

Vehicle-Track Measurement Technologies

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ENSCO Rail

May 1st 2018



Summary

Overview of Measurement Systems

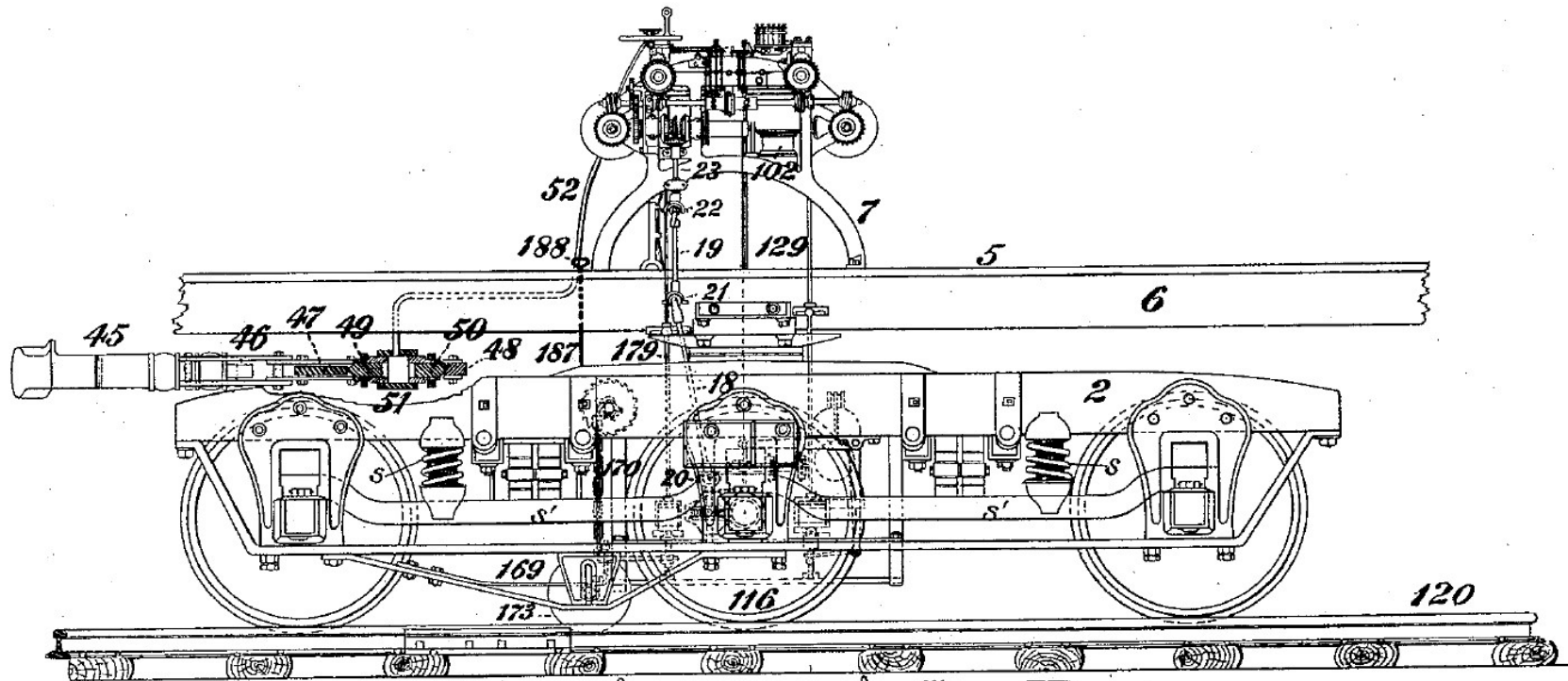
Overview of Asset Management



P. H. DUDLEY.
MEANS FOR RECORDING THE CONDITIONS OF AND MARKING
RAILWAY TRACKS.

No. 367,708.

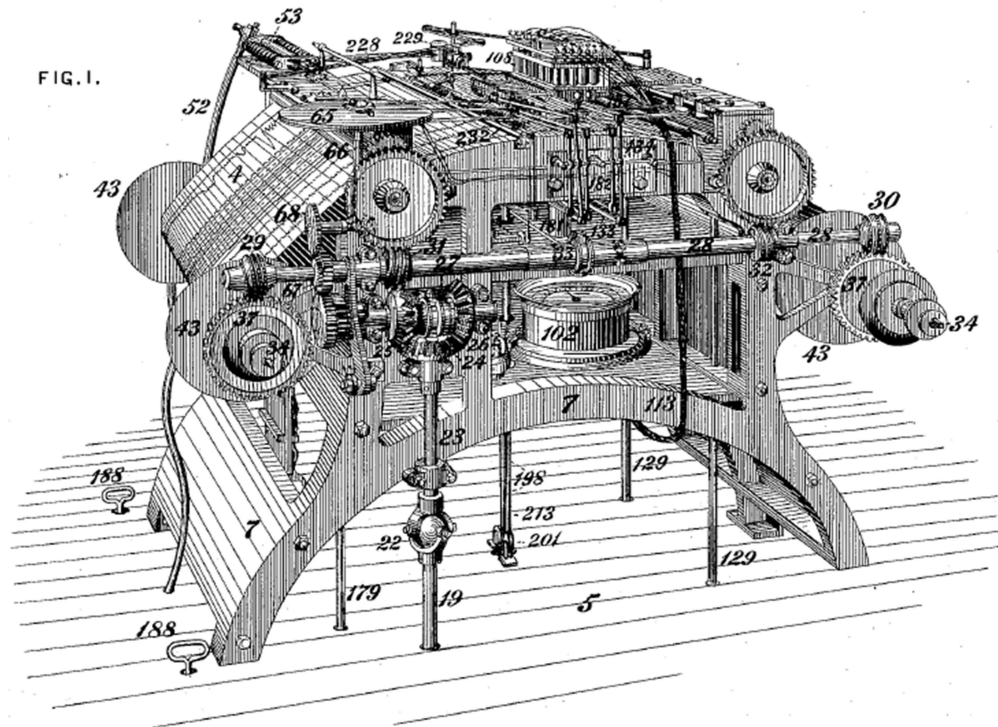
Patented Aug. 2, 1887.



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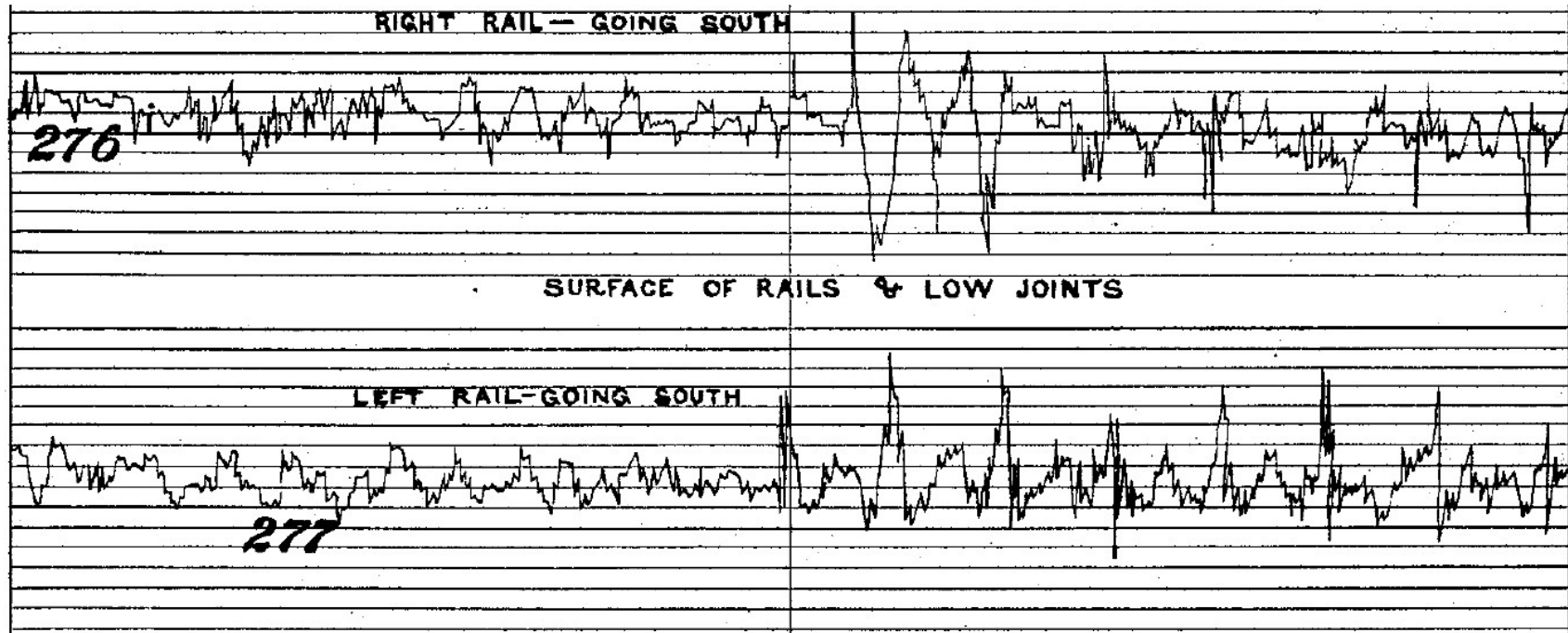
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Overview of Measurement Systems

There are five basic categories of measurement system.



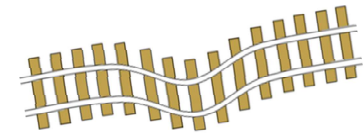
Categories of Measurement Systems

1) Mounted on Vehicle to measure the Vehicle.



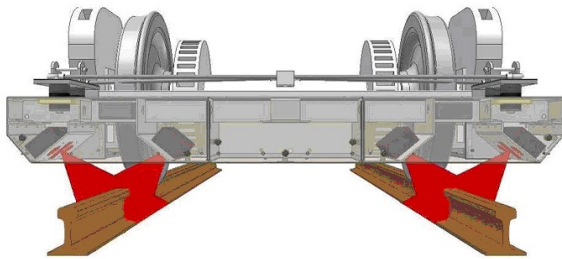
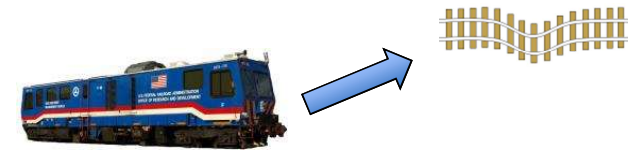
Categories of Measurement Systems

2) Mounted on Track to measure the Track.



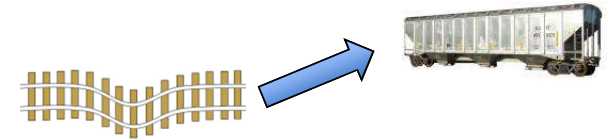
Categories of Measurement Systems

3) Mounted on Vehicle to measure the Track.
(Manned, Unmanned, and Autonomous)



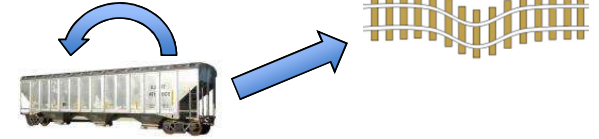
Categories of Measurement Systems

4) Mounted on Track to measure the Vehicle.



Categories of Measurement Systems

5) Mounted on Vehicle to measure the Vehicle & Track.



Track Measurement

Rail Profile Measurement System

Track Geometry Measurement

V/TI Monitor Axle Impact

Ultrasonic Rail Flaw Detector

Machine Vision



Vehicle Measurement

Wheel Profile Detector

**Truck Condition Monitor
(TBOGI)**

Wheel Impact Load Detector

Cracked Wheel Detector

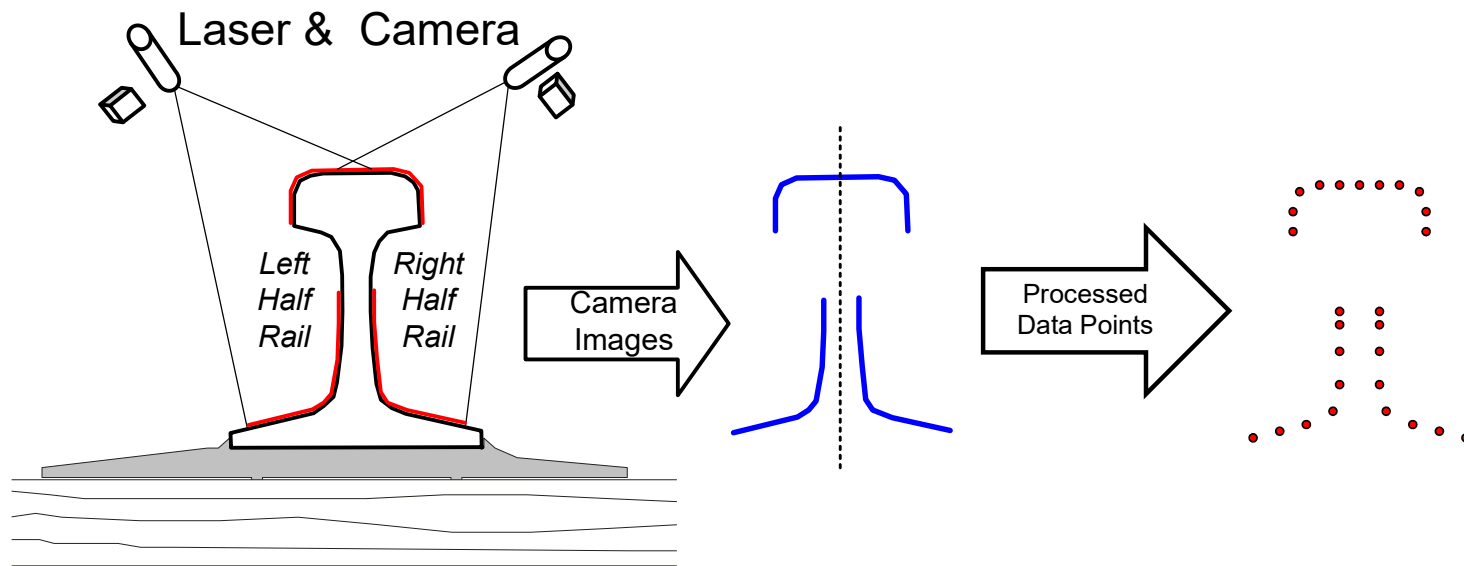
Machine Vision



Profile Measurement



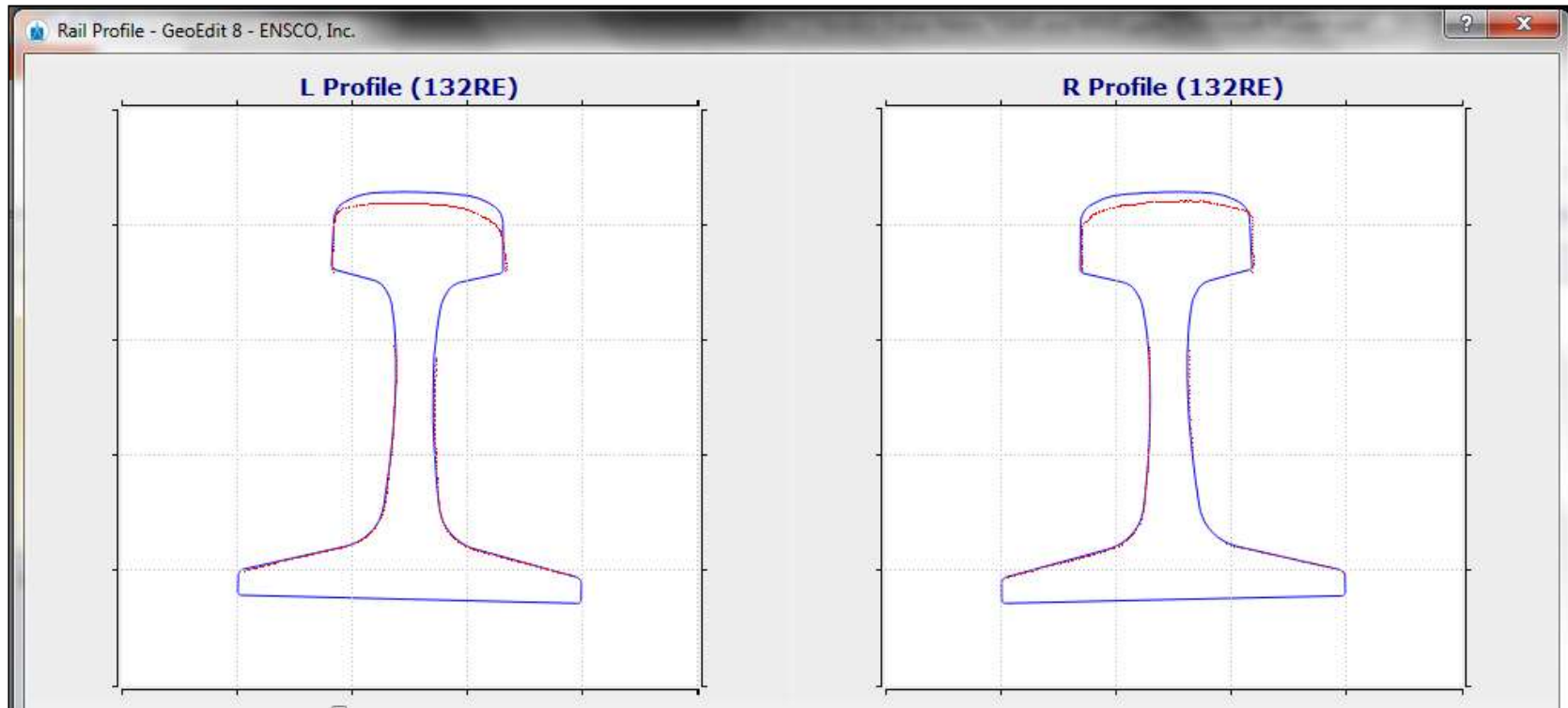
Laser Triangulation Measurement



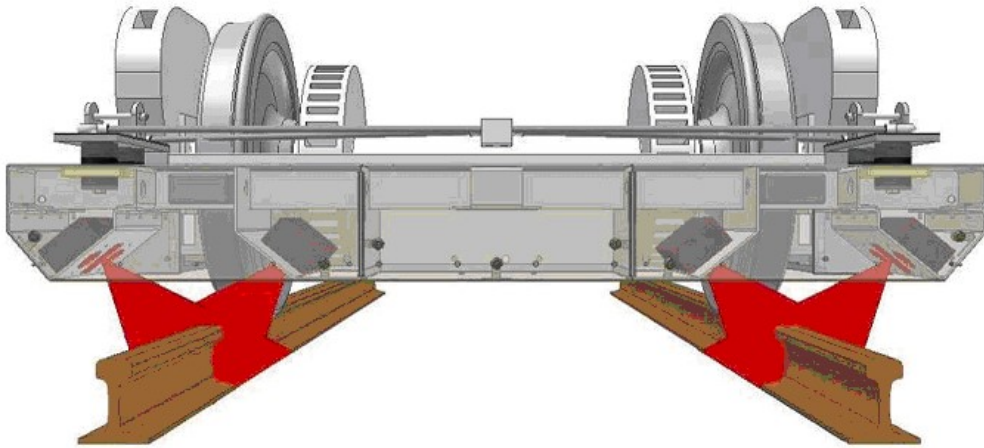
Ref 1



Laser Triangulation Measurement



Rail Profile Measurement System



Vehicle Platforms:



Railbound Manned



Hi-Rail Manned



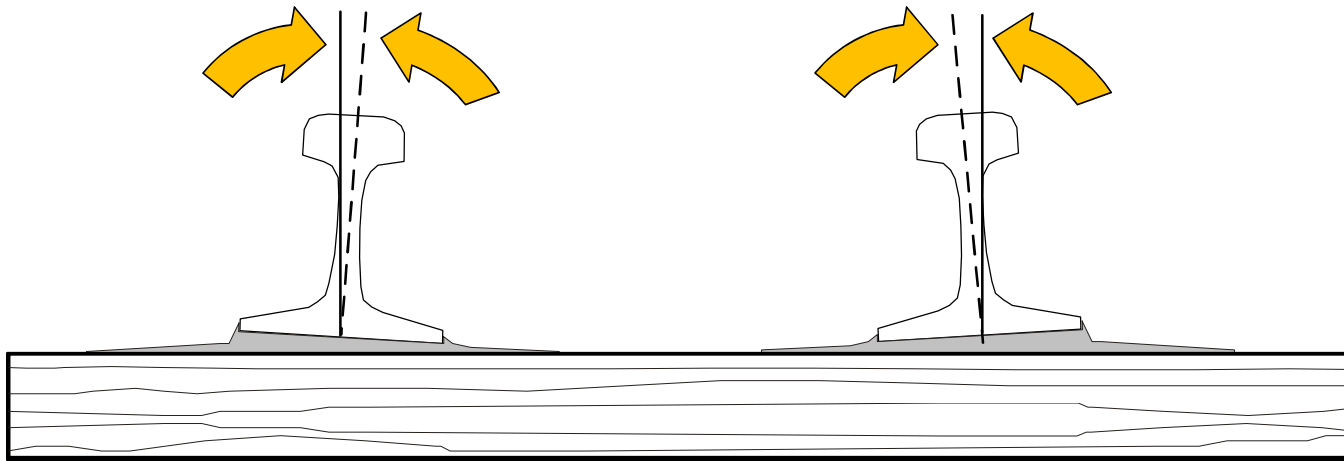
Autonomous



Absolute Measurements:

(Doesn't Require Template)

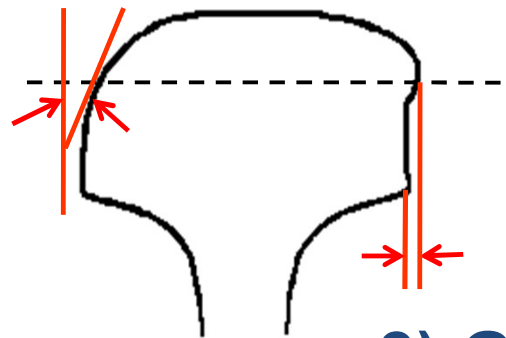
1) Cant (Deg)



Absolute Measurements:

(Doesn't Require Template)

**2) Gage
Face Angle
(Deg)**



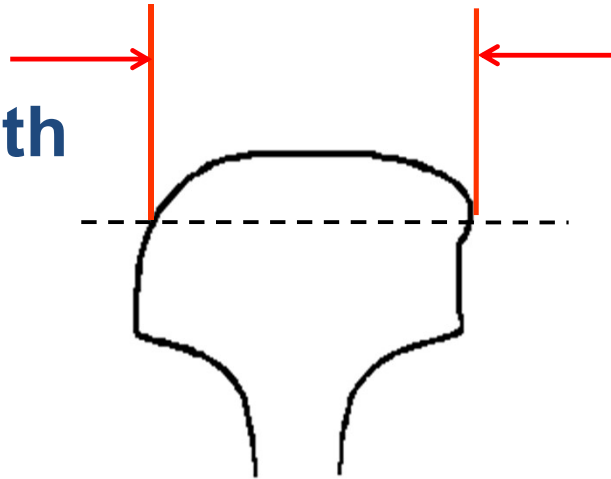
**3) Gage/Field
Side Lip (In, mm)**



Absolute Measurements:

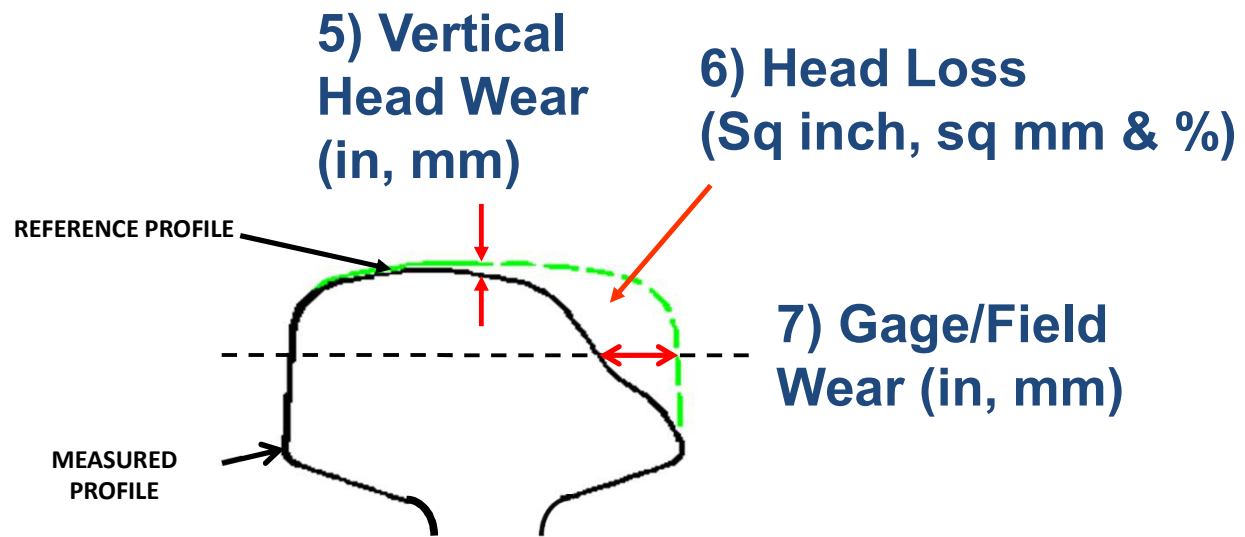
(Doesn't Require Template)

**4) Head Width
(in, mm)**



Relative Measurements:

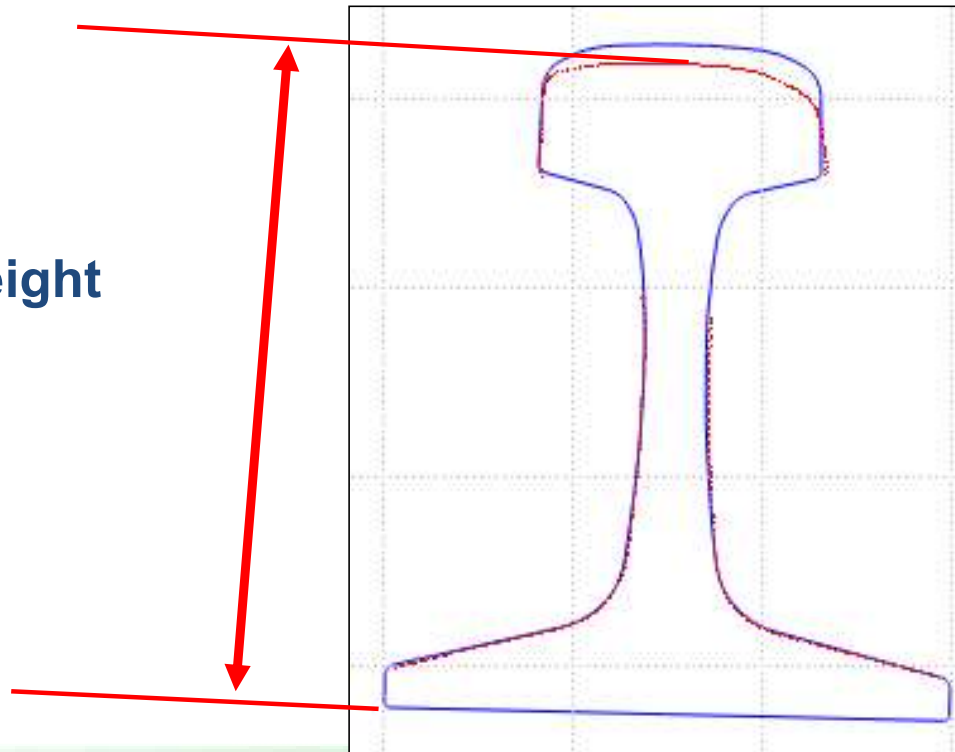
(Does Require Template)

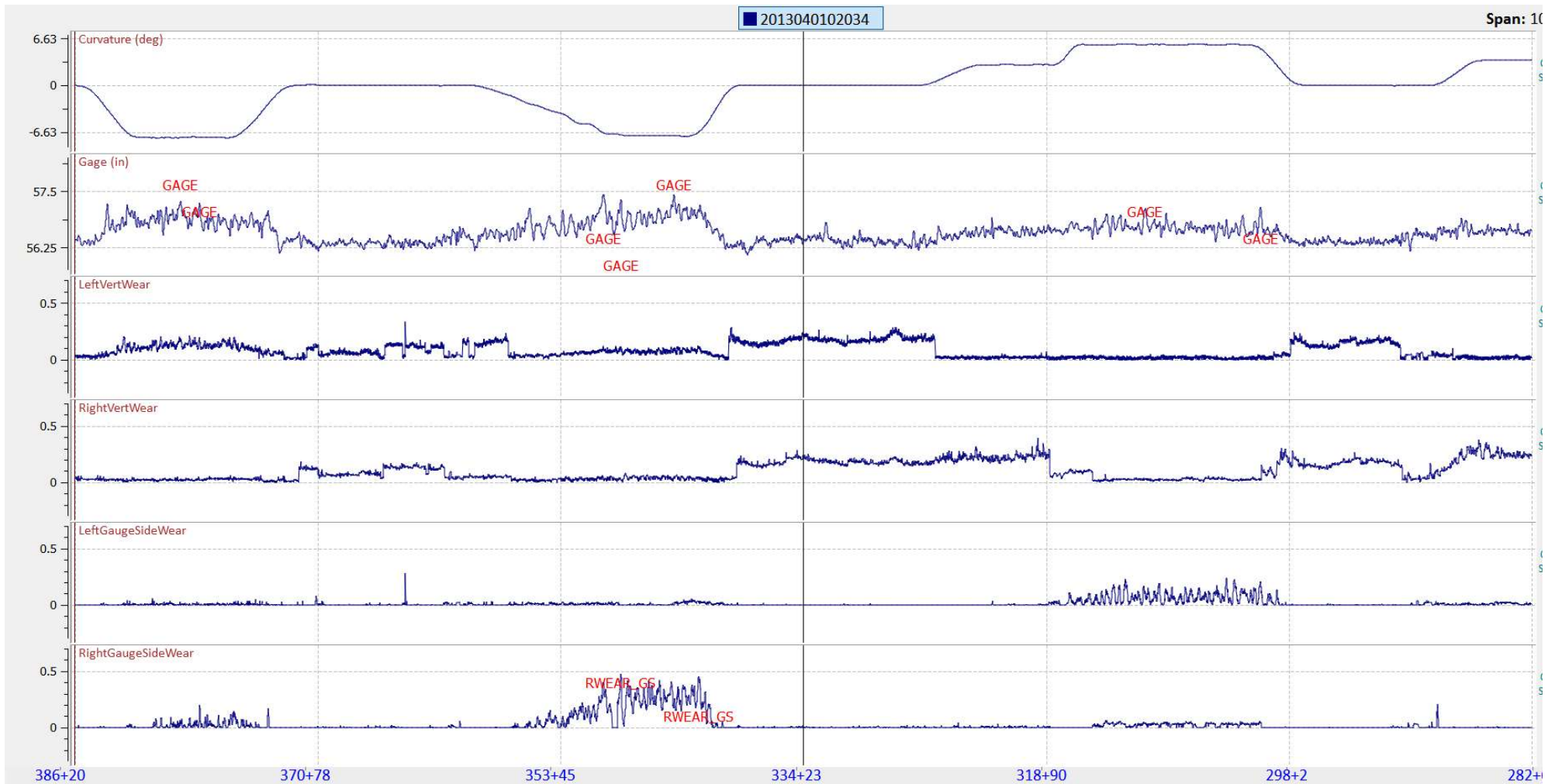


Relative Measurements:

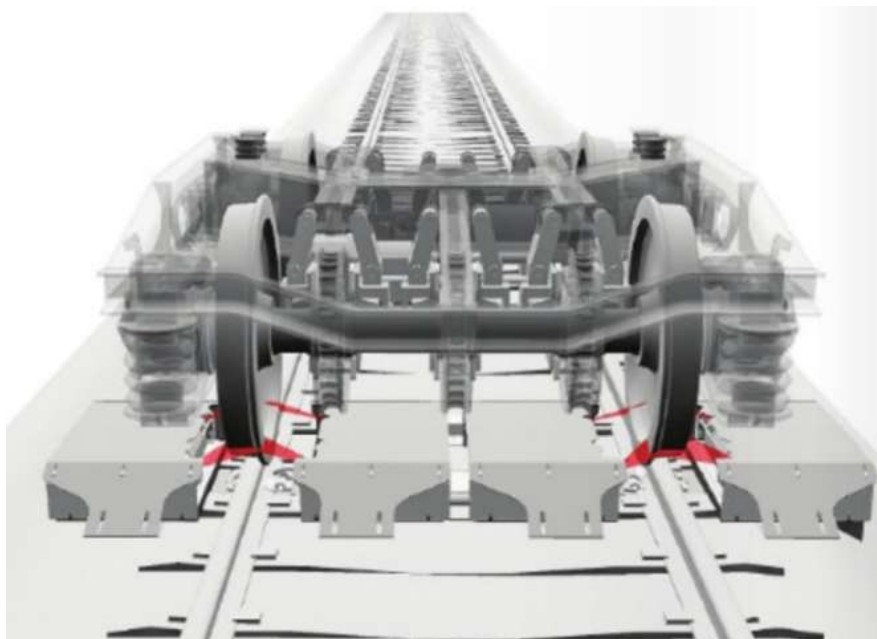
(Does Require Template)

8) Total Height
(in, mm)





Wheel Profile Detector



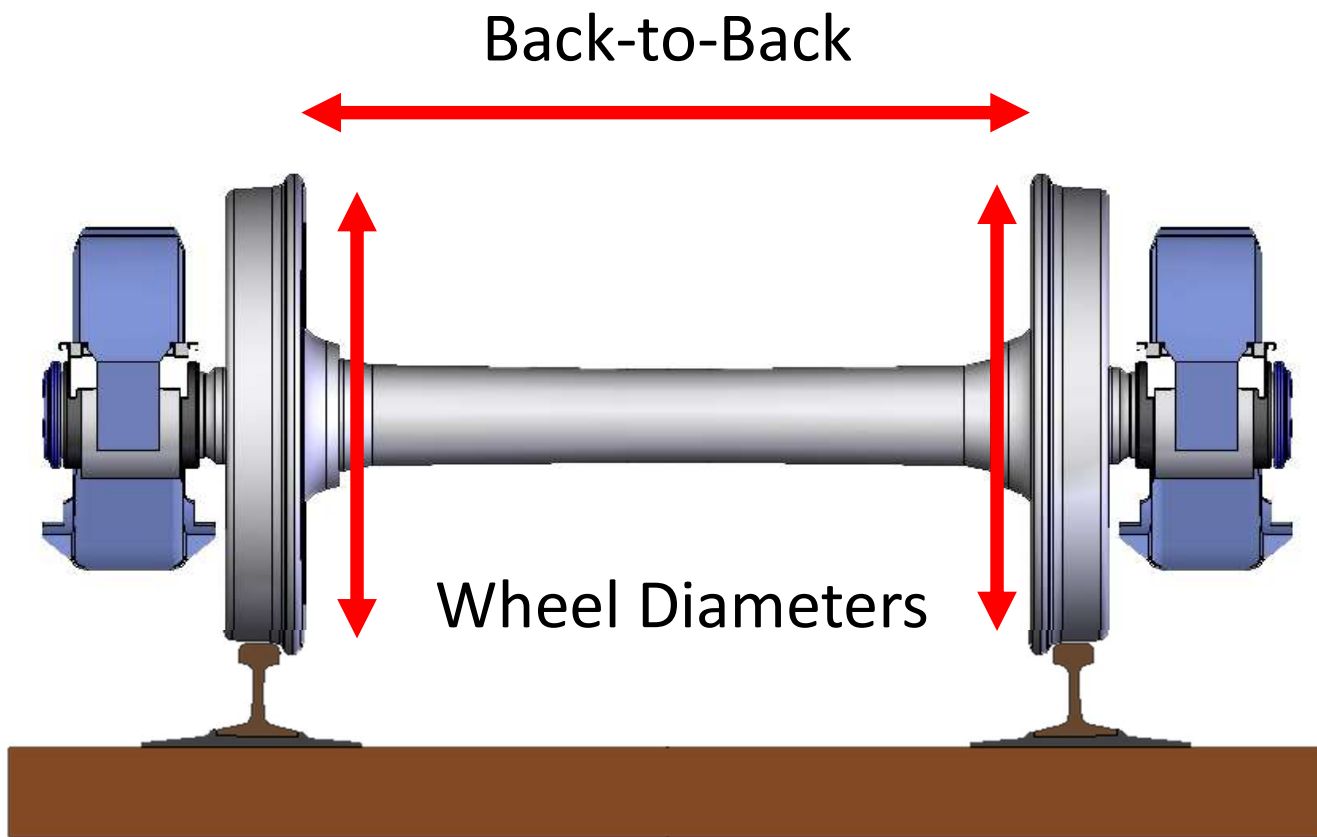
Images from Beena Vision
http://www.beenavision.com/BV_Brochure_2016/mobile/index.html#p=16

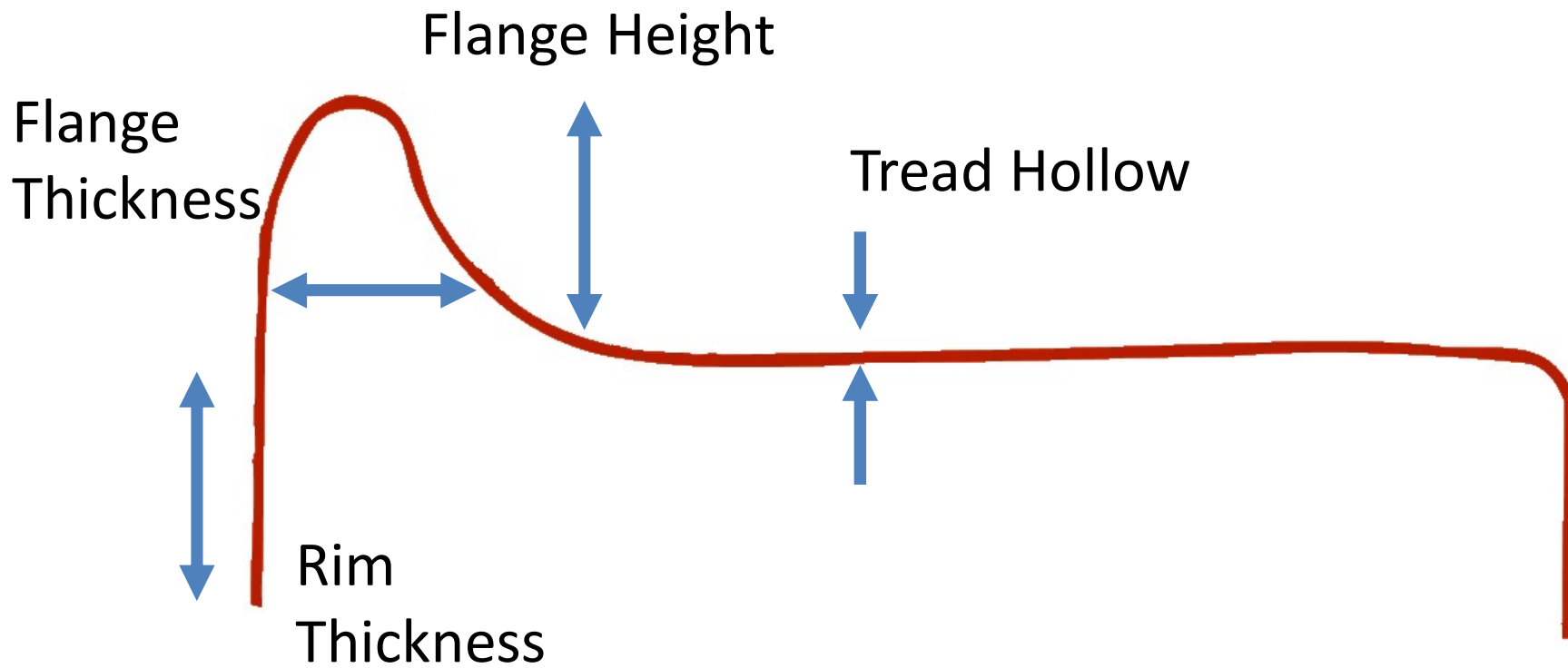


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Geometry Measurement



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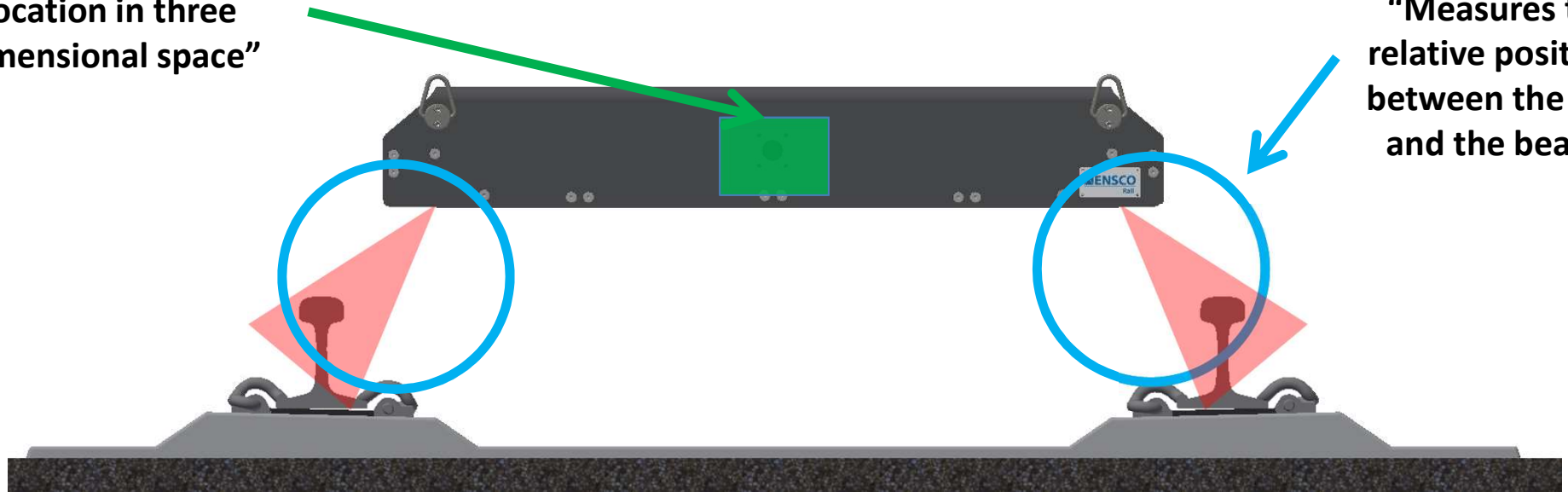


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Track Geometry Measurement System

Inertial Package
“Measures the beam location in three dimensional space”

Laser/Cameras
“Measures the relative positions between the rails and the beam”



Vehicle Platforms:



Railbound Manned



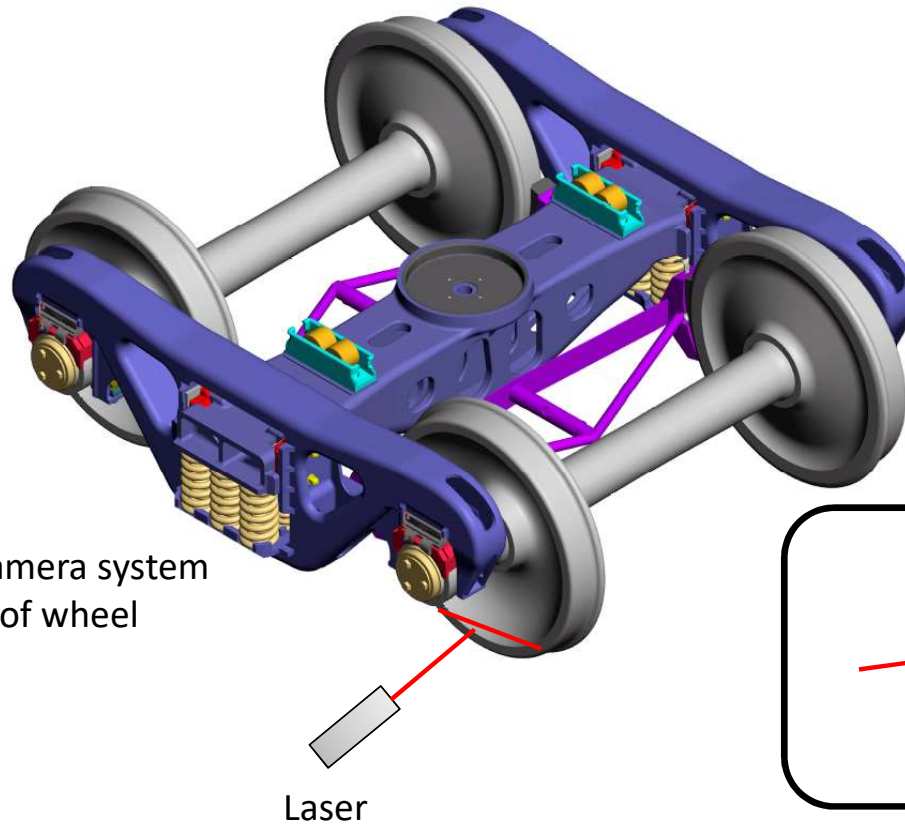
Hi-Rail Manned



Autonomous



Truck Condition Monitor (T-BOGI)



Wayside Laser/Camera system measures profile of wheel plate.

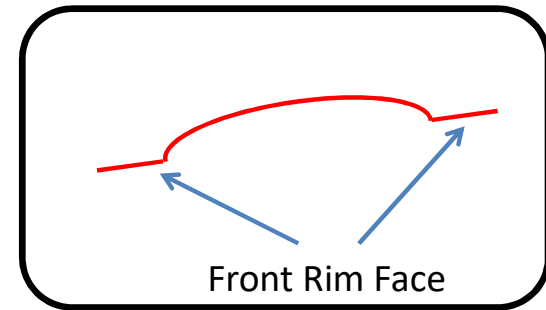
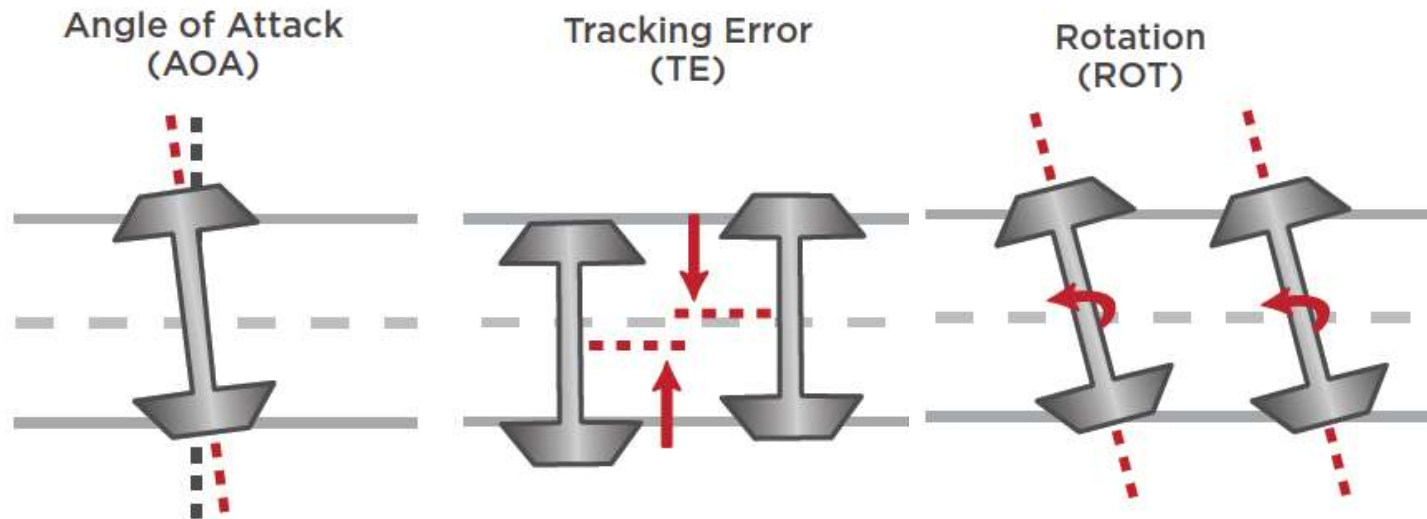


Image from Standard Car and Truck Maintenance Manual
<http://www.sctco.com/pdf/Section1.pdf>



How does a truck condition monitor work?



Images from Wayside Inspection Systems
http://wid.ca/sites/default/files/brochures/TBOGI/WID_TBOGI_Brochure_US.pdf



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Impact Measurement



Wheel Impact Load Detector (WILD)



Image from L.B. Foster
<https://www.youtube.com/watch?v=7CJycCggHgw>



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Image from Frauscher
<https://www.youtube.com/watch?v=gTfU4tGZzgo>



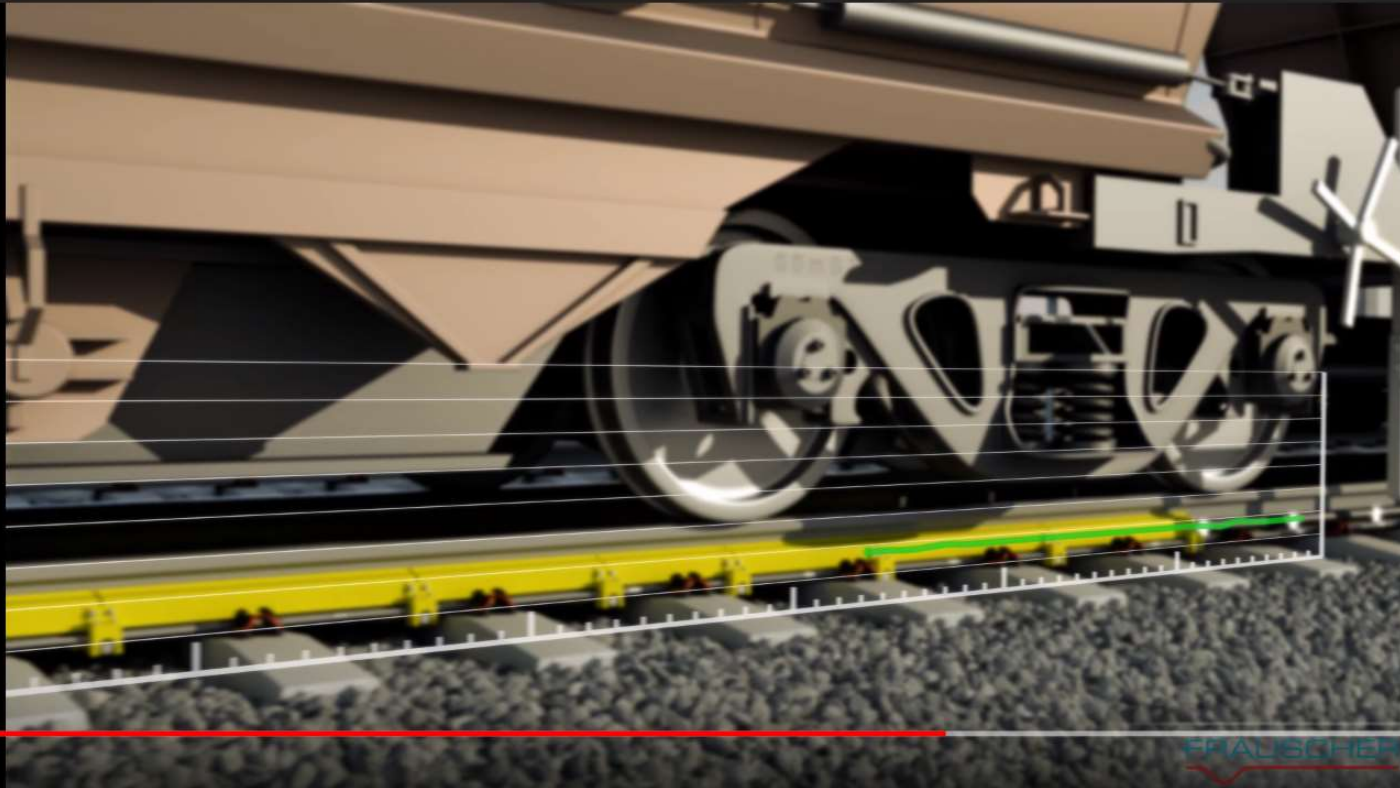


Image from Frauscher
<https://www.youtube.com/watch?v=gTfU4tGZzgo>



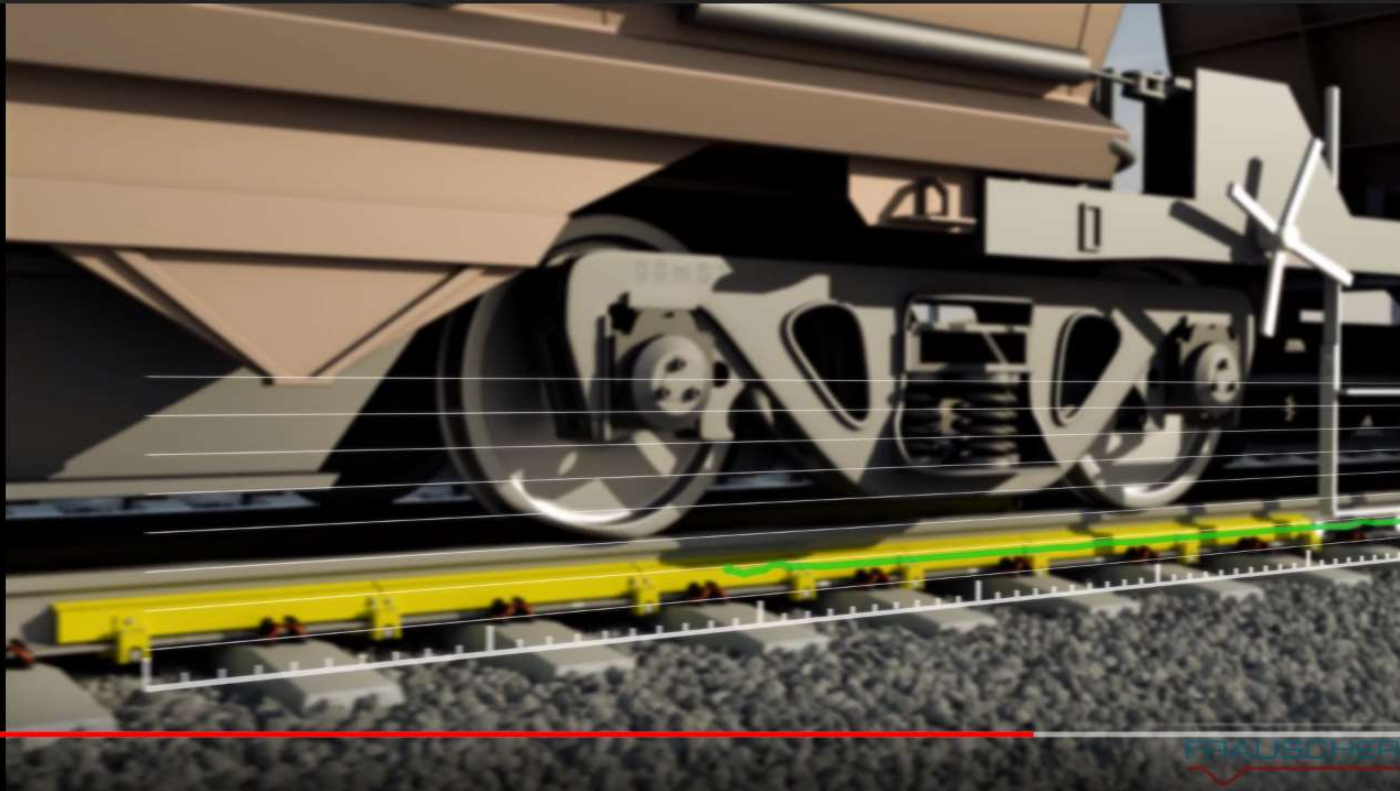


Image from Frauscher
<https://www.youtube.com/watch?v=gTfU4tGZzgo>



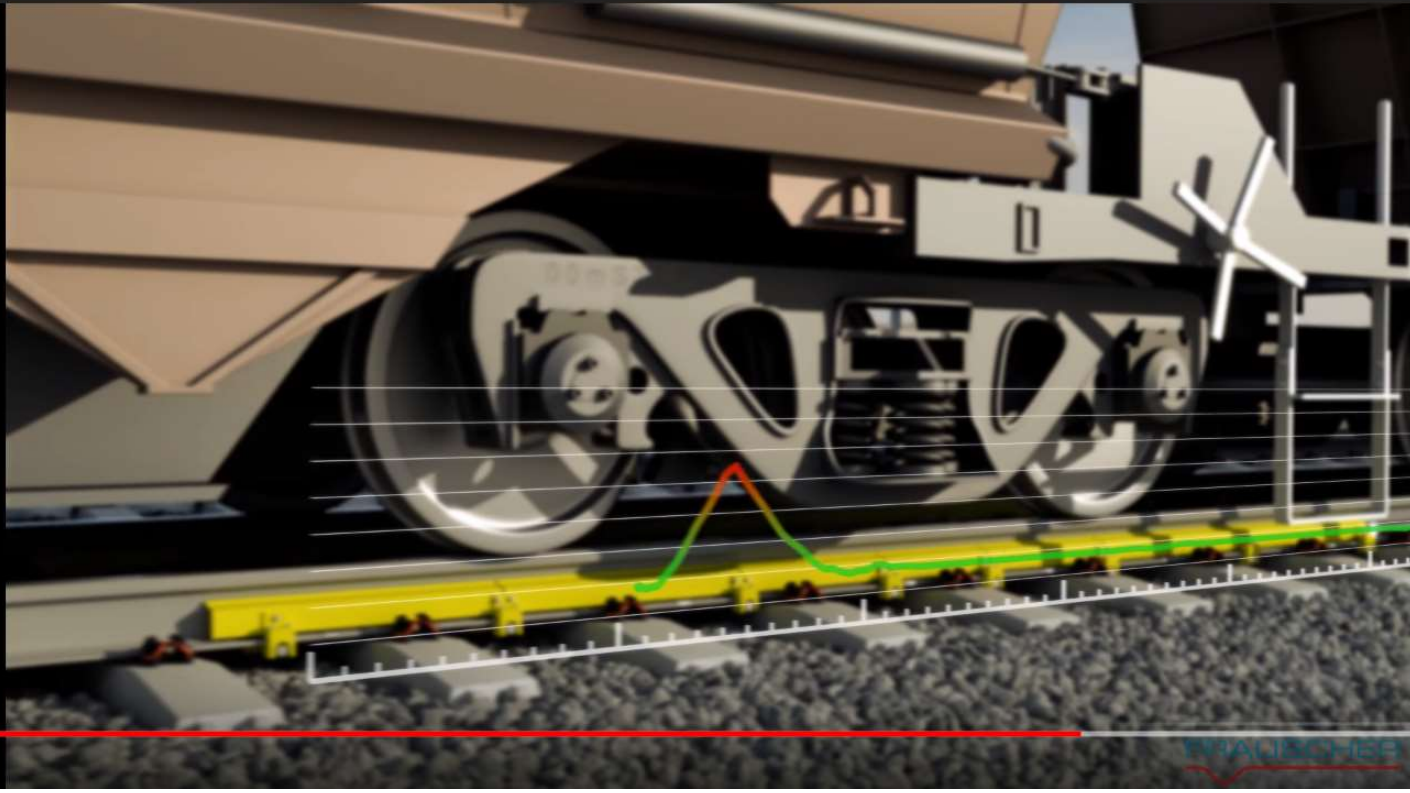


Image from Frauscher
<https://www.youtube.com/watch?v=gTfU4tGZzgo>



Example WILD Defects



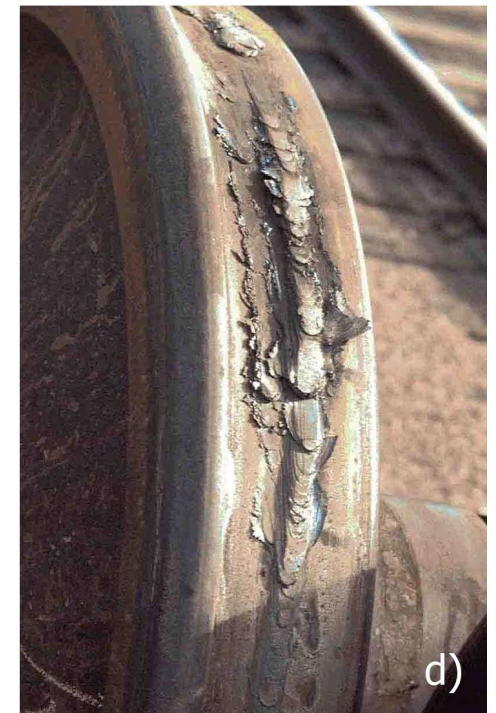
Slid Flat



Shelling &
Spalling



Shattered Rim



Built Up Tread



Measurements

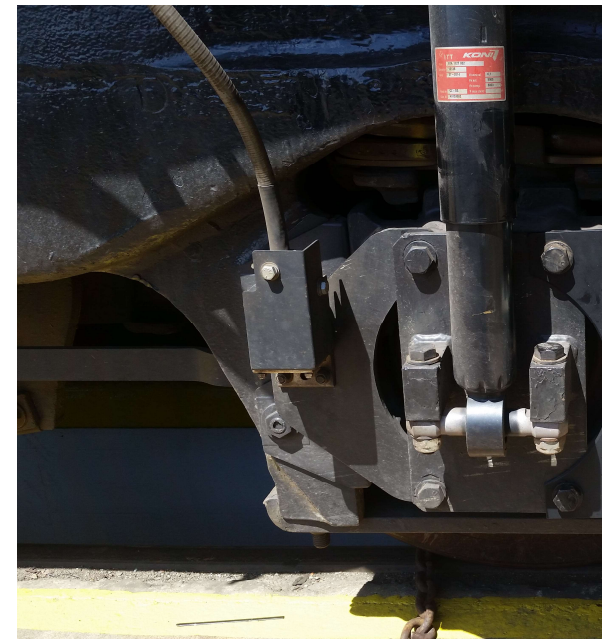
- Nominal Load
- Peak Load
- Dynamic Load (=Peak-Nominal)
- Ratio (=Peak/Nominal)

Things to Keep in Mind

- Loaded/Empty
- Speed
- Track Stiffness



V/TI Monitor – Impact Measurement



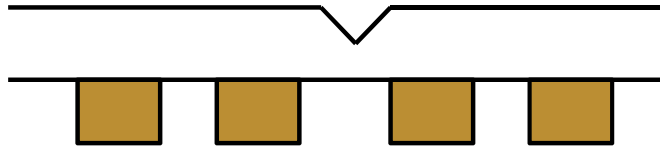
Example V/TI Monitor Axle Sensor



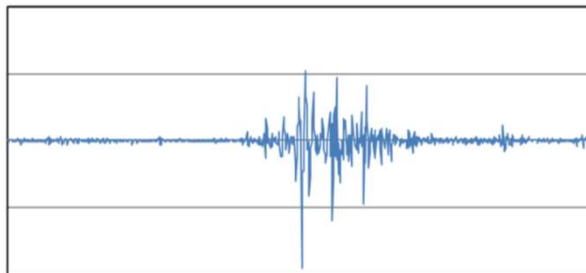
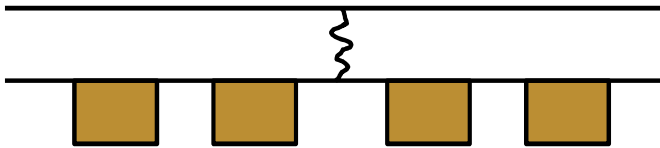
Vehicle Platforms: Revenue Vehicles



Dent



Break



- Vertical acceleration measured at axle box
- Wheel/Rail Impact acceleration measured
- Peak acceleration is used to calculate peak load.



Example V/TI Monitor Defects



Battered
Joint



Cracked/Broken
Joint Bar



Cracked/Broken
Frog



Broken Rail



Measurements

- Peak Load

Things to Keep in Mind

- Loaded/Empty
- Speed
- Track Stiffness

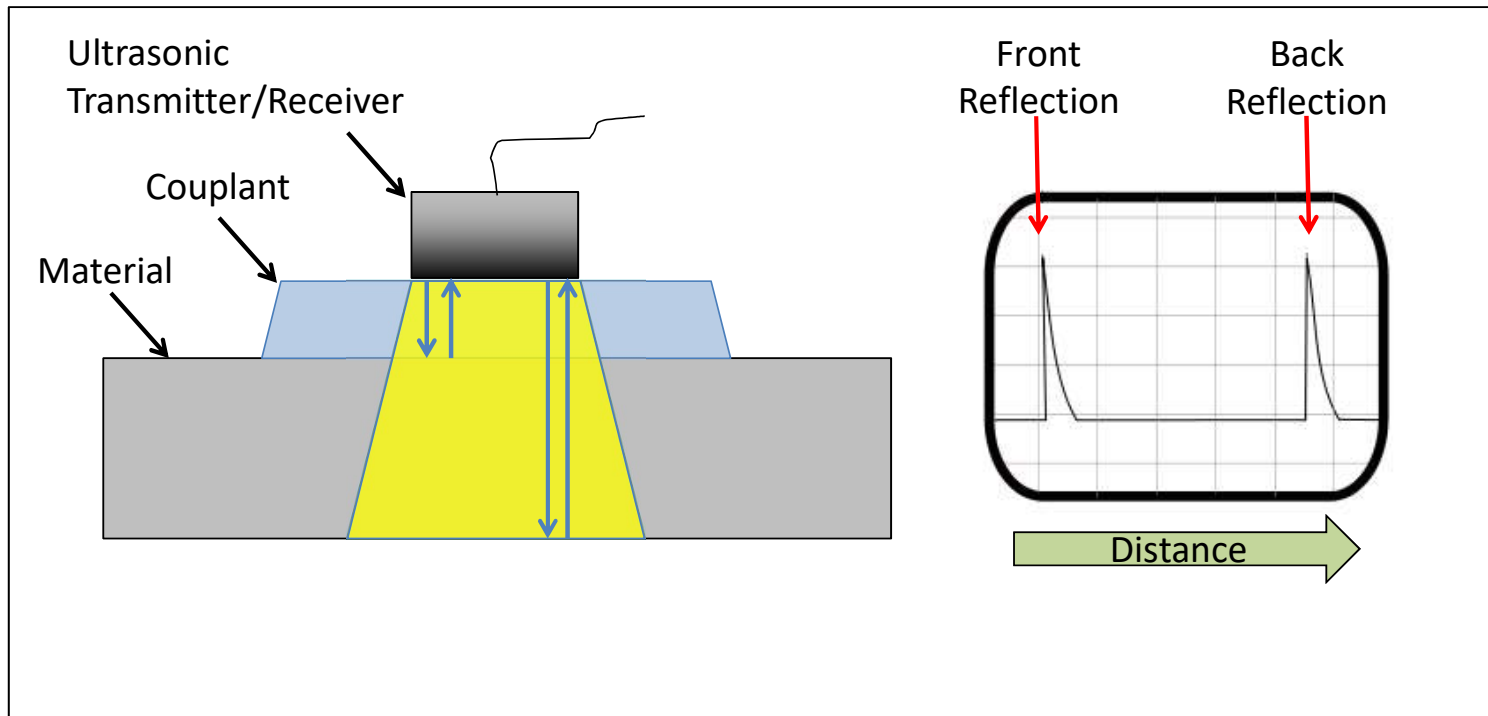


Ultrasonic Measurement



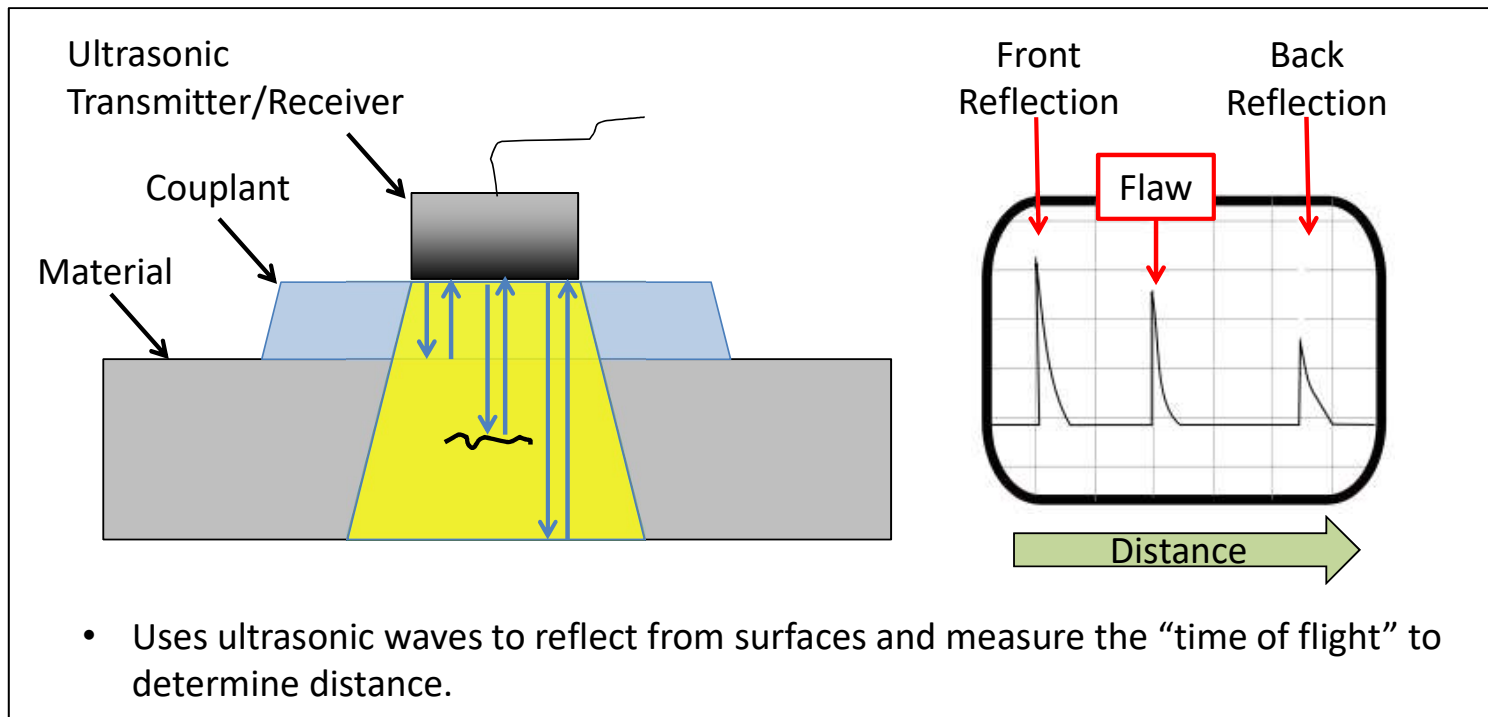
Ultrasonic Sensors

- Can measure depth, size, and orientation of internal flaws in a material



Ultrasonic Sensors

- Can measure depth, size, and orientation of internal flaws in a material



Ultrasonic Rail Flaw Detectors

Exemplar Wheel Probe System
(Most Commonly Used in North America)

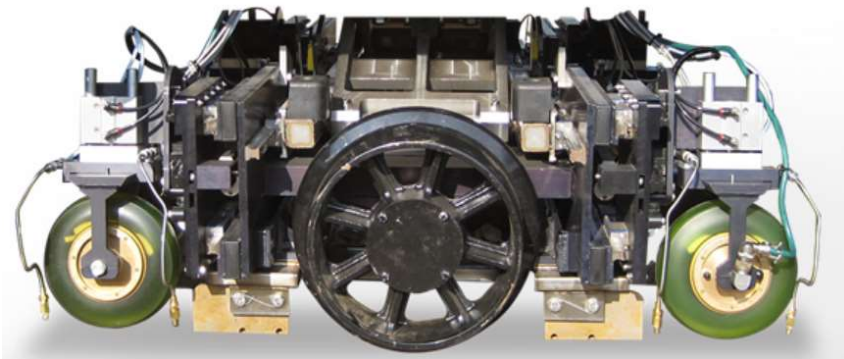
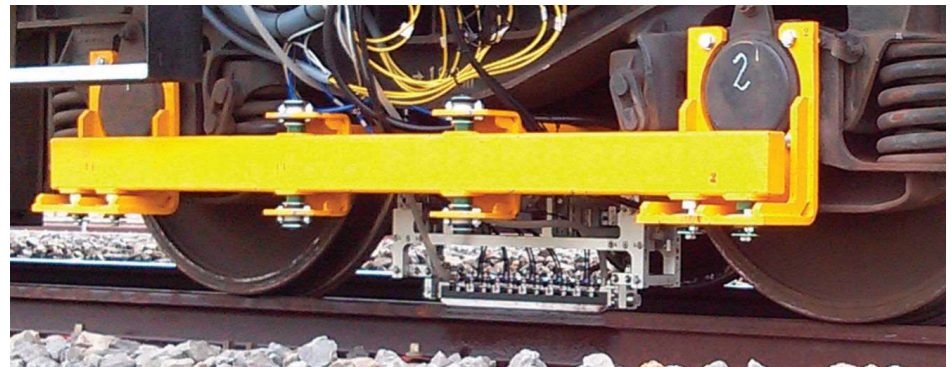


Image from Nordco
<http://www.nordco.com/products-catalog/inspection-technologies/rail-bound-inspection-systems/rail-bound-rail-flaw-inspection-system-.htm>

Exemplar Sled Probe System
(Most Commonly Used in Europe)



ScanMaster
<http://scanmaster-irt.com/wp-content/uploads/2015/11/TrackMaster-High-Speed-brochure.pdf>



Vehicle Platforms:



Railbound Manned



Hi-Rail Manned



ATV Manned



B-Scan
Composite of multiple sensors to better visualize the flaw

A-Scan
Individual Sensor



Image from Nordco
<http://www.nordco.com/products-catalog/inspection-technologies/vehicle-inspection-systems/NRS-260-Prime.htm>



Cracked Wheel Detector



Image from Proceedings of 2018 AAR Review Matthew Witte, "Effectiveness of Cracked Rim Detectors to Identify Broken Wheels"



Example Plunger Probe System

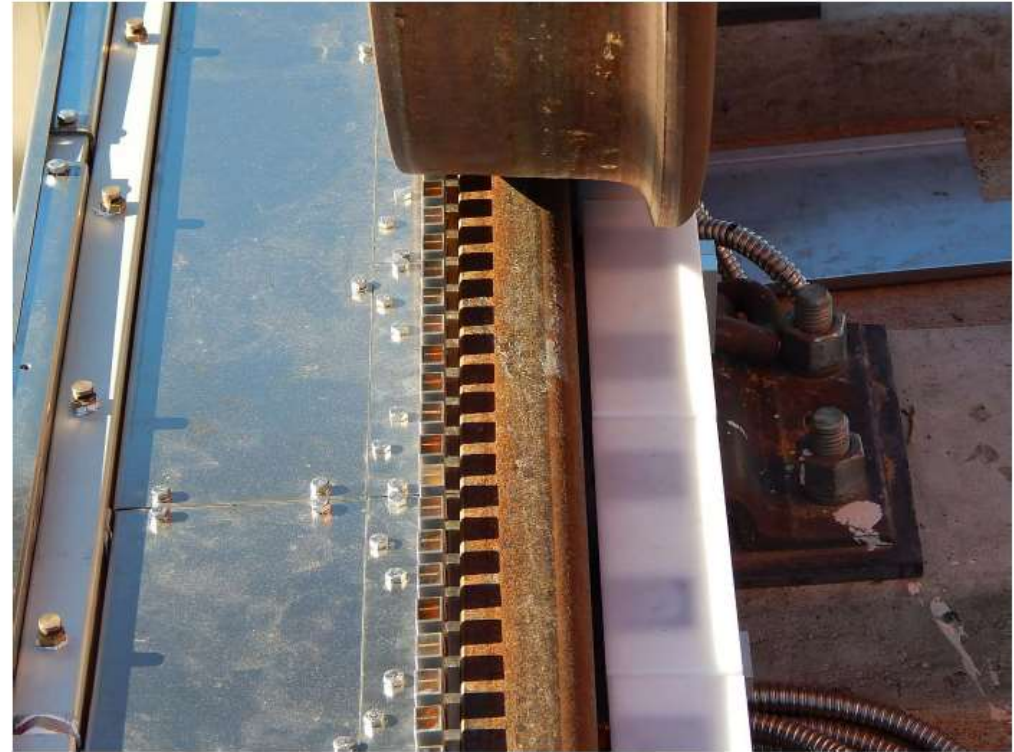


Image from Proceedings of 2018 AAR Review Matthew Witte, "Effectiveness of Cracked Rim Detectors to Identify Broken Wheels"



Example Robotic System

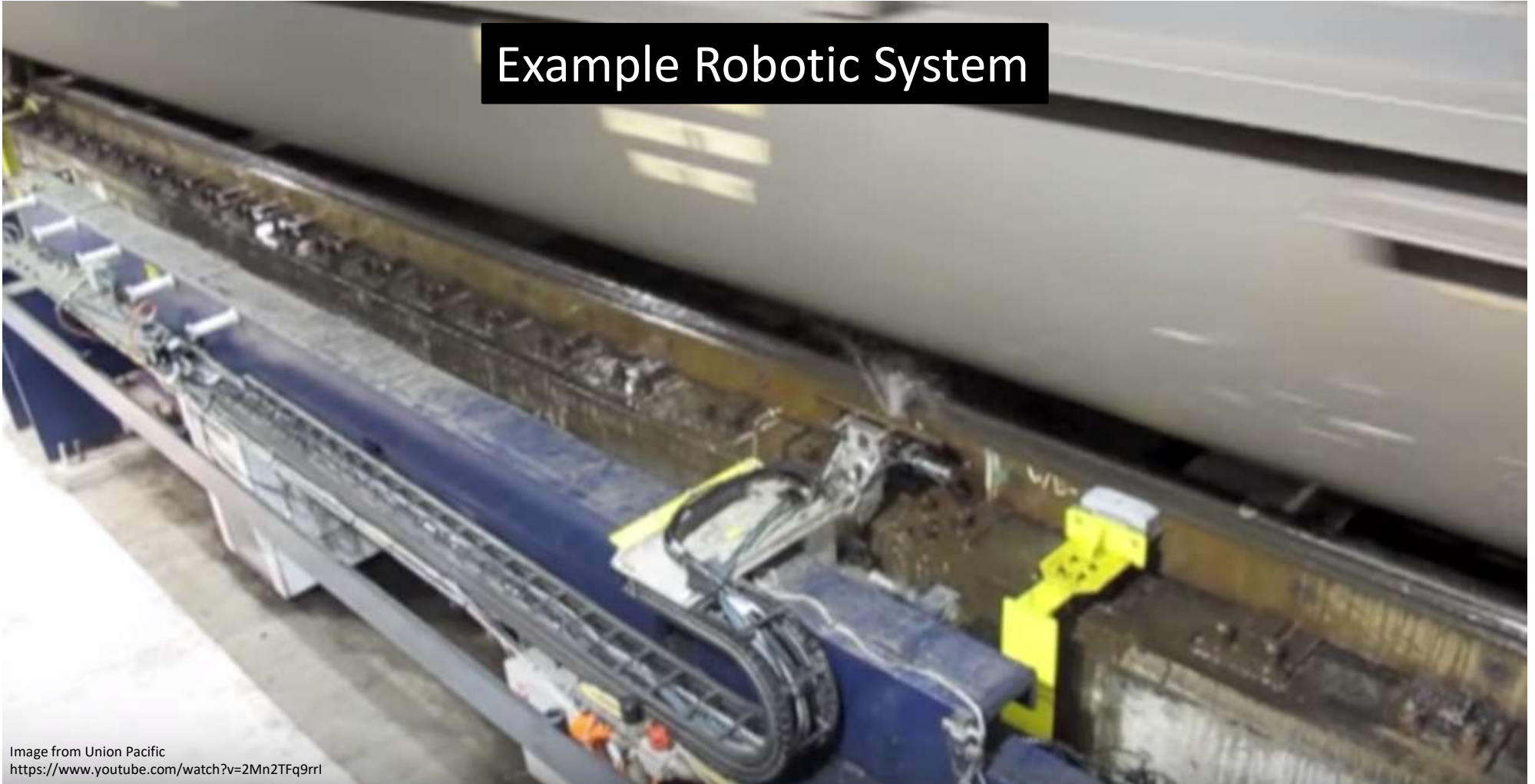


Image from Union Pacific
<https://www.youtube.com/watch?v=2Mn2TFq9rrl>



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Example Robotic System

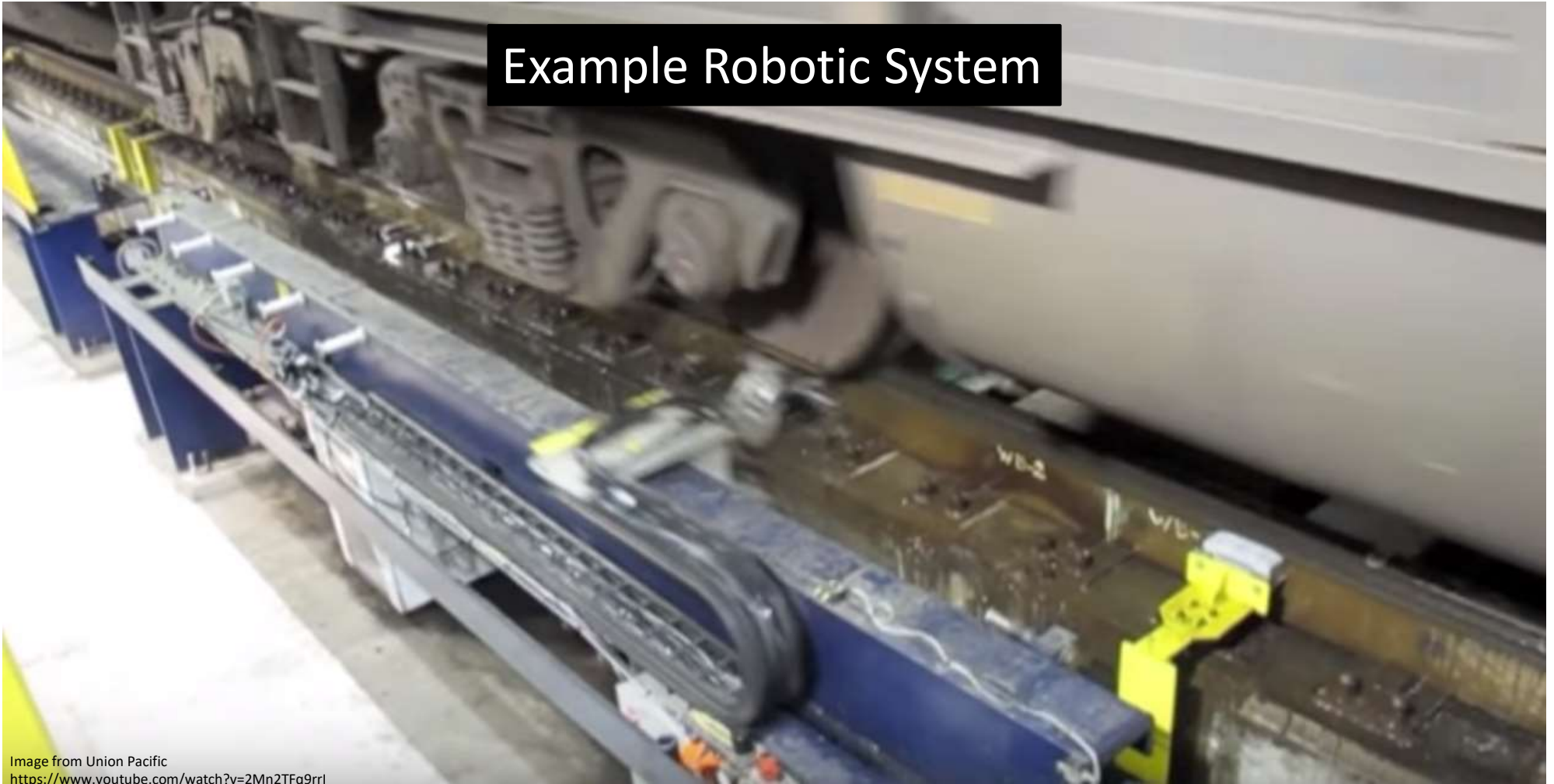


Image from Union Pacific
<https://www.youtube.com/watch?v=2Mn2TFq9rrl>



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Imaging



Cameras

“Line Scan” Cameras aka “Slit Scan”

Works like your document scanner

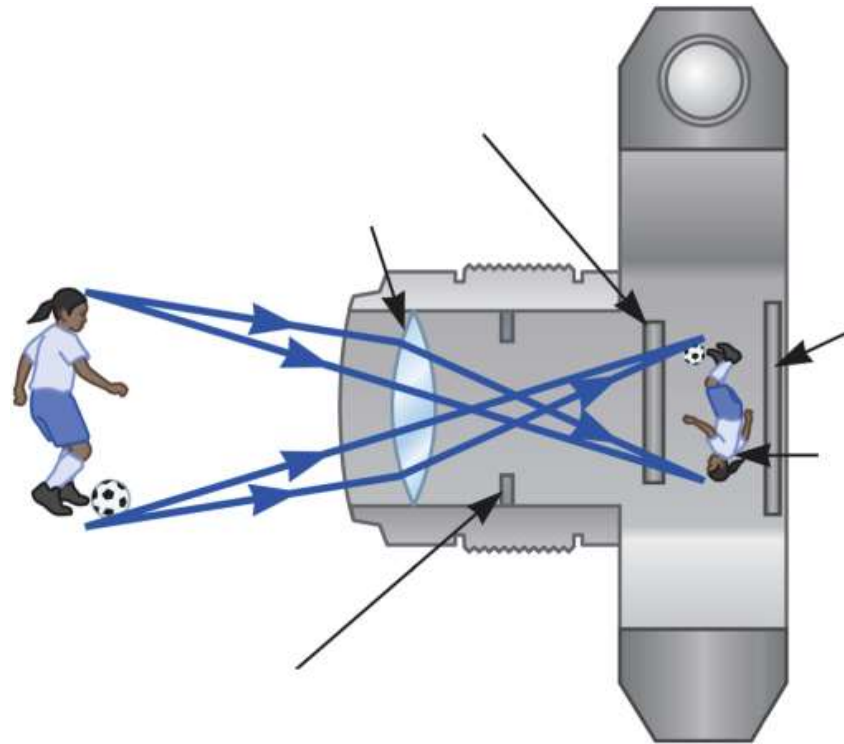


“Area Scan” Cameras aka “Full Frame”

Works like your standard camera



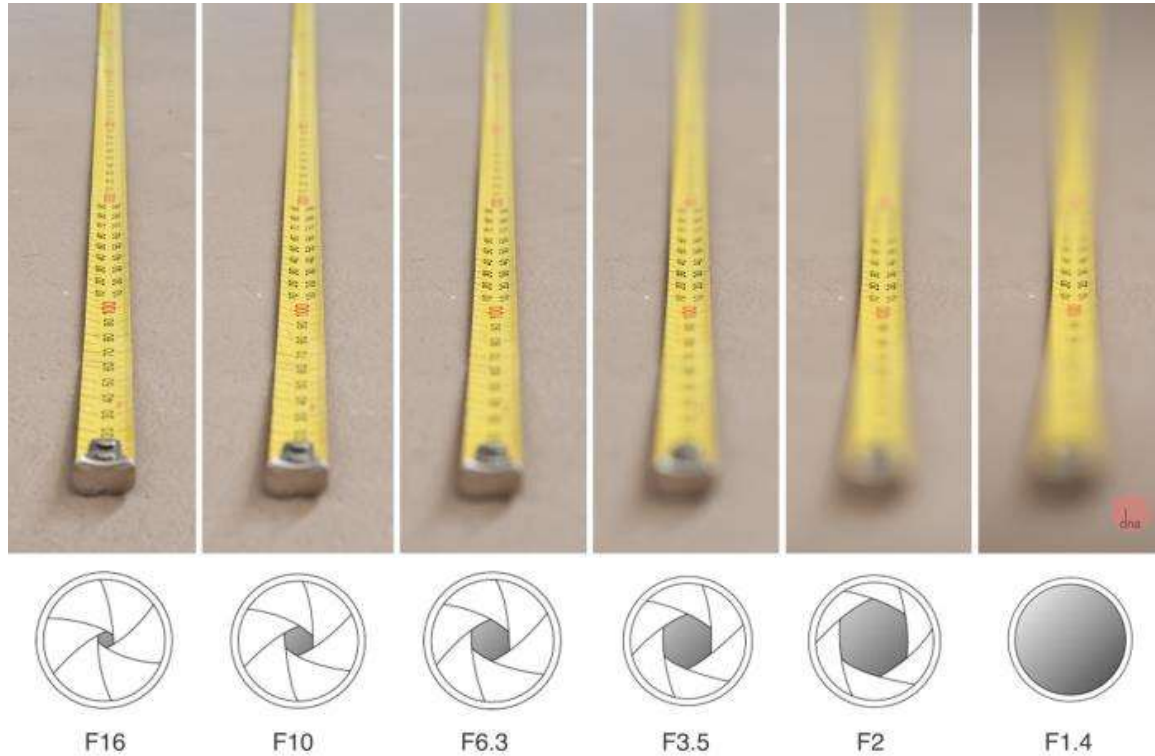
Cameras



Ref: <http://www.physics.byu.edu/faculty/colton/courses/phy123-fall12/warmups/jitt30a.html>



Cameras



Ref: <https://www.ormsdirect.co.za/blog/2012/05/08/what-is-aperture-desmond-louw-explains/>



Cameras

What is needed for a railroad application:

Ideally want **large depth of field (small aperture)** for maximum content in focus.

Want **fast shutter speed** to capture quickly moving objects.

Generally **need lots of light.**



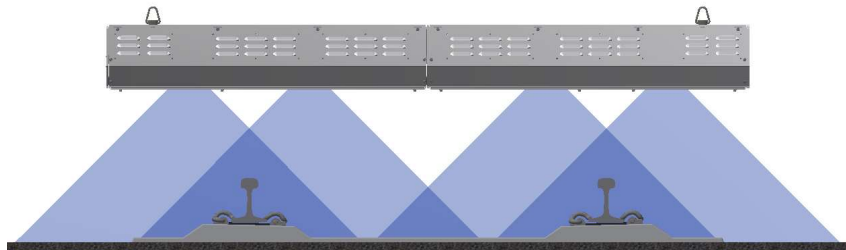
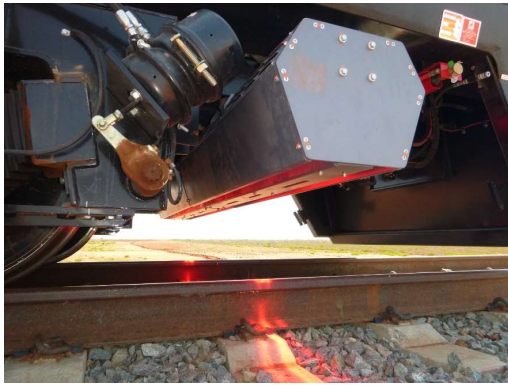
Example Camera Systems



Wheel Sensor



Example Camera Systems



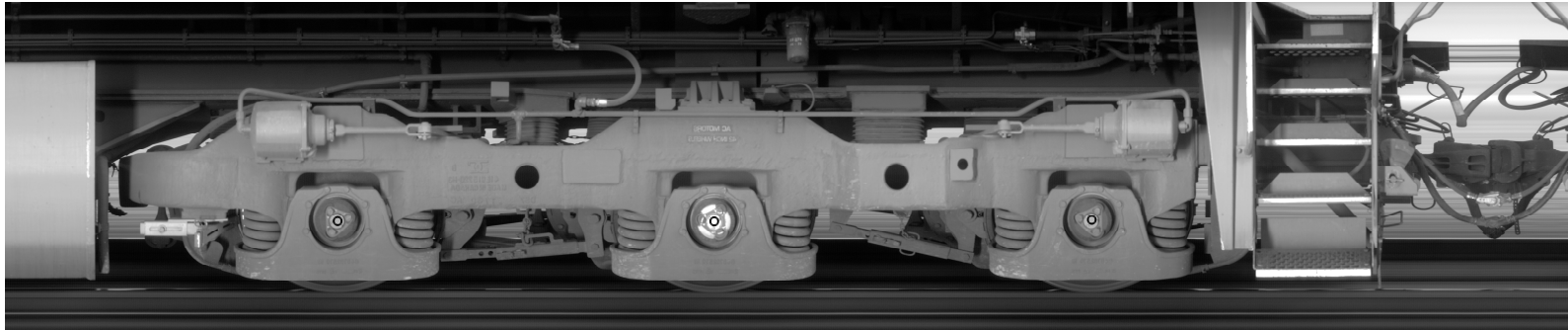
Track Component Imaging



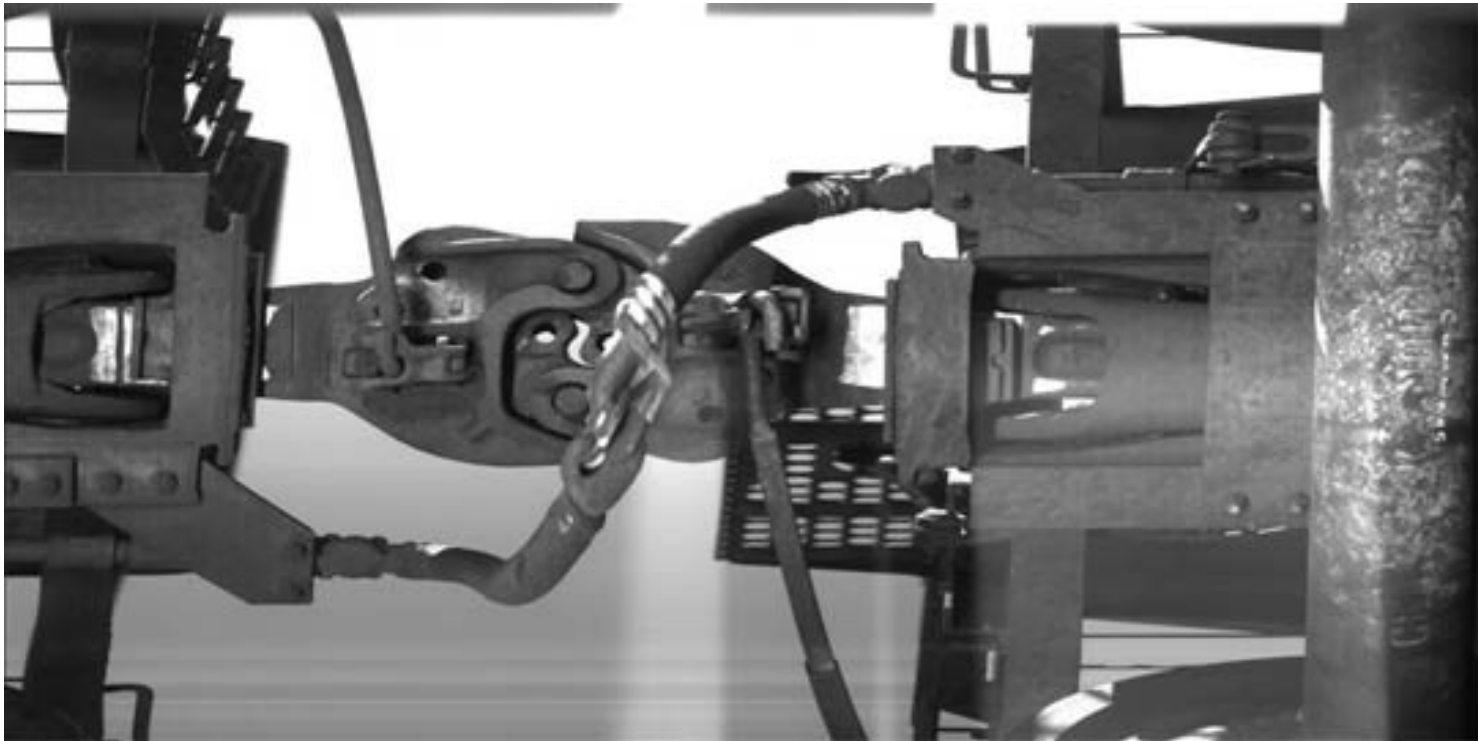
Joint Bar Imaging



Example Line Scan Images



Example Line Scan Images



Example Line Scan Images



Example Line Scan Images



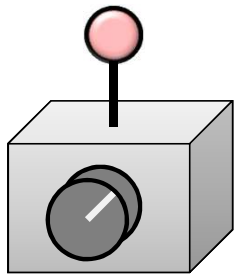
Asset Management



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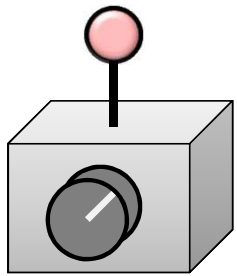


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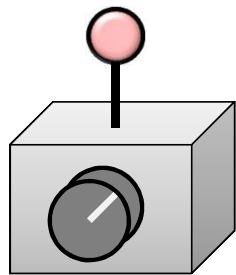
System identifies problem when measurement **exceeds threshold** and transmits direct to field personnel for repair.





I want to know this ahead of time to plan better!





Am I spending my maintenance funds the best?



Asset Management



Data Validation
& Correction



Asset
Assignment



Prediction & Work
Identification



Resource
Planning





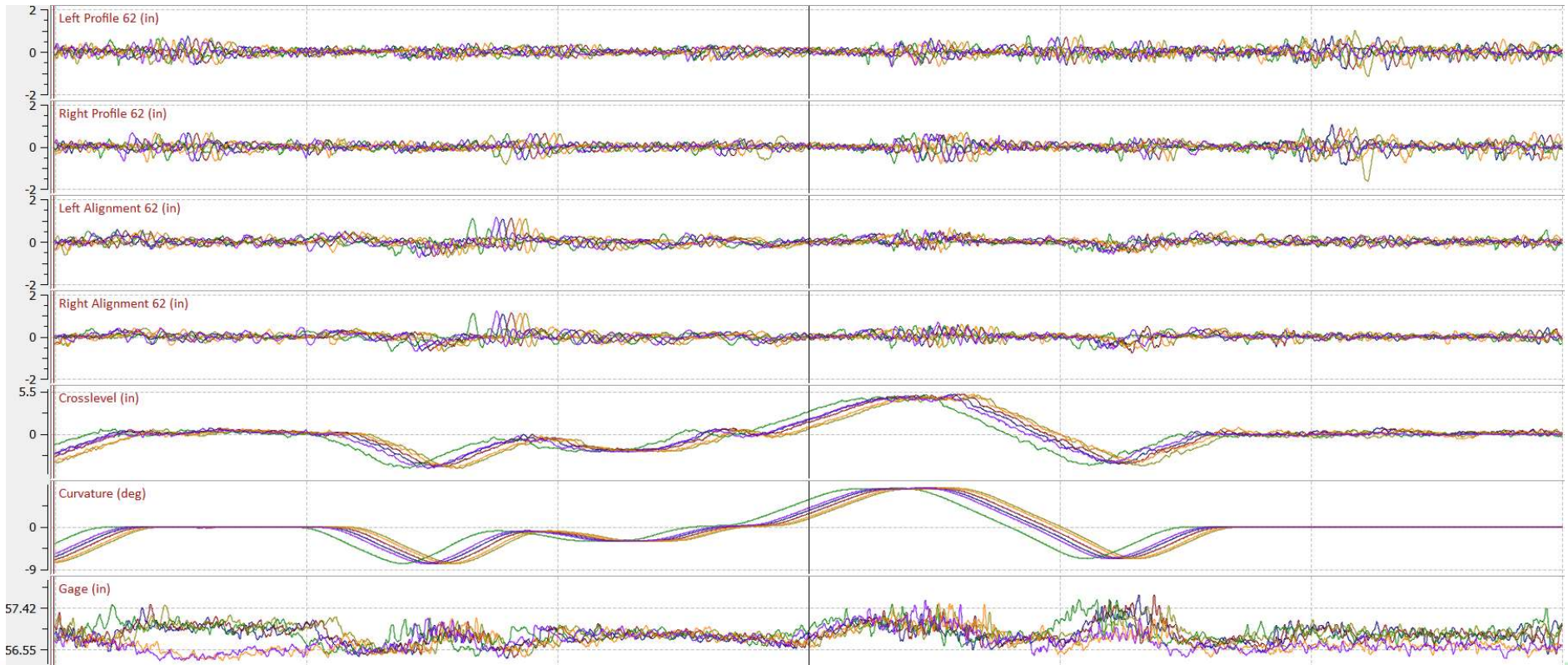
Data Validation & Correction

- We're using measurement like we haven't before.
- This requires a greater need for data accuracy!
 - Erroneous Data Removed
 - Profile Template Matching
 - Data Alignment



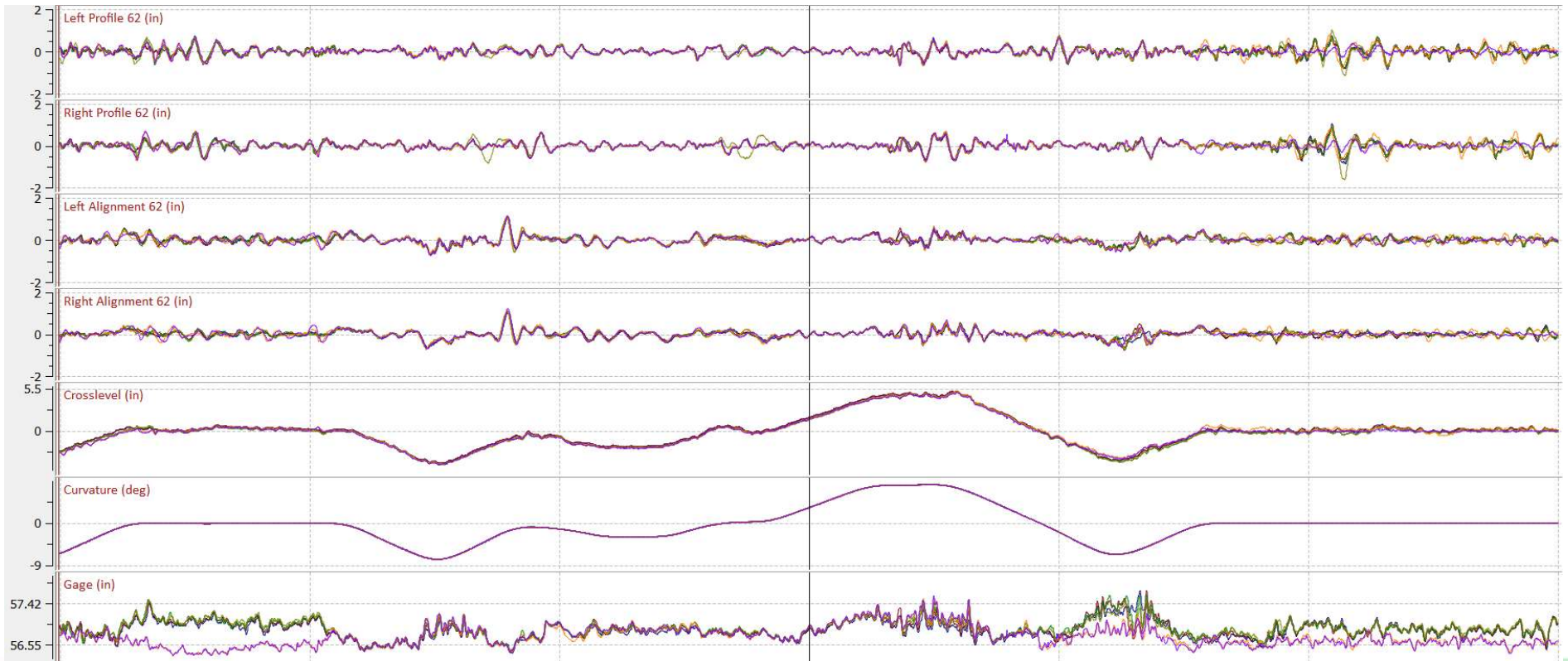


Data Validation & Correction





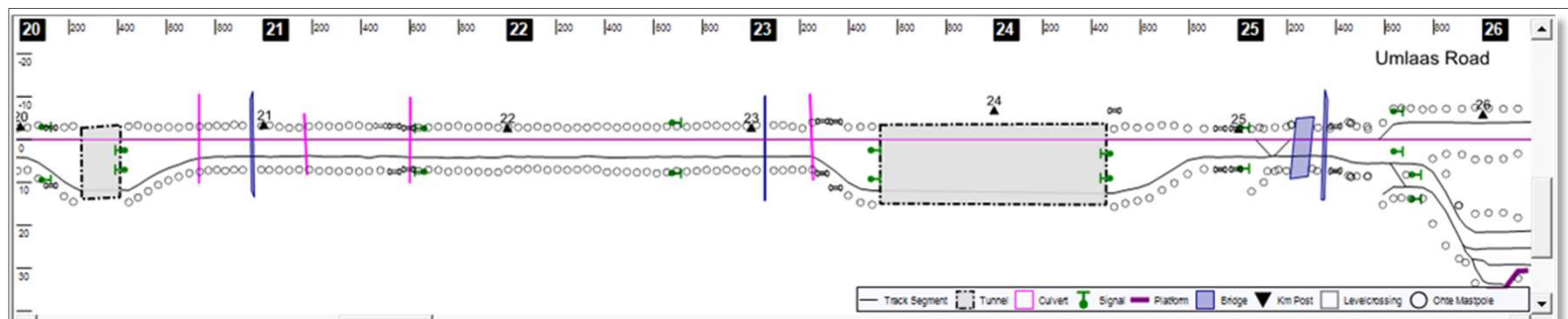
Data Validation & Correction



2

Asset Assignment

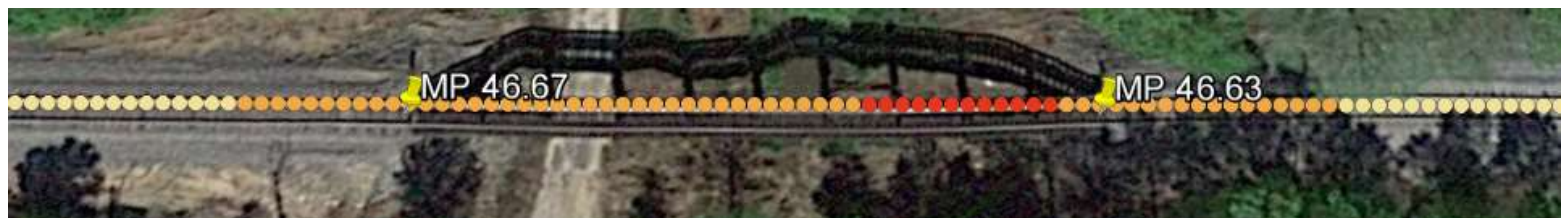
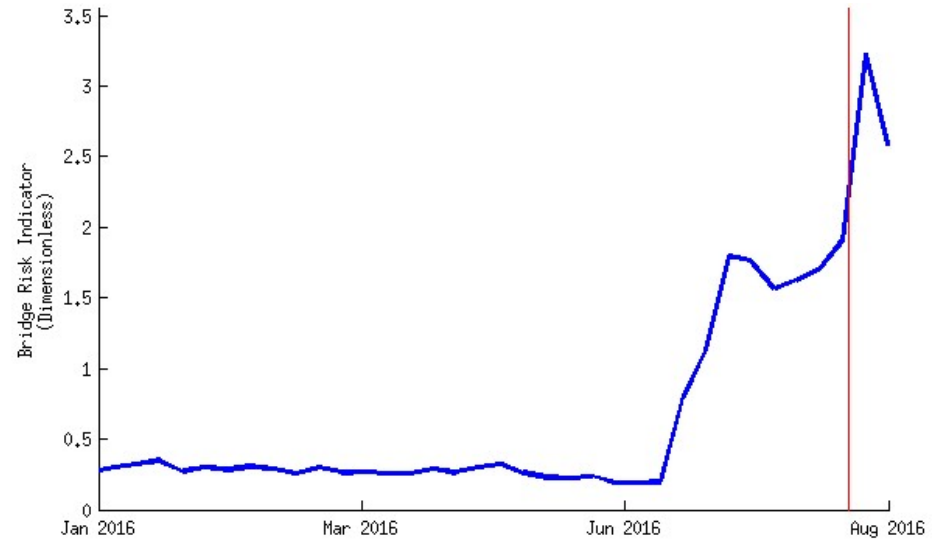
- First: What and where are your assets?
- Second: Assign data to the correct asset.





Prediction & Work Identification

- If #1 and #2 are done well, #3 is much easier!
- Prediction needs to be prescriptive as much as possible



4

Resource Planning

- Receive the Identified Work associated to Assets.
- Execute the Work with Work Orders.
- Linear Asset Management (LAM)



Questions?



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