NxGen Rail Services – Track inspection technologies
# Track Inspection Technologies

<table>
<thead>
<tr>
<th>Traditional</th>
<th>Emerging</th>
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<tbody>
<tr>
<td>Manual measurements</td>
<td>Machine vision systems</td>
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<tr>
<td>Human eyes</td>
<td>Ground penetrating radar (GPR)</td>
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<tr>
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<td>Lidar</td>
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<td>Rail profile measure</td>
<td>xRays</td>
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<td>Track geometry</td>
<td>Track circuit measurements</td>
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<td>Signaling and radio communications</td>
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<td></td>
<td>measurements (ERTMS, GMSR, PTC)</td>
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# Track Inspection Technologies

## Traditional
- Manual measurements
- Human eyes
- Rail flaw inspection
- Rail profile measurement
- Track geometry measurement

## Emerging
- Machine vision systems
- Ground penetrating radar (GPR)
- Lidar
- xRays
- Track circuit measurements
- Signaling and radio communications measurements (ERTMS, GMSR, PTC)
Machine Vision Capabilities

- Rail head inspection
  - Broken rails
  - Wheel burns
  - Corrugation
  - Squashed heads
- Broken or cracked concrete ties
- Wooden tie condition
- Fasteners
- Anchors

- Joint bars
  - Cracks
  - Breaks
  - Missing bolts
- Third rail
- Catenary
  - Height
  - Stagger
  - Wear
- Virtual track walk
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<thead>
<tr>
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<th>Value 3</th>
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GPR capabilities

- Ballast depth
- Depth to fouling
- Ballast fouling index (Selig)
- Ballast pockets
- Water
- Culvert health check
- Subgrade analysis
- Tie type
Harnessing GPR and machine vision technologies

- Training machine vision
  - Overcoming false positives
  - Using rules to provide useful information, not just data
    - Clustering algorithms
    - Moving windows
  - Increased productivity – 56.000 Kms per annum with a crew of 3 people and one vehicle
Data fusion to aid defect classification

- Extracting the useful bits
  - Defects, conditions and context
- Ease of access
  - Web enabled platforms, interactive widgets
- Fusing databases
  - Localization and data formats
Using data fusion to help classify defects

- Track gauge compared with tie and fastener condition
  - A better understanding of the problem helps the maintenance planner to send out the right repair instructions

Wide gauge defect on concrete ties at a transition from concrete to wooden ties. The location has several missing fasteners.
Using data fusion to help classify defects

- Ballast condition and geometry
  - A correlation between ballast fouling and surface geometry is emerging as more data gets analysed

Rail Surface defect at locations with water between the ballast and the subgrade next to a road crossing
Surface Ballast Fouling and Geometry Exceptions

GPR analysis shows surface fouling that extends to the full height of the ballast across the area of interest.

This information can be used to accurately plan corrective maintenance such as undercutting and surfacing.
Using data fusion to help classify defects

- Ballast condition compared with track geometry
  - A correlation between ballast fouling and surface geometry is emerging as more data gets analyzed

Cross level defects at locations with a variation in ballast depth to fouling on one side of the track
Using data fusion to help classify defects

- Depth to fouling vs Surface Geometry
Using data fusion to help classify defects

- Ballast fouling Index vs Surface Geometry
Using data fusion to help classify defects

- Geometry, GPR and culverts
Using data fusion to help classify defects

- Rail Surface defects and rail geometry
  - A chain is as strong as its weakest link

Section of track with multiple rail head anomalies and worn rail
Using data fusion to help classify defects

- Automated analysis of S&C
  - Geometry system to create image of switch under dynamic load and take measurements
  - Machine Vision for fasteners, joint bars, bolts etc..

Example from a switch report showing measurements
Using data fusion to help classify defects

- **Machine Learning**
  - The above examples offer opportunities for integrated database systems to learn the relationships between conditions in the track, and the correct remedial action to apply enabling the system to prompt users with the optimal mitigation procedures in each case.
  - The system can also provide historical information about how similar circumstances elsewhere on the network were resolved.

- **Successes achieved**
  - **Safety**
    - As more systems like those we have described come on line and are being utilized by class one railroads in North America, derailment numbers caused by track defects have been steadily decreasing.
  - **Efficiency**
    - Applying the right remedy in the most cost effective manner saves money, and increases network efficiency reducing downtime for maintenance.
    - Just one example: Shoulder cleaning vs undercutting. Knowing where to do each can save huge amounts of time and cost.

  

Money spent on testing is a high yield investment