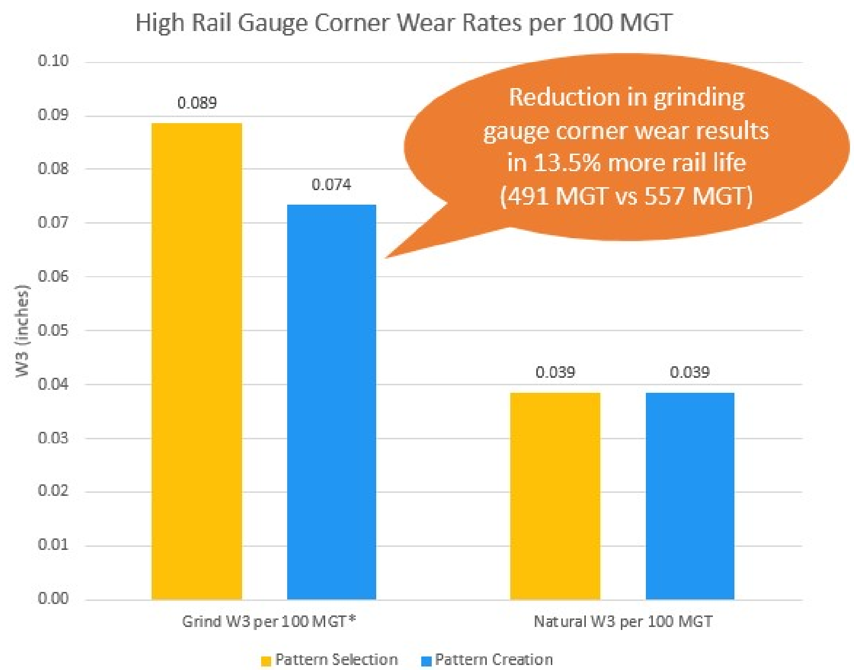
Low Rail Example – Columbus N690.1 T1

Measuring the rail height on the low rail at curve N690.1 on Main Track 1 on the Columbus subdivision over 11 equally spaced grind cycles indicates a reduction in vertical wear rates since the change to Pattern Creation



Rail Life Increase





*Grind wear estimated based on expected metal removal on same inspections using pattern creation and pattern selection

Conclusions

- Creating patterns allows a rail grinder to be flexible enough to reach an almost exact match to the prescribed template
- Field testing evidence shows
  - A more productive rail grinder to help keep grinding on preventive cycles
  - Improved finished grind quality with respect to profile
  - Improved surface conditions in subsequent cycles
  - Rail life increases by grinding the precise amount of metal required

Thank you!

Special thanks to the Norfolk Southern and Brandon Sherrod for their cooperation in field testing over the past two years

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