Class I Prospective

(UIUC Symposium)

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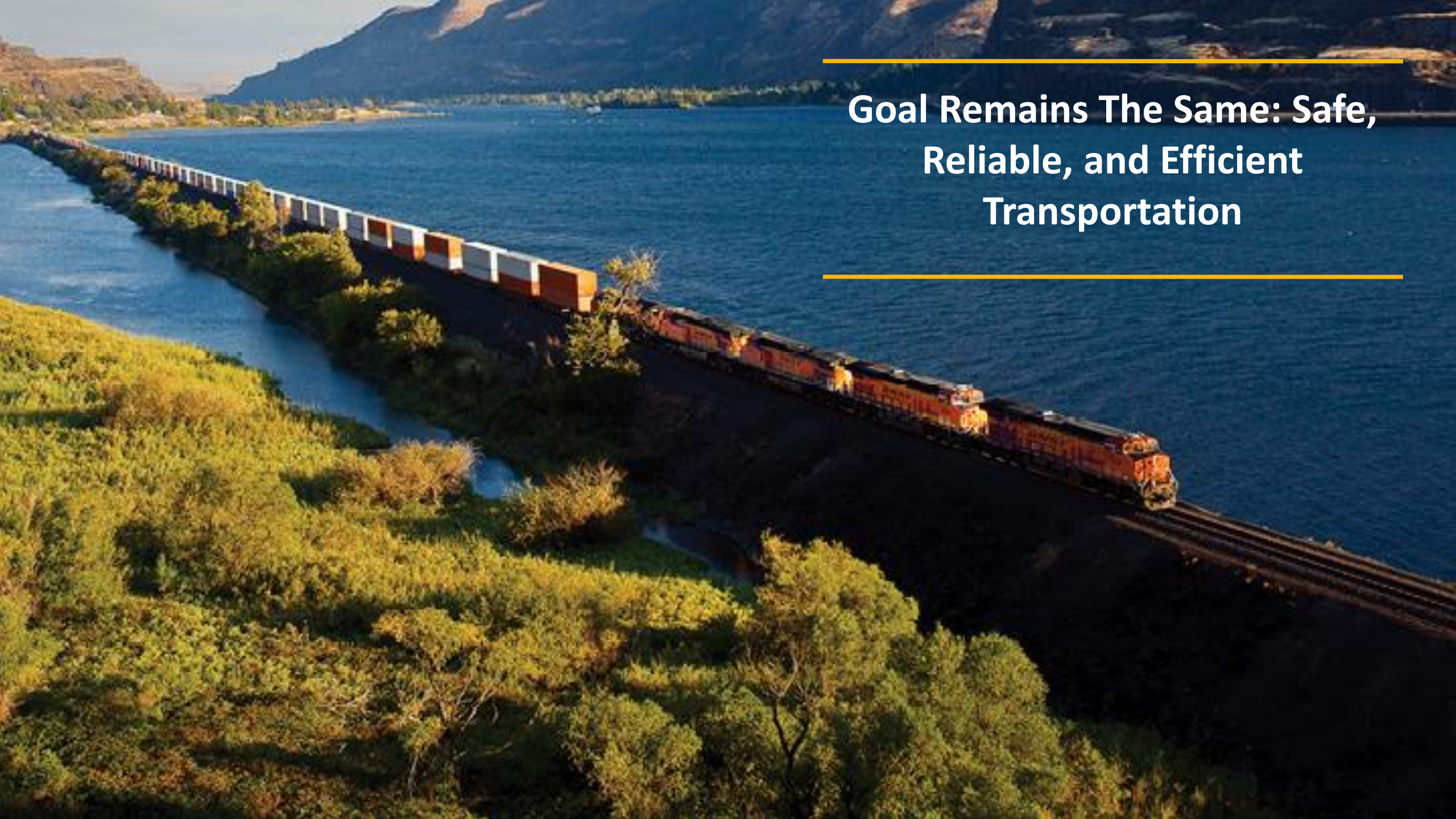
Crosstie / Fastening System Design & Performance Future Trends

The Business Is Always Changing



Goal Remains The Same: Safe, Reliable, and Efficient Transportation

Overview

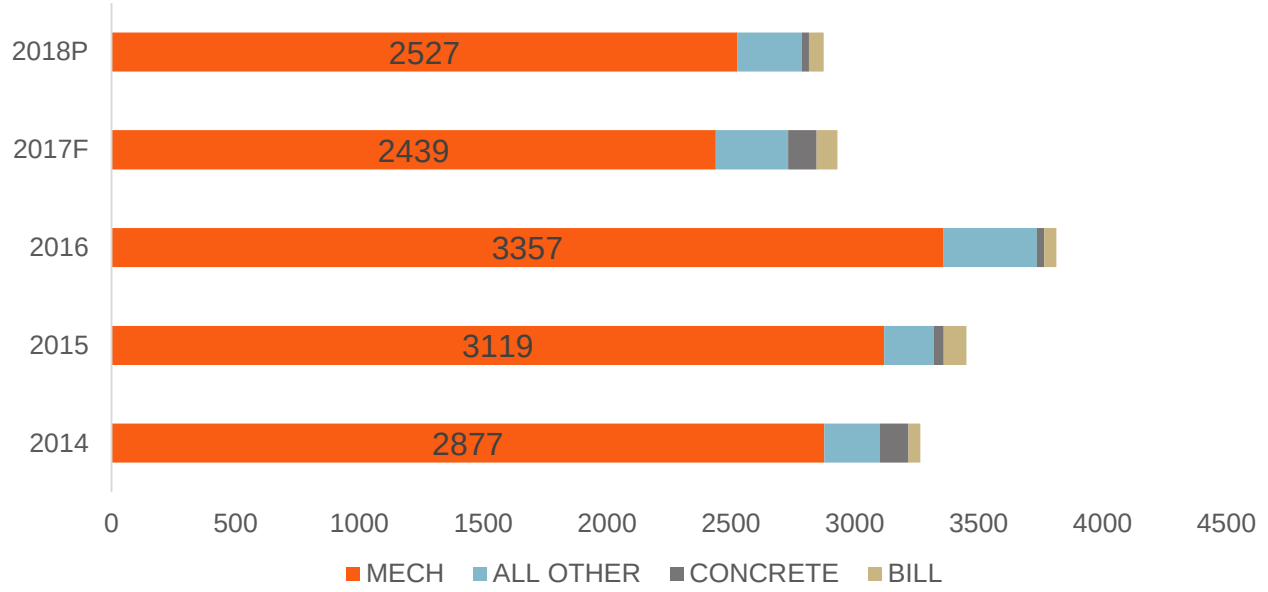
- Created on Sept. 22, 1995 with the Merger of the BN & ATSF
- Acquired by Warren Buffett on Feb. 12, 2010 and became part of the Berkshire Hathaway Family
- 32,500 Route Miles Primarily in the Western 2/3 of the US, 28 States & 3 Canadian Provinces
- 160 Plus Years Old Company Comprised of over 390 Predecessor Roads
- CB&Q Aurora Branch Feb. 12, 1849

Ties by the Numbers - Mains

- 76,000,000 Wood Ties
- 11,000,000 Concrete Ties
- 50,000 Composite, Steel, and Other
- In total approximately 12,500,000 Concrete Ties Installed. (Concrete Ties Used in New Yard Tracks & Others Retired)
- Concrete Tie Installations have ranged from 140,000 to 850,000 per year. The near term outlook is reduced and is expected to be in the lower range. However as traffic increases demand increases with expansion.
- Wood Tie Replacement between 2.5M – 3.5M per year, Dual Treatment to Drive Down Replacement.

Maintenance Replacement Ties

- Reset the Network / Tie Blocks, Transportation Knows What to Expect
- Normalized Wood Tie Replacement
- Borates and Wood Tie Life Extension – (Downward Trend)
- Opportunity to Better Understand Failure Modes With Longer Wood Tie Life and to Adopt Standards Accordingly
- Opportunity to Better Understand Concrete Performance at Maturation



	MECH	ALL OTHER	CONCRETE	BILL
2014	2877	225	115	48
2015	3119	200	41	91
2016	3357	378	30	49
2017F	2439	292	116	83
2018P	2527	260	28.1	60

Cross Tie & Fastening System

- Important to Recognize them as a System Working Together Over Their Life Cycle / Opportunity For Improved Fasteners as Rail Life and Tie Life Increases
- Ease of Use With Rail Change Cycles
- Multi Pronged Approach With Diverse Network
- Manage Tie Type and Track Feature Transition Zones
- Consistency In Fabrication and Installation (Small Changes Have Lasting Impacts)
- Life Cycle Cost

Traditional Wood Ties & Cut Spikes Are Hard to Beat

- Evolution of Dual Treated Ties to Prolong Life
- Cost Per Mile to Maintain vs Change to Alternate Ties
- Opportunity to Improve Anchoring For Longer Rail Life
- Match Plate Size to Tie Wear For Longer Tie Life
- Longest History / Best Understood / Cost

Black Gum Tie w/ 1941 Date Nail In East Texas

- 19 ½” spacing
- 7”x 9”x 8’-6”
- Cut Spikes
- Unit V Common Anchor
- Curve block all curves, every 3rd tie high and low rail
- 14” AREMA plate
- Step and Half Treating Process (Borate / Creosote)

Concrete Ties

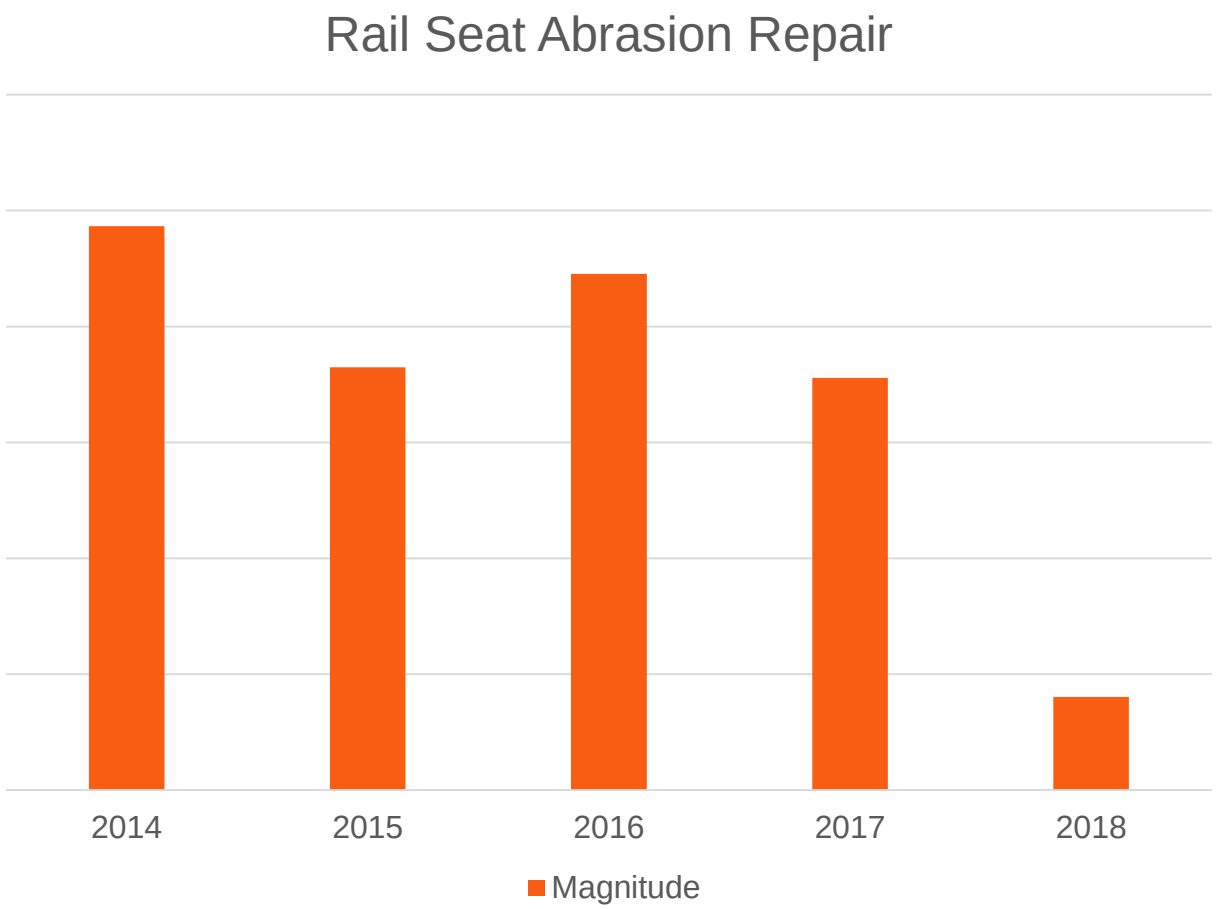
- Traditionally Long Line Production
- Looking To The Next Generation Tie – Post Tensioned Carrousel Production – Cost Competitive - Higher Deflection Range, Additional Capacity, Eliminates Transfer Length
- Padding – Opportunity For Understanding Cost / Benefit
- SKL Fastening Systems (Opportunity to Reuse OTM)
- Opportunity for Improved Field Production / Shorter Track Windows / Less Disruption to Transportation

Concrete Tie Use Guidelines

- Curves >= 2º 30’
- Curves >= 2º w/1% grade Curves
- 2º w/70 MPH or greater speeds
- Middle track of at least 3-MT territory where both track centers are <= 18-feet and ties are due for mechanical replacement.
- Curves with chronic gauge deviations.
- Rail and tie cycles are due concurrently to warrant concrete tie installation.
- Harden tracks through and adjacent to terminals.
- Other Primary Corridors
- Expansion

Rail Seat Abrasion Repair – Concrete Ties

- Analytics / Ability to Predict Timing of Repairs
- Better Planning
- Changing Traffic Mix
- Lubrication Management / Reduced Stress State
- Improved Replacement Materials / Innovative Products



Composites

- Currently Best Opportunity Is For High Rot Zones
- Our Experience Is that Predrilling is Required
- Cut Spikes and Anchors
- Must Perform Interspersed With Wood Ties
- Cost Premium / Service and Maintenance Life Still Unknown
- Continue to Test and Evaluate / Interesting New Products on The Market / Consistency in Fabrication

Steel

- Predominately Used in Yard Turnouts on BNSF
- Alternative for High Rot Zones, Opportunity for Increased Use
- Elastic Fasteners
- Ability to Hold Gage - Minimal Future Maintenance
- Proper Installation Imperative
- Cost Competitive With Alternatives

Turnouts

- Predominately Wood Ties / Ease of Prefabrication / Panelization, Delivery & Installation
- Evaluating Concrete on High Use Corridors in Concrete Tie Territory
- Pandrol Plates and E – Clip Fasteners with Coach Screws
- Common Standard w/ UPRR
- Always Opportunities For Improved Ties, Anchoring, Transition Zones, and Plating With Tie Life Extension

End of Two Main Trks Winona Jct. 60 mph #24 Equilateral

Track Measurement / Testing Overview

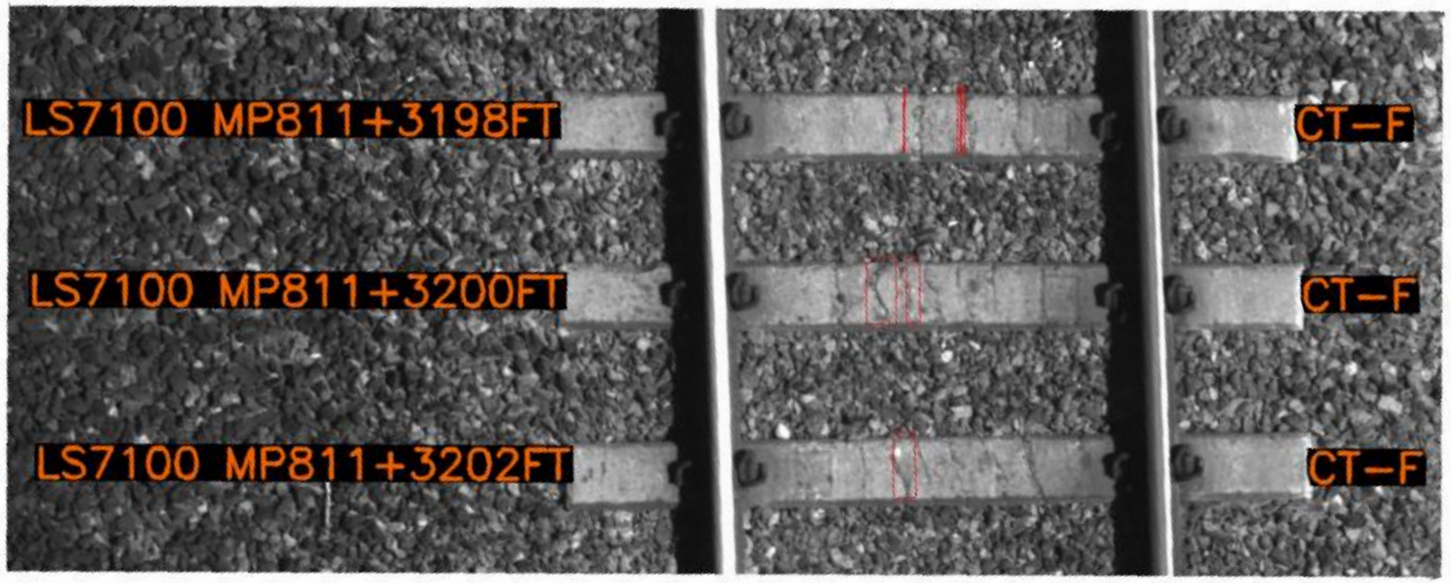
More Testing More Data

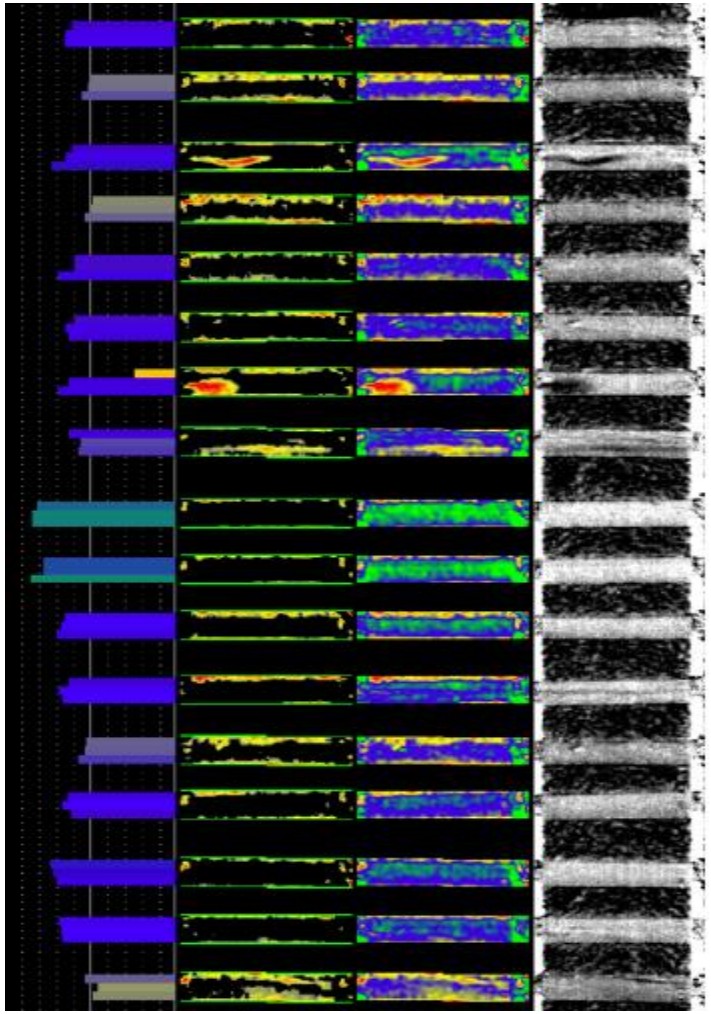
- 3 Manned Geometry Cars
- 2 Unmanned Geometry Cars
  - Operate 24/7
  - Data is analyzed by managers in our NOC in real time
- Various BNSF and Contractor Hyrail Vehicles
- Analytics / Degradation Models / Granular Comparative Analysis
- Base Gage and Rail Cant

Technology Advancements Examples

- Aurora Tie Inspection
- Drones

Event Summary	
Aircraft / Payload Number	N610BN-HD50-00064
Date	03/29/2018 11:43 UTM
Event	Concrete Tie Condition
Division	SOUTHWEST CLOVIS
Track	MAIN TRACK 2
Curvature	0° 0'
Latitude	34.65362486
Longitude	-105.58891046
Position	LS7100 MP811+3198FT
Severity	Red Tag - Defect
Number of Ties	3
Image	2018_03_29__11_43_59/24/02458.jpg





Tie & Fastening Systems (Consider The Achilles Heel)

- In Greek mythology, when Achilles was a baby, it was foretold that he would die young. To prevent his death, his mother Thetis took Achilles to the River Styx, which was supposed to offer powers of invulnerability, and dipped his body into the water; however, as Thetis held Achilles by the heel, his heel was not washed over by the water of the magical river. Achilles grew up to be a man of war who survived many great battles. One day, a poisonous arrow shot at him was lodged in his heel, killing him shortly afterwards.
- *When designing tie and fastening systems it is imperative to consider potential future failure modes as a complete system during its service and maintenance lifecycles.*

Thank You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