Evaluating Comprehensive Track Inspection Vehicles for Transit Operations

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June 18, 2019

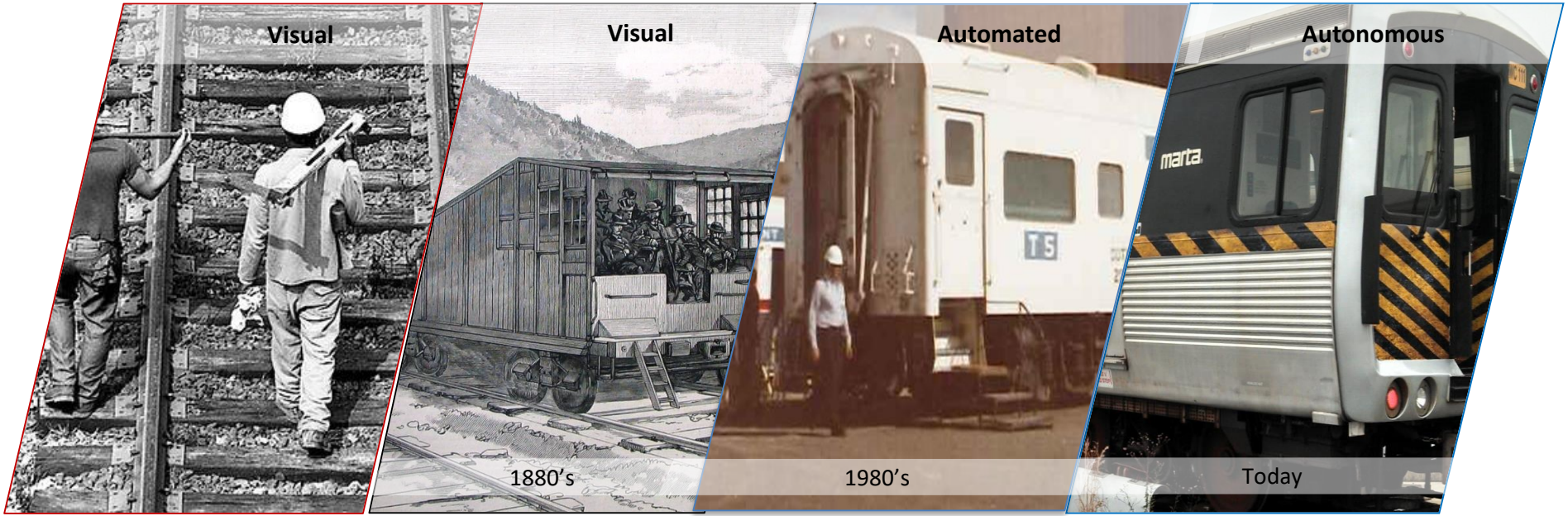
Evaluating Comprehensive Track Inspection Vehicles for Transit Operations

- History & Evolution of Track Inspection
- Comprehensive Track Inspection Vehicle Platforms
- Typical Comprehensive Track Inspection Systems
- Future of Track Inspection

Key Presentation Take-Aways

- The Value of Comprehensive Track Inspection Vehicles….more effective and efficient when compared to single use Track Inspection Vehicles
- The Future of Track Inspection….emergence of Autonomous Track Inspection and Automated Data Management Technologies provide for next level improvements including:
  - Earlier identification of anomalies through more frequent inspections;
  - More efficient inspections at much lower overall costs;
  - Planned maintenance instead of reactive maintenance, resulting in fewer emergency repairs and slow orders.

History & Evolution of Track Inspection



Manual

Dedicated Manned Inspection Vehicles

Autonomous Track Inspection

Comprehensive Track Inspection Vehicles

Multiple Inspection Technologies installed onboard a single track inspection vehicle

PROS

- Lower Cost of Implementation (Single Vehicle vs. Multiple Vehicles)
- Reduced Track Occupation Time as multiple test conducted simultaneously
- Data Alignment as all data referenced back to common GPS/Localization.

CONS

- Vehicle downtime impacts all systems
- Special considerations needed to collect data at the same speed (Ultrasonic and Track Geometry on same vehicle)

Comprehensive Vehicle Platforms

Hi-Rail Manned

Railbound Manned

Autonomous

Comprehensive Vehicle Platforms

Hi-Rail Manned

Road/Rail Travel

Maximum Flexibility on Distributed Network

Railbound Manned

Maximum space for multiple systems.

Self-Propelled:
Survey routing flexibility

Towed Coach:
Maximum speed at lower costs

Autonomous

Lowest vehicle costs (revenue vehicles)

Lowest operational and maintenance costs

Sample Hi-Rail Inspection Vehicle Layout

Operator Station

Driver View Video

Signaling & Communication Inspection

Track Component Imaging

Rail Surface Imaging

Track Geometry Measurement

Rail Profile Measurement

Joint Bar Imaging

Sample Hi-Rail Inspection Vehicle Layout

Operator Station

Ultrasonic
Rail Flaw

Zero-Speed Track Geometry
Rail Profile
Deployable Gage Restraint
Measurement System

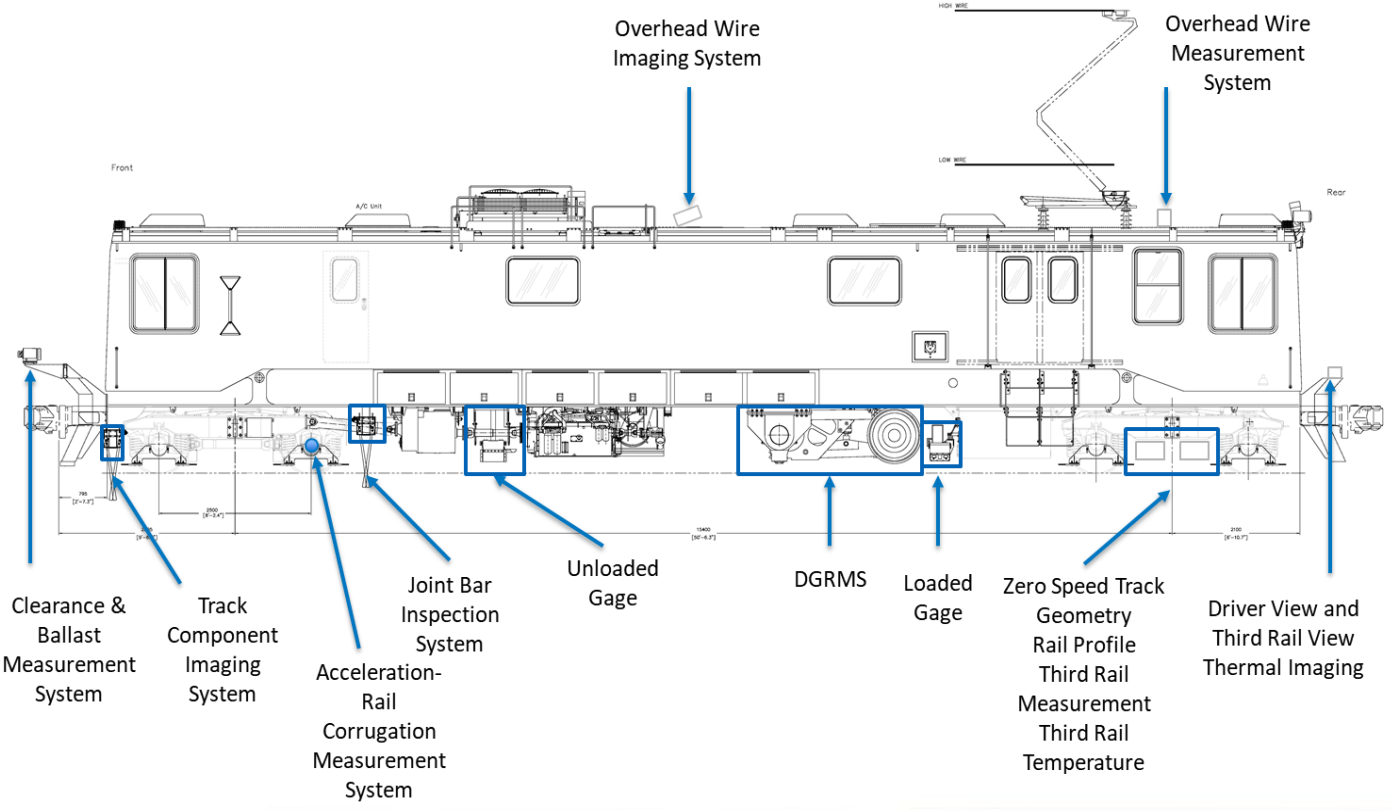
Sample Self-Propelled Railbound Vehicles

Four Axle

Two Axle

Two Axle

Sample Railbound Inspection Vehicle Layout



Sample Railbound Inspection Vehicles

US – Washington D.C.
Eight (8) Inspection Systems Onboard:

- Zero-Speed Track Geometry
- Rail Profile
- Third Rail
- Thermal Imaging
- Ultrasonic Rail Flaw
- Track Circuit Signal Measurement
- Driver View Imaging
- Platform Edge Measurement

US- New Jersey
Four (4) Inspection Systems Onboard:

- Track Geometry
- Rail Profile
- Driver View Imaging
- Joint Bar Imaging

Sample Railbound Inspection Vehicles

US - East Coast
Five (5) Inspection Systems Onboard various vehicles:

- Track Geometry
- Rail Profile
- Ride Quality
- Right of Way Video
- GRMS

Sample Railbound Inspection Vehicles

US – New York City
Eleven (11) Inspection Systems Onboard:

- Zero Speed Track Geometry
- Rail Profile
- Third Rail
- Driver View, Overhead View, Track Component and Joint Bar Imaging Systems
- Gauge Restraint Measurement
- Rail Corrugation
- Clearance Measurement
- Overhead Wire Measurement

US – New York City
Nine (9) Inspection Systems Onboard:

- Zero Speed Track Geometry
- Rail Profile
- Third Rail
- Ultrasonic Rail Flaw
- Rail Corrugation
- Clearance Measurement
- Driver View, Rail Surface and Thermal Imaging

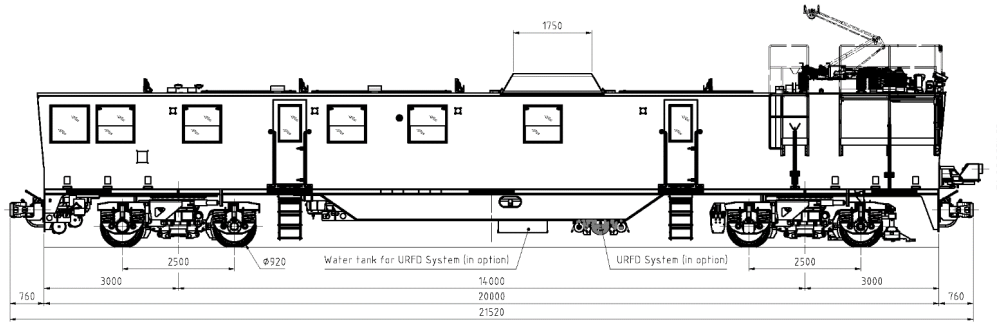
Sample Railbound Inspection Vehicles

Canada – Toronto

Six (6) Inspection Systems Onboard:

- Driver View Imaging (Infrared)
- Thermal Imaging
- Third Rail Imaging
- Joint Bar Imaging
- Rail Surface Imaging
- Track Component Imaging

Sample Railbound Inspection Vehicles



Australia – Brisbane

Eight (8) Inspection Systems Onboard:

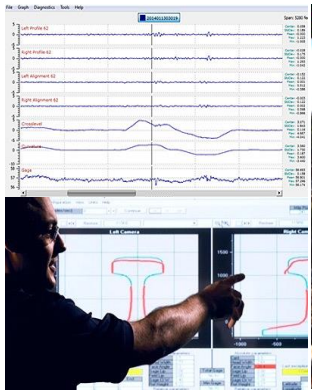
- Zero-Speed Track Geometry
- Rail Profile
- Driver View Imaging
- Track Component Imaging
- OH Wire Inspection
- OH Wire Imaging
- Structure Clearance
- Rail Corrugation

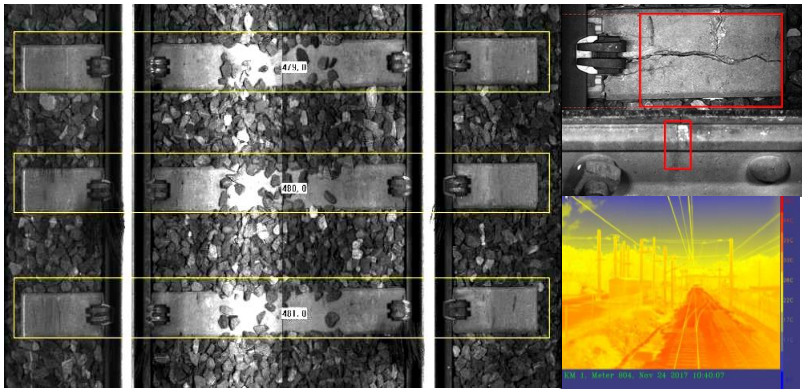
Australia - Melbourne

Eleven (11) Inspection Systems Onboard:

- Zero-Speed Track Geometry
- Rail Profile
- Driver View Imaging
- Track Component Imaging
- Joint Bar Imaging
- Rail Surface Imaging
- OH Wire Measurement
- OH Wire Imaging
- OH Wire Thermal Imaging
- Clearance Measurement
- Rail Corrugation

Typical Comprehensive Track Inspection Systems

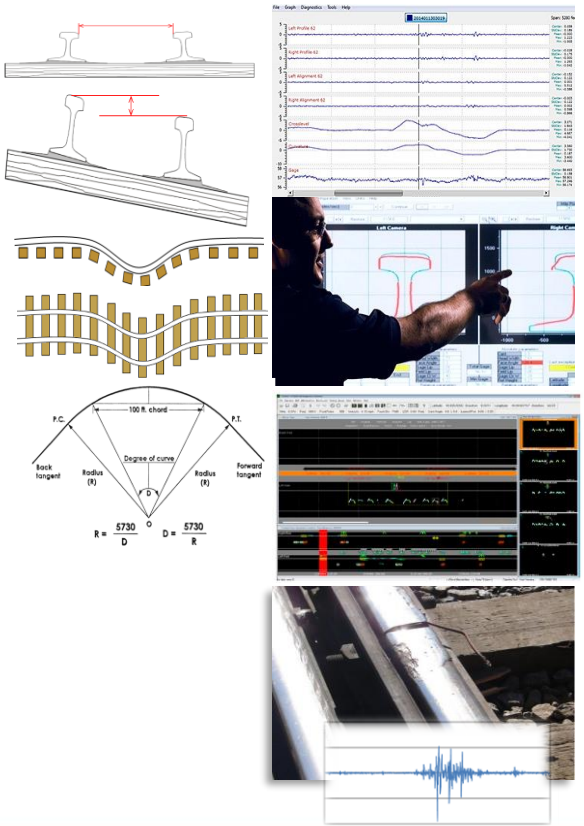




Track Measurement Systems

- **Track Geometry Measurement***
- **Rail Profile Measurement***
- **Vehicle/Track Interaction Monitor (V/TI)***
- **Ride Quality Measurement System***
- **Overhead Wire Measurement System***
- **Third Rail Measurement System***
- **Rail Corrugation Measurement System***
- **Signal and Communication Measurement System***
- Deployable Gage Restraint Measurement Systems
- Clearance & Ballast Measurement System
- Ground Penetrating Radar
- Ultrasonic Rail Flaw Detection (RFD)

**** Indicates can be deployed Autonomously***

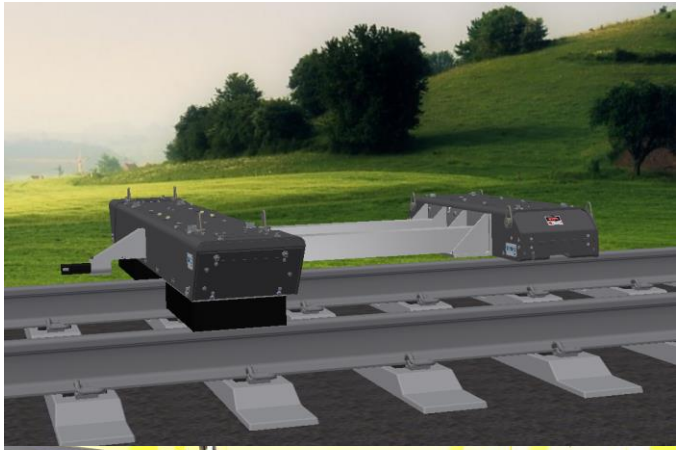


Measurement Systems

Zero-Speed Track Geometry Measurement (Z-TGMS)
Rail Profile Measurement (RPMS)
Third Rail Measurement (TRMS)

Modern Key Features:

- All systems are included in one assembly
- Inertial, non-contact
- Measures all Parameters to zero-speed



Measurement Systems

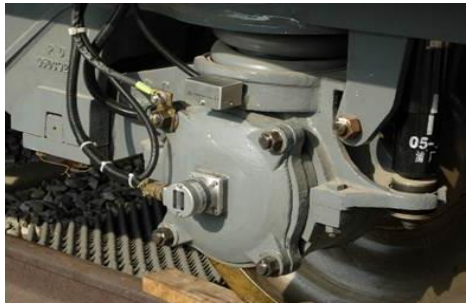
Laser Based Rail Corrugation Measurement System (L-RCMS)
Acceleration Based Rail Corrugation Measurement System (A-RCMS)

Laser Based - Modern Key Features:

- Highest Accuracy
- Multiple wavelength bands for corrugation RMS, Peak-to-Peak, and Space Curve

Acceleration Based - Modern Key Features:

- Lower cost
- Non-optical

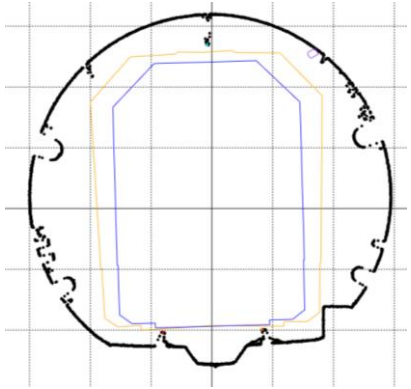


Measurement Systems

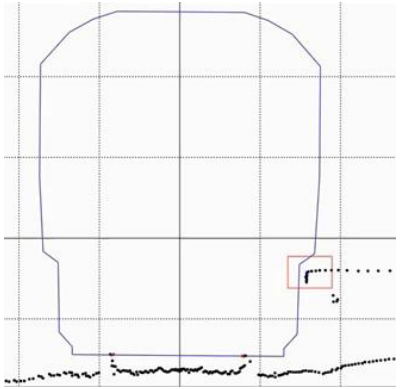
Clearance and Ballast Measurement System (CBMS)

Modern Key Features:

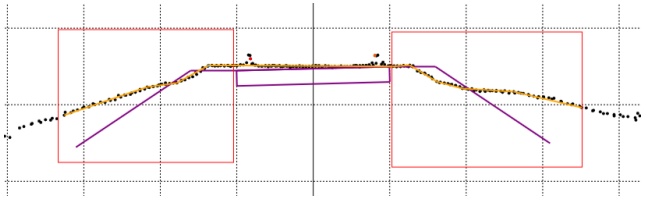
- Lidar lasers
- Onboard clearance encroachment exception detection



Tunnel Clearance



Station Platform Clearance



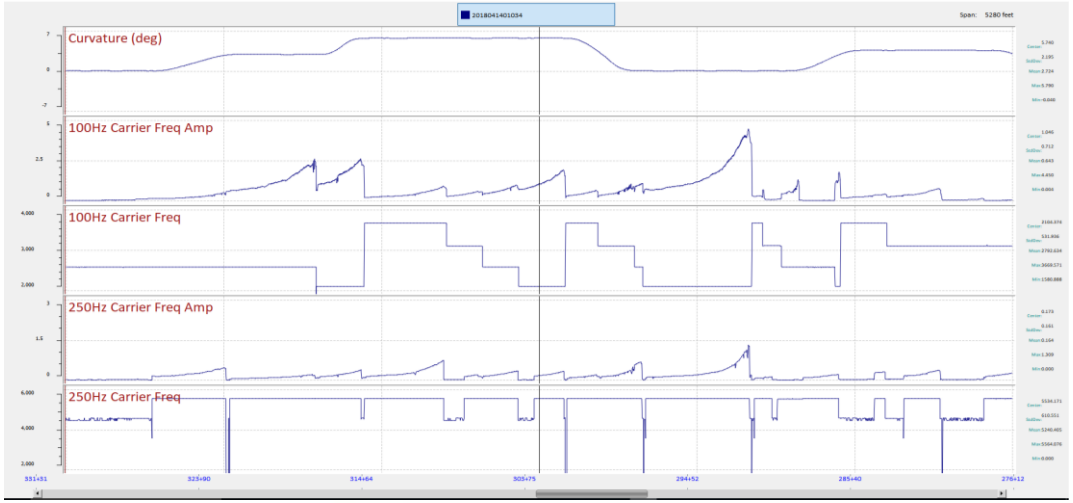
Ballast Profile

Measurement Systems

Signal and Communication Inspection System (SCIS)

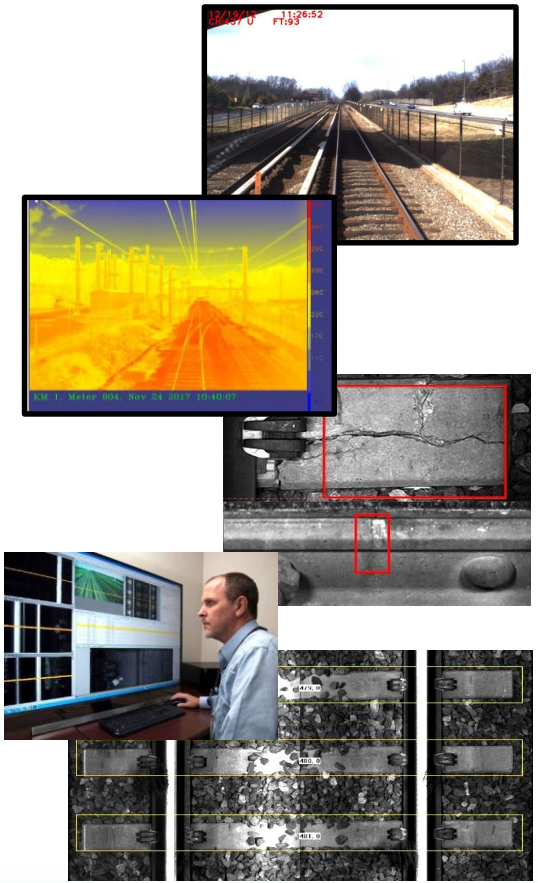
Modern Key Features:

- Measures AC Track Circuits, Train Control Signaling and Wayside Transponders
- Detects train control and signaling deficiencies



Track Imaging Systems

- Rail Surface Imaging*
- Track Component Imaging*
- Joint Bar Imaging System*
- Thermal Imaging*
- Third Rail (Power Rail) Imaging System*
- Driver View Imaging
- Overhead Wire Imaging



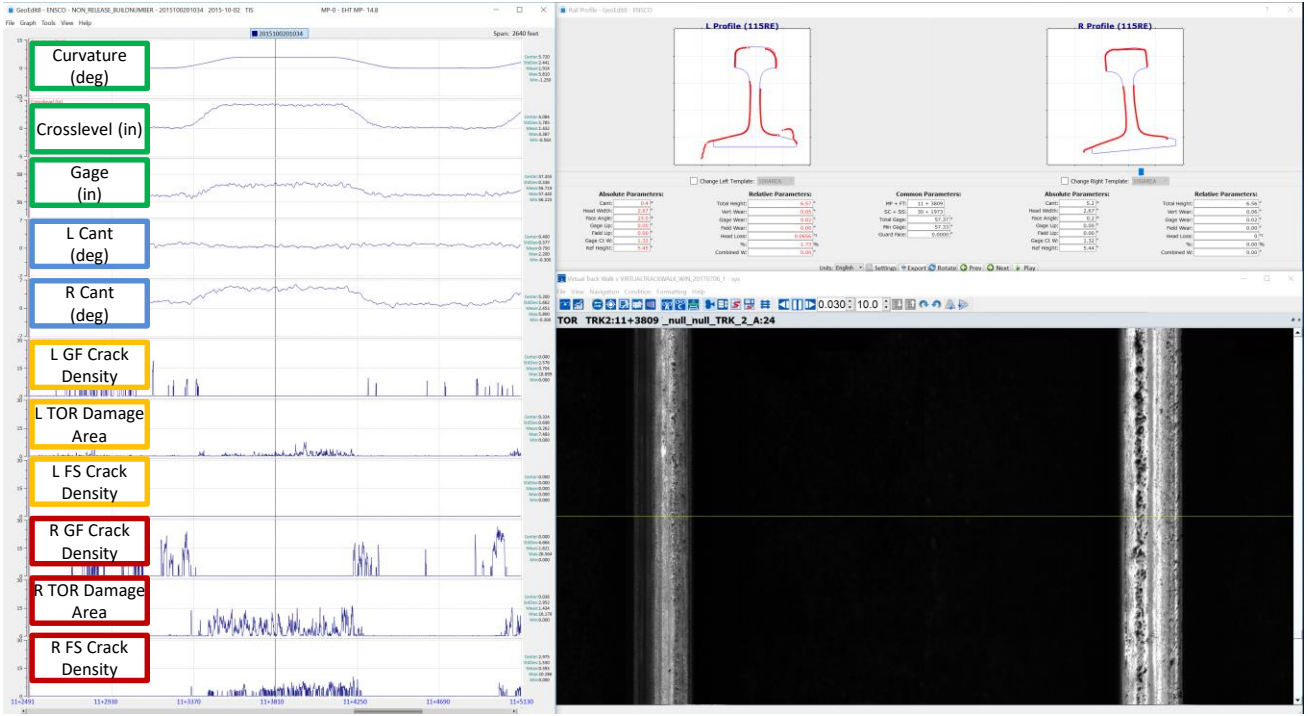
** Indicates can be deployed Autonomously*

Imaging Systems

Rail Surface Imaging System (RSIS)

Modern Key Features:

- Strip chart measurement
- RCF Density
- Surface Damage Area
- Synchronized with rail wear data



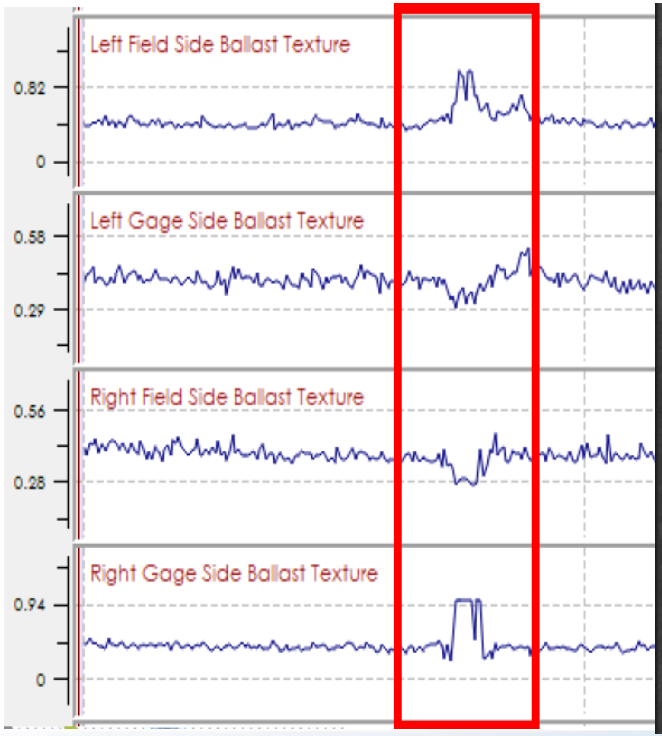
Patent Pending

Imaging Systems

Track Component Imaging System (TCIS)

Modern Key Features:

- Strip chart measurement
- Ballast texture measurement
- Fouled ballast detection



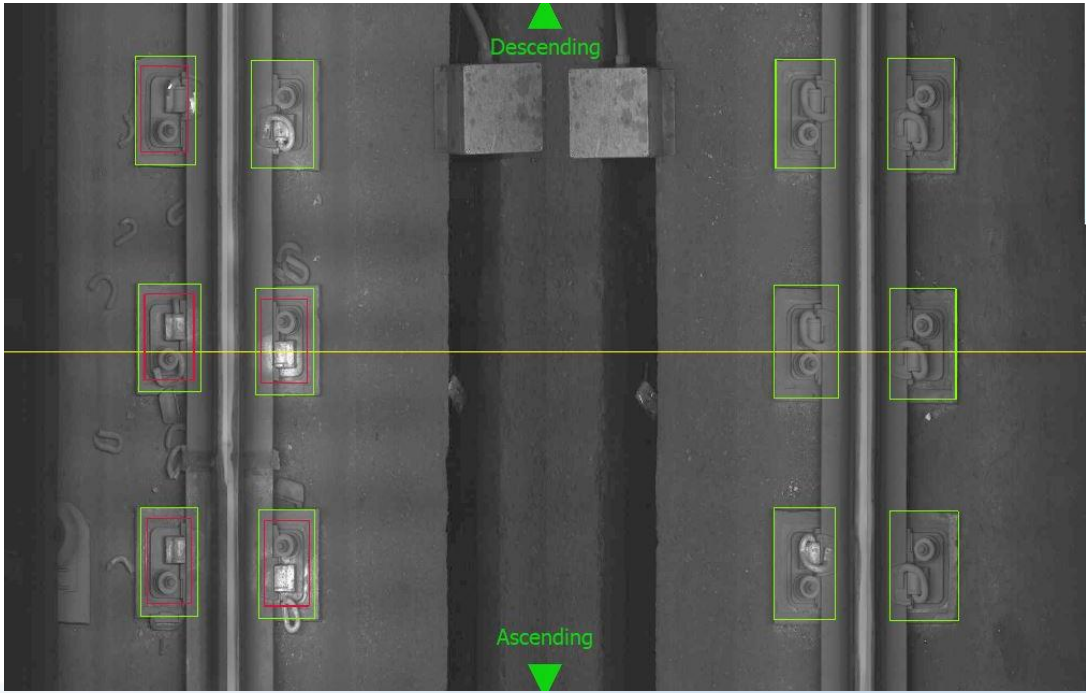
Patent Pending

Imaging Systems

Track Component Imaging System (TCIS)
Joint Bar Imaging System (JBIS)

Modern Key Features:

- Trained algorithms to identify component defects
- Missing Fasteners
- Broken Rail
- Broken/Cracked Joint Bars
- Missing Joint Bar Bolts
- Synchronized with all other systems

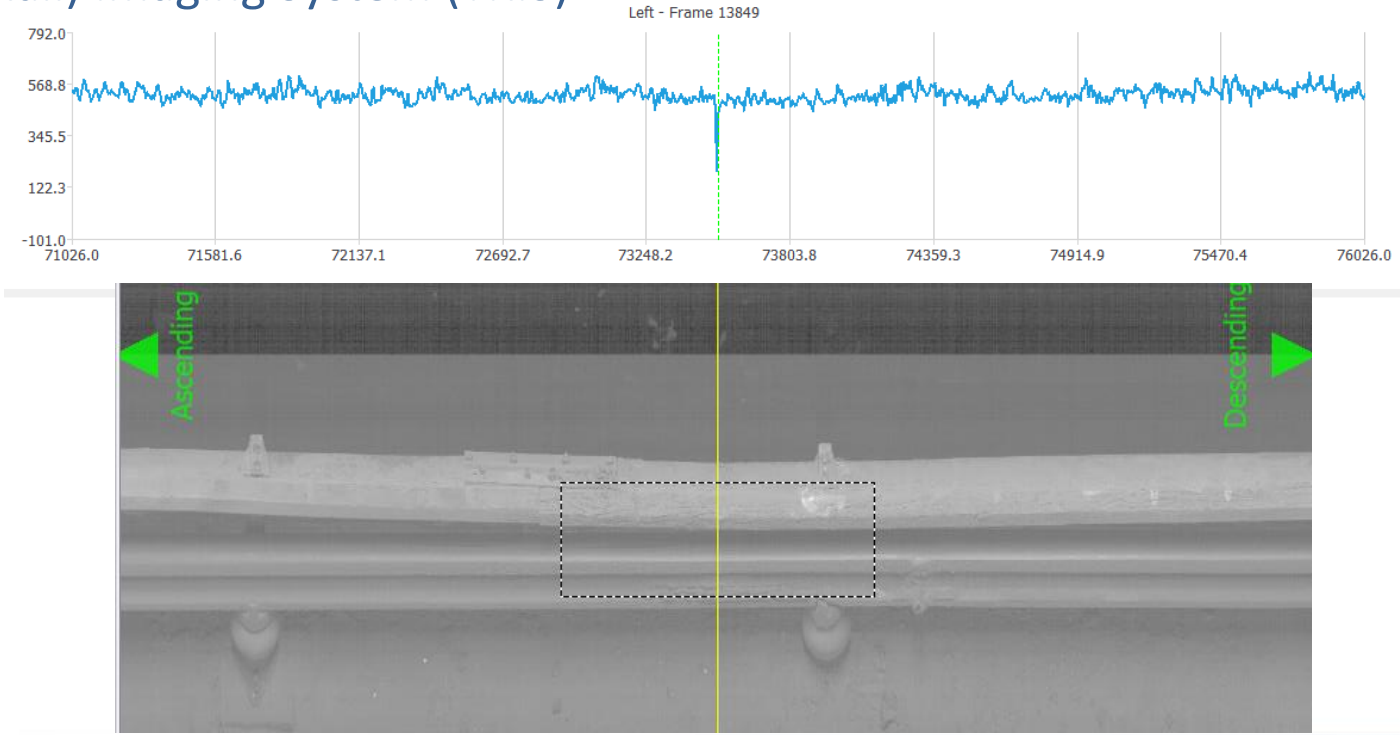


Imaging Systems

Third Rail (Power Rail) Imaging System (TRIS)

Modern Key Features:

- Low Coverboard Detection
- Trained algorithms to identify component defects
- Synchronized with all other systems.



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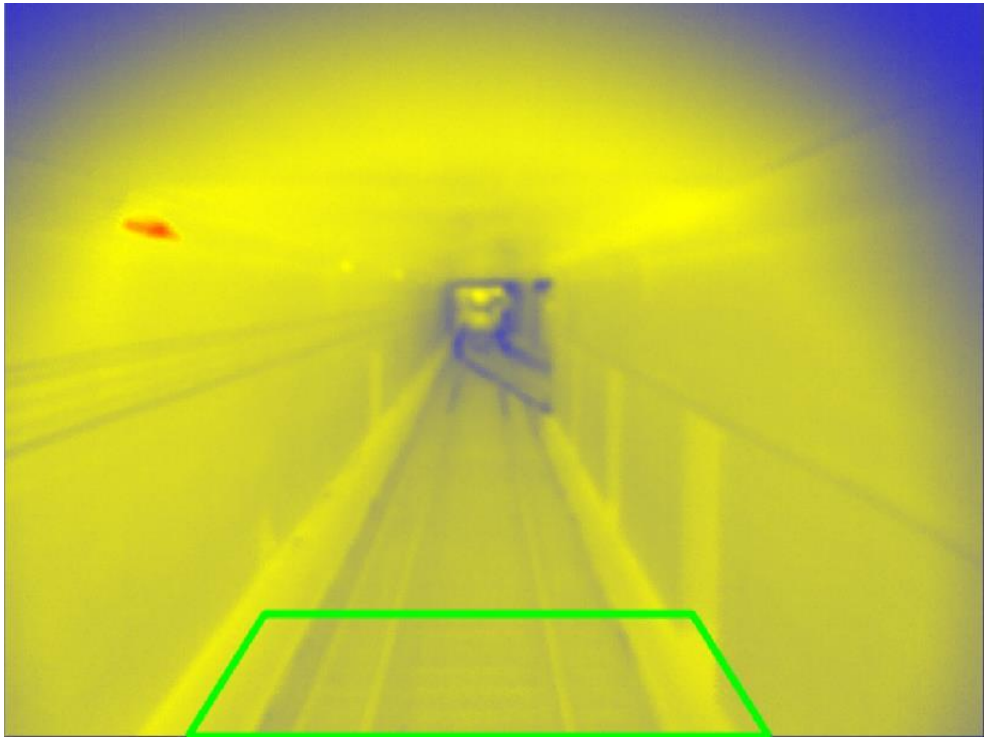
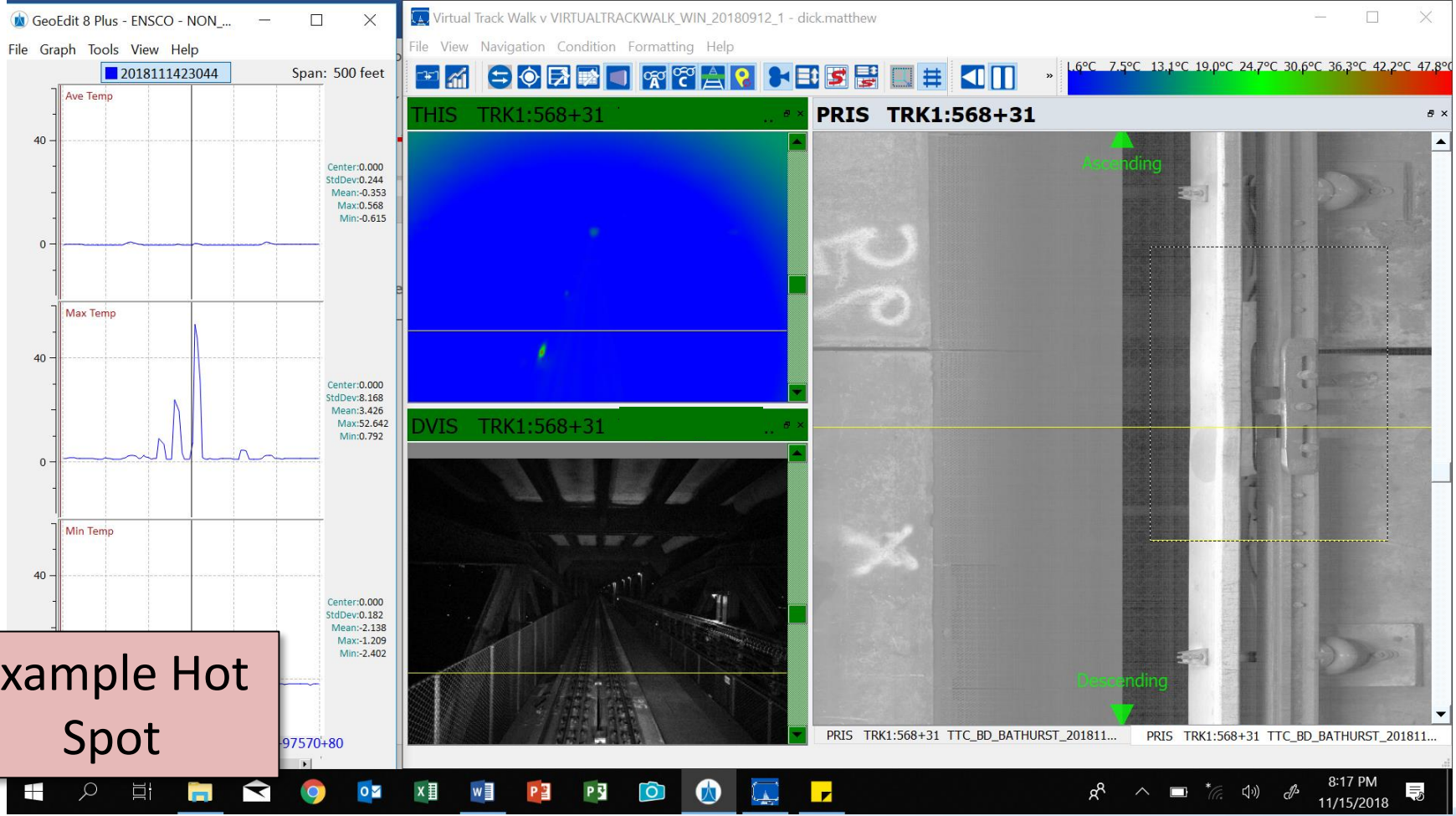
Imaging Systems

Thermal Imaging System (THIS)

- Window of Interest (WOI) Box is used.
- Maximum, Minimum and Average Temperatures within the WOI are made into strip chart.





Example Hot Spot

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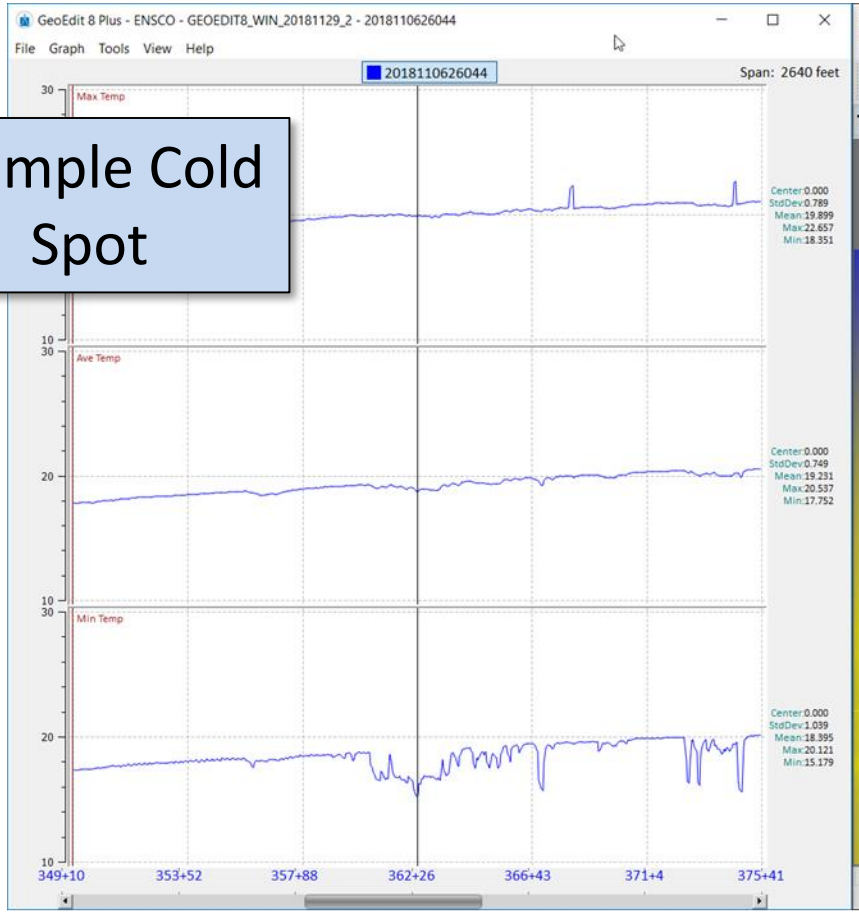
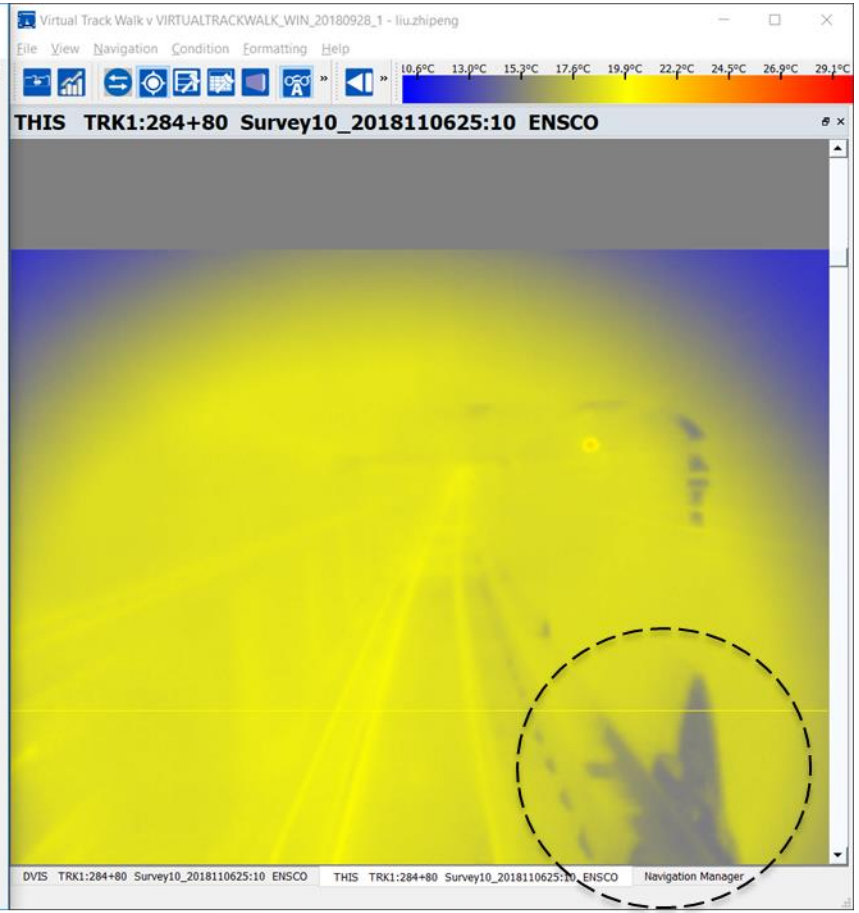
Example Cold Spot





Patent Pending

Autonomous Track Inspection

The Future of Track Condition Monitoring

What is Autonomous Inspection?

Autonomous Inspection – Process of inspecting the track from revenue service trains using unattended instrumentation with minimal direct involvement.

Typical Autonomous System Architecture

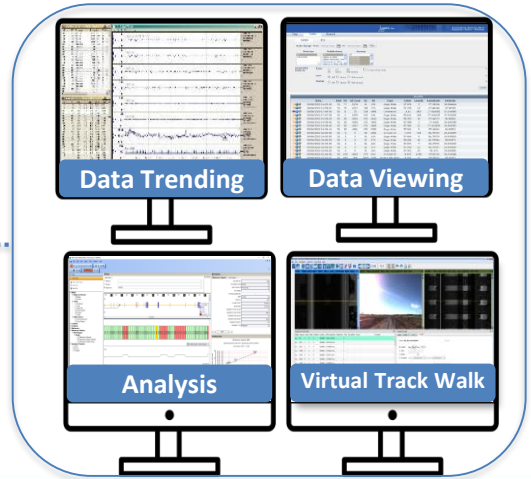
GPS

Continuously collects & streams data

Remote Servers

- **Automatic** track and class determination
- **Automatic** exception editing
- Data hosting on web application.

Email Alerts



Autonomous Track Inspection

PROS

- Earlier identification of anomalies through more frequent inspections;
- More efficient inspections at much lower overall costs;
- Autonomous Algorithms standardize application of business rules
- Automated notifications via email

CONS

- Maintenance of systems requires coordination with rolling stock & transportation.

Every train movement presents an opportunity to assess the vehicle and track system.

Automated Asset and Data Management
&
Predictive Analytics

Moving from REactive to PROactive

Automated Asset & Data Management

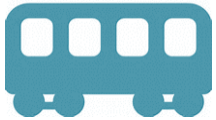
PROS

- Turns data into actionable information.
- Uses latest statistical methodology to assess track & asset condition and develop comprehensive asset management plans.
- Plans and prioritizes maintenance activities based on risk resulting in fewer emergency repairs and slow orders.
- Prioritizes capital and operating investment based on risk and needs.
- Provides an Automated End-to-End Solution when coupled with Autonomous Inspection Systems.

CONS

- Requires investment in data analysis
- Requires commitment to process and process discipline to turn data into action.

Automated Asset & Data Management



Autonomous Car

Manned Car

Inspector Entries

ERP

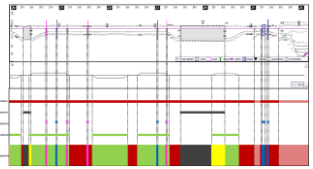
GIS

Interface

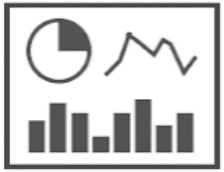
Work Orders

Automated Asset & Maintenance Management Suite

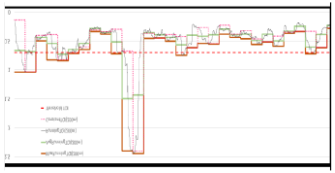
Track Segmentation



Data Analytics



Track Quality Indices (TQI)



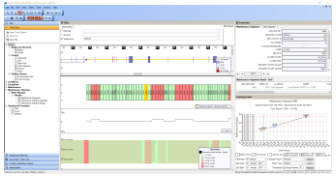
Maintenance Plans

- Ballast Renewal
- Bridge Risk
- Condition Assessments
- Derailment Risk
- Diamonds
- Gauging
- Rail Grinding
- Rail Replacement
- Right of Way Clearance Risk
- State of Good Repair
- Tie/Tie Pad Replacement
- Turnouts
- Track Tamping

Data Alignment

Track Charts

Predictive Analytics



Final Thoughts

- Comprehensive Track Inspection Vehicles are more effective and efficient when compared to single use Track Inspection Vehicles
- The emergence of Autonomous Track Inspection and Data Management Technologies provide for next level improvements including:
  - Earlier identification of anomalies through more frequent inspections;
  - More efficient inspections at much lower overall costs;
  - Planned maintenance instead of reactive maintenance, resulting in fewer emergency repairs and slow orders.

Thank You

Questions?