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Rob Brownell, Director Rail Business Development

Intelligent Right of Way Safety & Inspection Systems

Dallas Texas - January 25, 2020

The FRA has Identified 6 Key Areas of Focus in 2020

1. Safety
2. PTC (Positive Train Control)
3. Regulatory Form
4. Crossing & Trespasser Accidents
5. Amtrak
6. Technology



Key Technology Points from the FRA

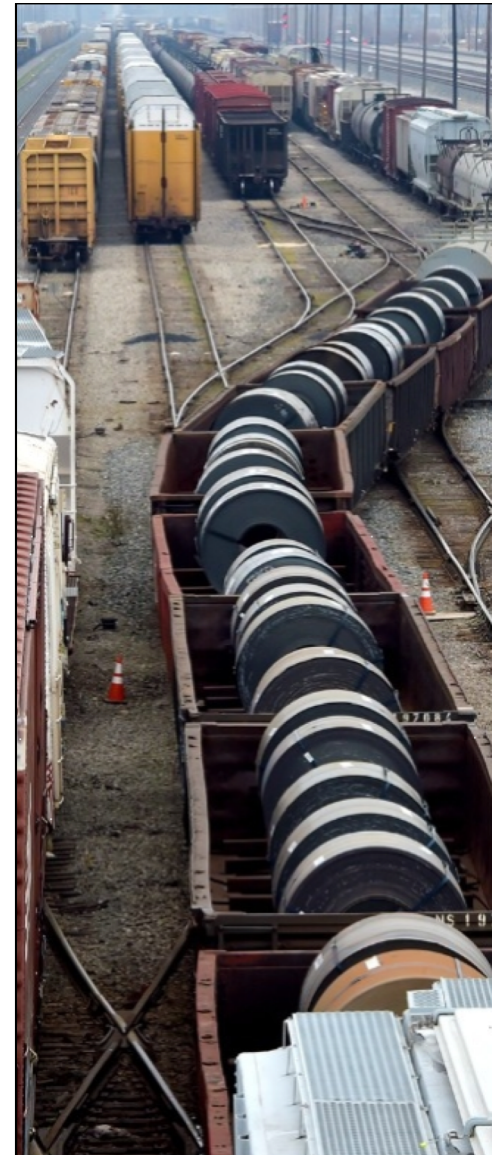
1. Developing Opportunities to promote safe methods to support growth.
2. Applying Prescriptive Regulations will do more harm for safe growth
3. Augmenting performance & Prescriptive-based rule making

Culture change with Technology

“The Federal Railroad Administration cannot issue regulations fast enough to keep up with technology advancements within the railroad industry”

“White Papers and interaction with vendors and railroads will help support advancement that is favorable with FRA “

Ronald Batory – FRA Administrator, March 26, 2019

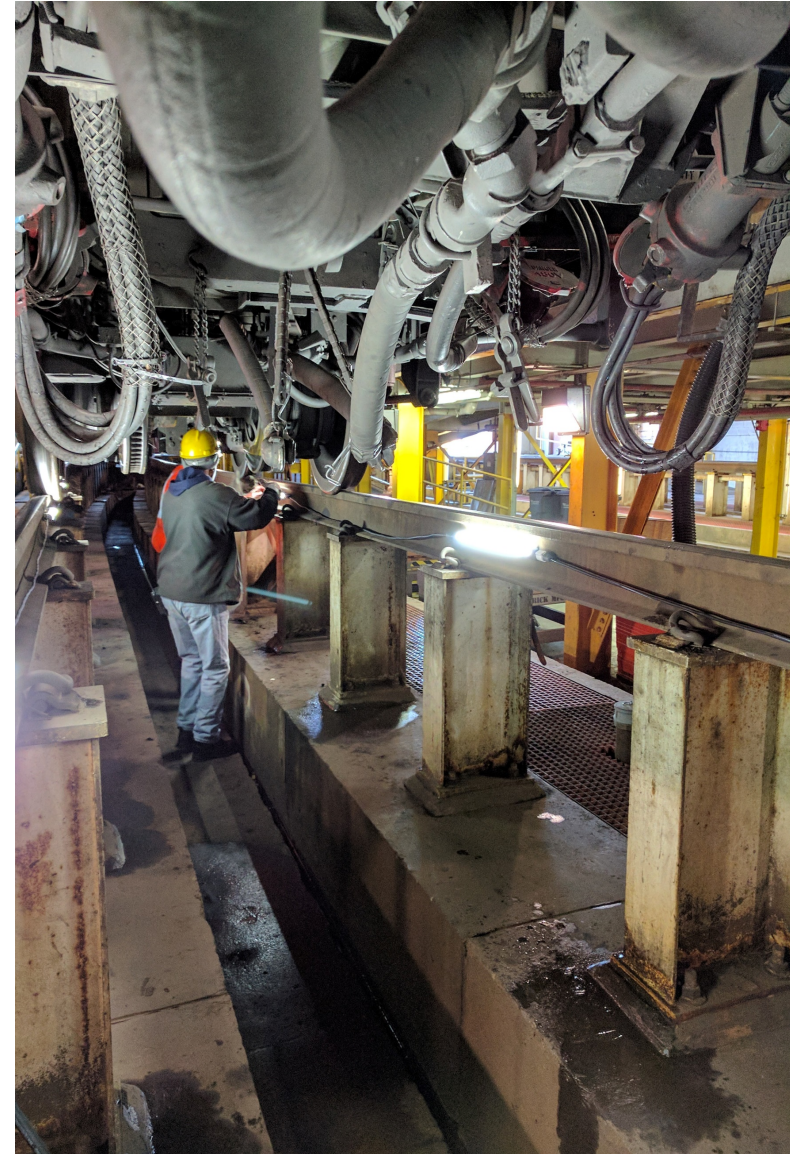


Today's World..

Both Passenger and Freight Transportation teams need the latest state-of-the-art technologies to **modernize, optimize** and **improve** the rail car inspection process, which result in:

- Improved Safety
- Reduced Online Failures
- Greater Productivity
- Improved Yard & Network Fluidity
- Increased System Velocity

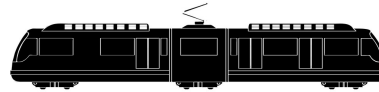
...most importantly, make it a more **reliable** and **safer** railroad.



Potential Rail Applications



FREIGHT



TRANSIT

rip[®]
Railcar Inspection Portals

vue[®] Vehicle Undercarriage Examiner

apis[®] Automated Pantograph Inspection System

tvue[™] Thermal Vehicle Undercarriage Examiner

trackaware[™] Track Intrusion Detection System

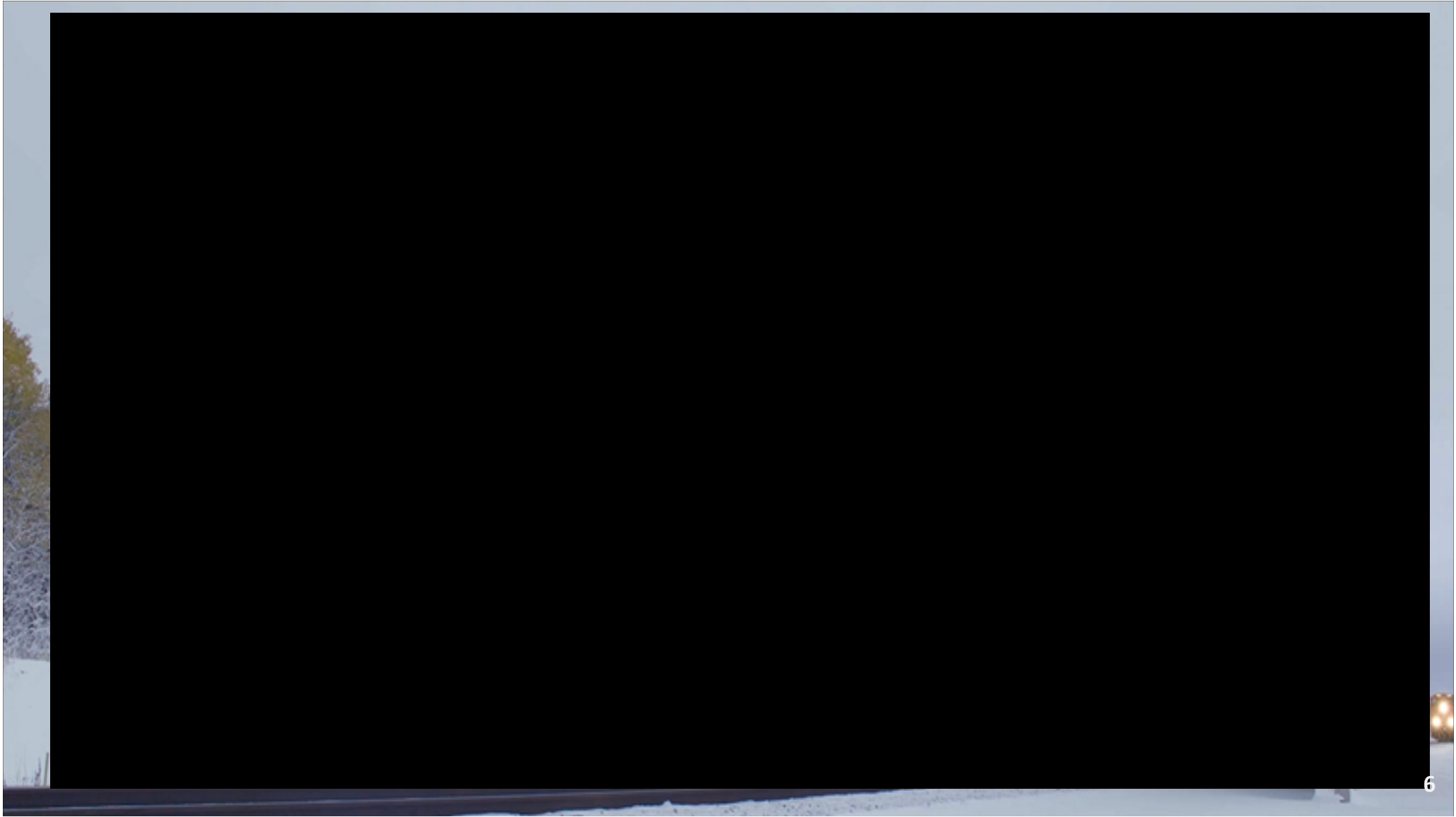
centraco[®]
Inspection Workflow Software Platform



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Automated Rail Inspection Portal



rip[®] Railcar Inspection Portal

The future of rail mechanical inspections

High speed, high resolution cameras

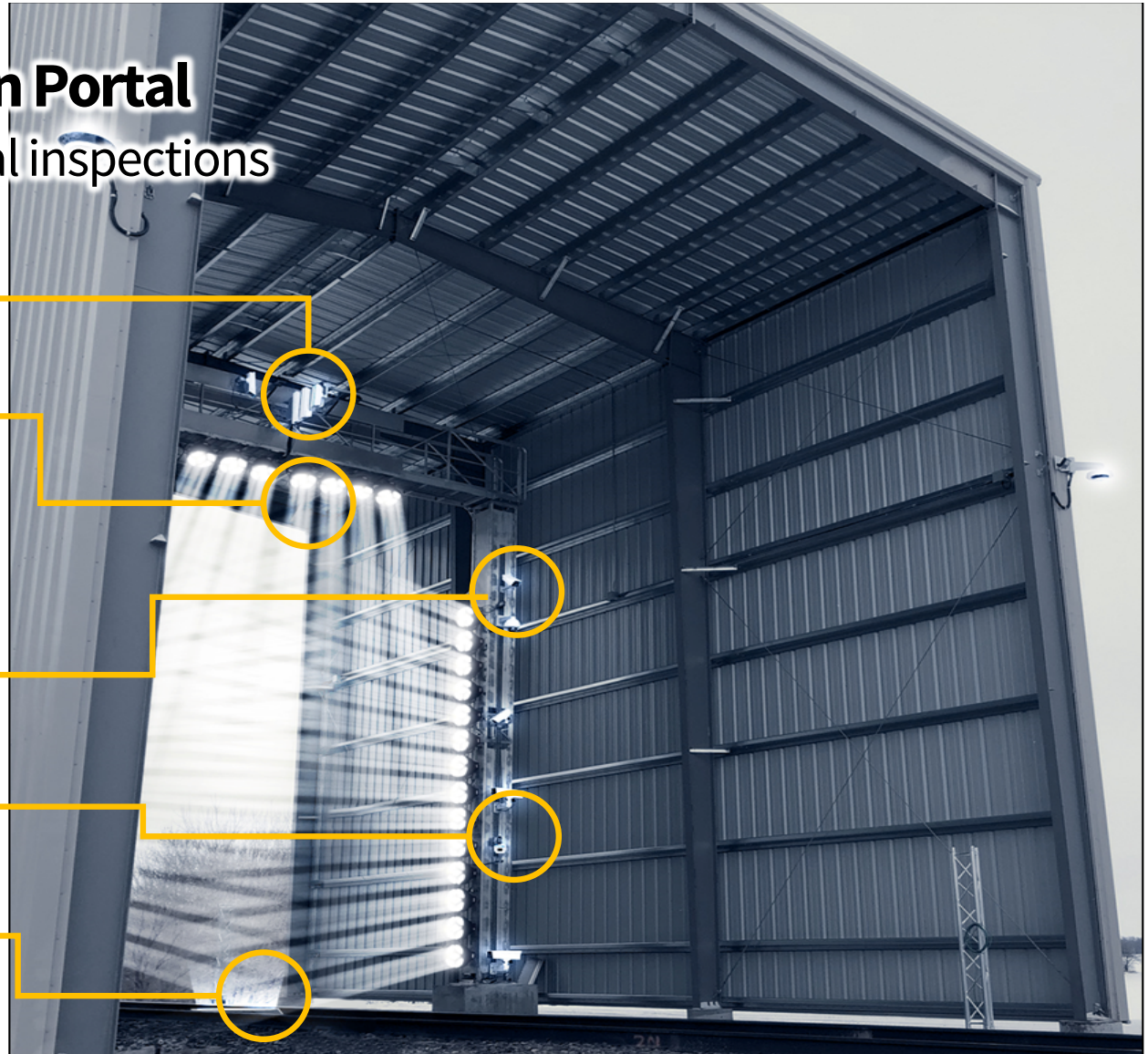
High-intensity LED lighting

AEI reader and car cutting subsystem

PTZ security cameras

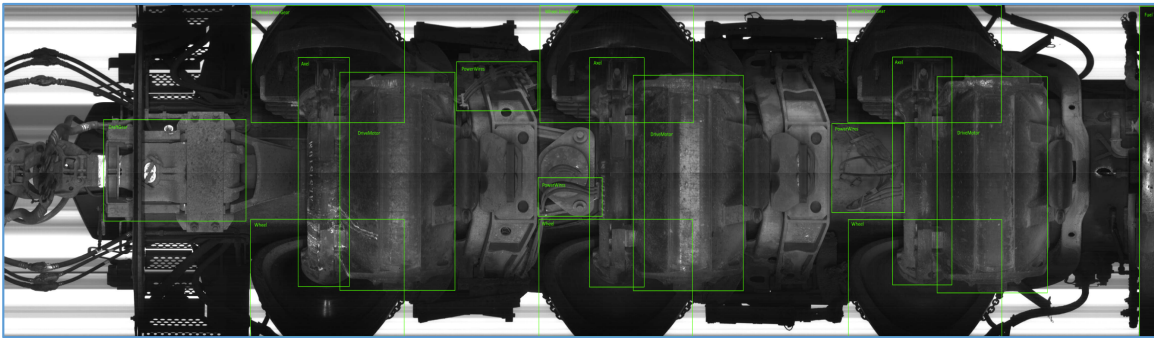
Laser motion sensing system

Vehicle Undercarriage Examiner

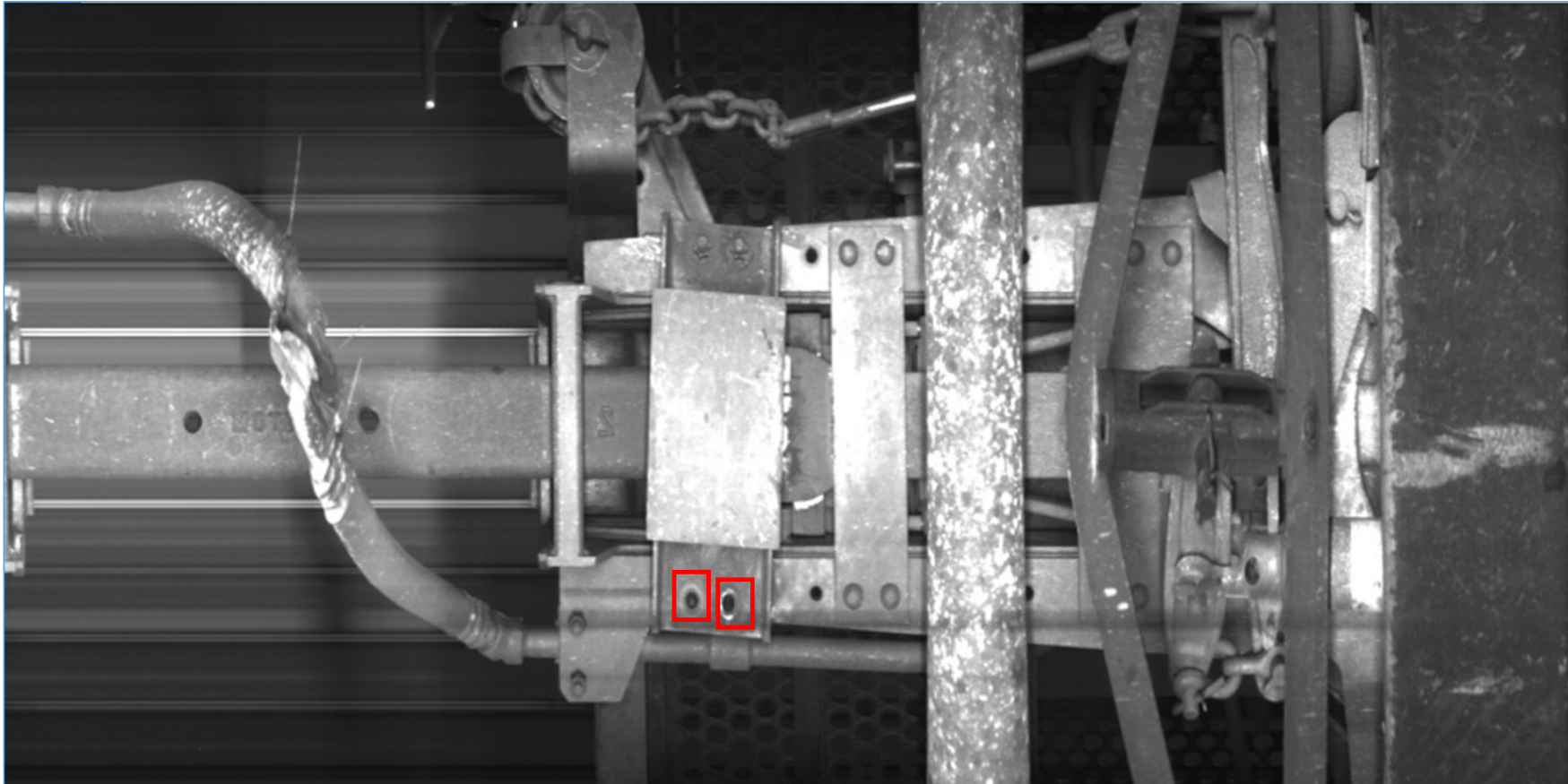


vue[®] Vehicle Undercarriage Examiner

- Ultra-high definition **xtd**[™] images
- Precision linear speed sensor
- Undercarriage images of rail cars
- Supports reduced inspection times



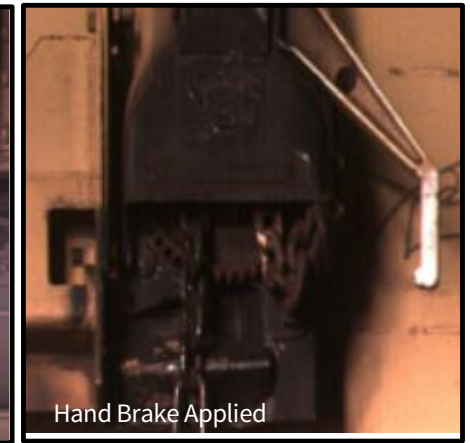
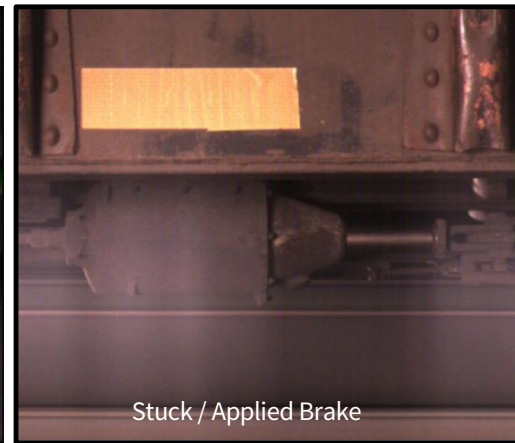
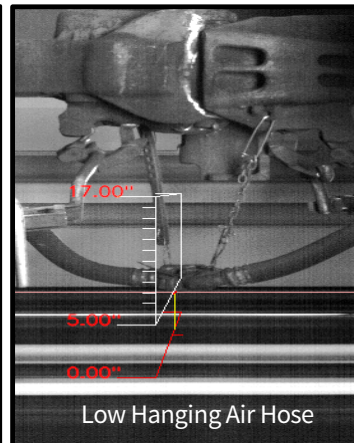
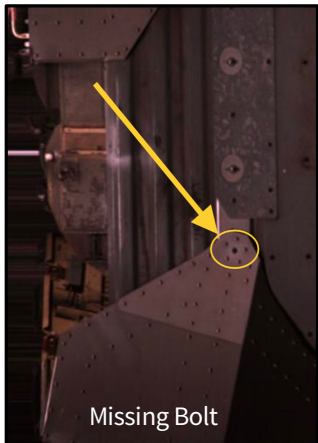
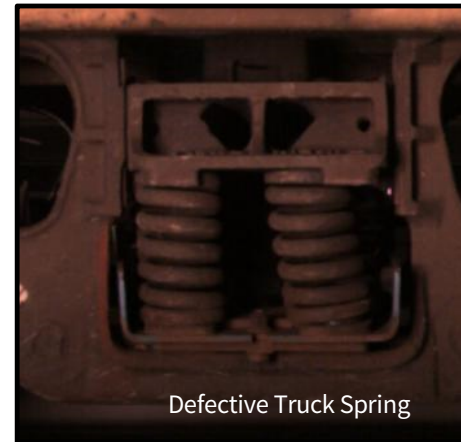
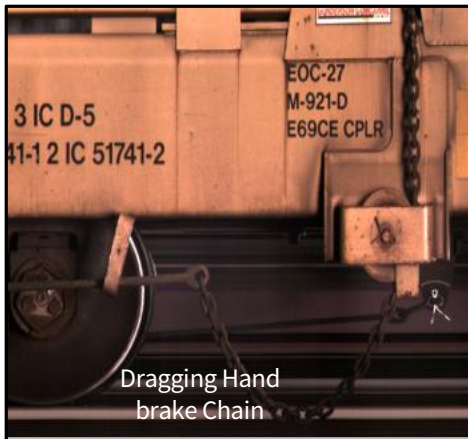
vue[®] Vehicle Undercarriage Examiner *cont'd*



vue[®] Vehicle Undercarriage Examiner *cont'd*

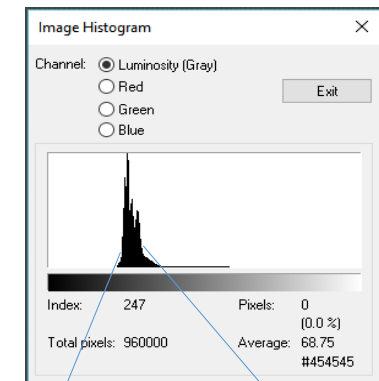
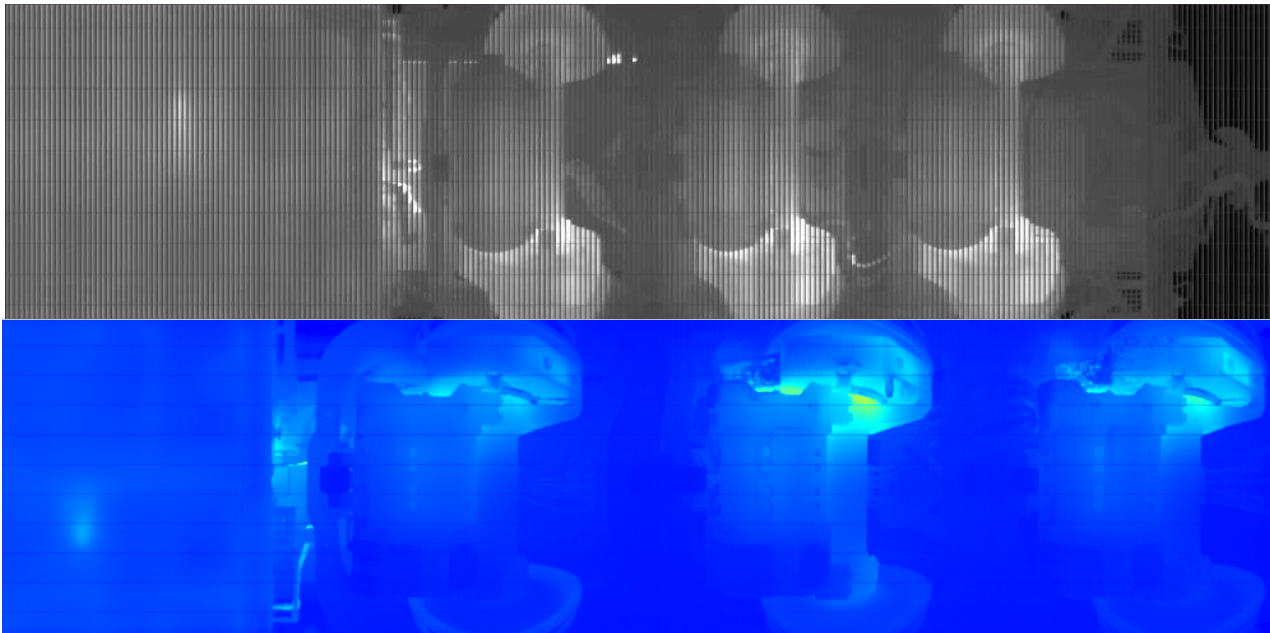


rip[®] Prevent the Accident Before it Becomes an Accident



t-vue[®] Thermal Vehicle Undercarriage Examiner

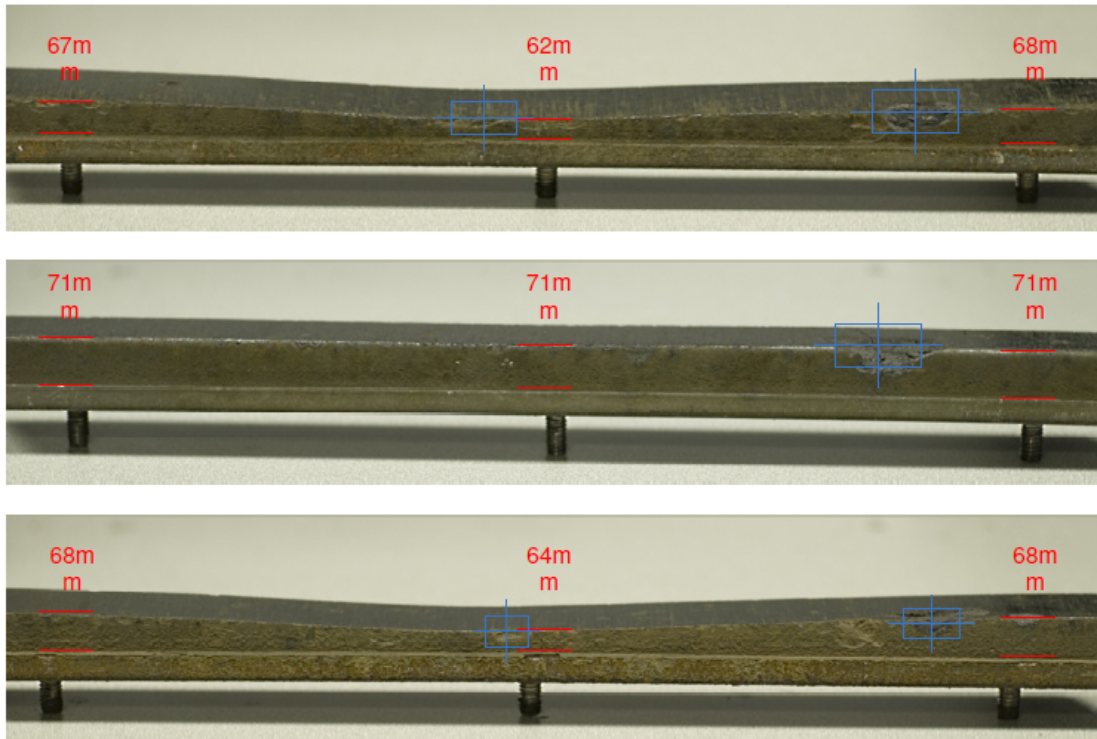
- Thermal imaging displays thermal signatures
- Identifies component's thermal signatures
- Components monitored include traction motors, motor bearings, gear drives, brakes, wheels, bearings, and power cables



t-vue[®] Thermal Vehicle Undercarriage Examiner



apis[®] - 3d Automatic Pantograph Inspection System



Pantograph Report

Pantograph Report
Dec, 1 2015

Pantograph 1

Measurement
Deviation 6 mm
Defects 2 minor
Pass – Watch Listed

Pantograph 2

Measurement
Deviation 0 mm
Defects 1 major
Failure – replace

Pantograph 3

Measurement
Deviation 4 mm
Defects 2 minor
Pass – Watch Listed

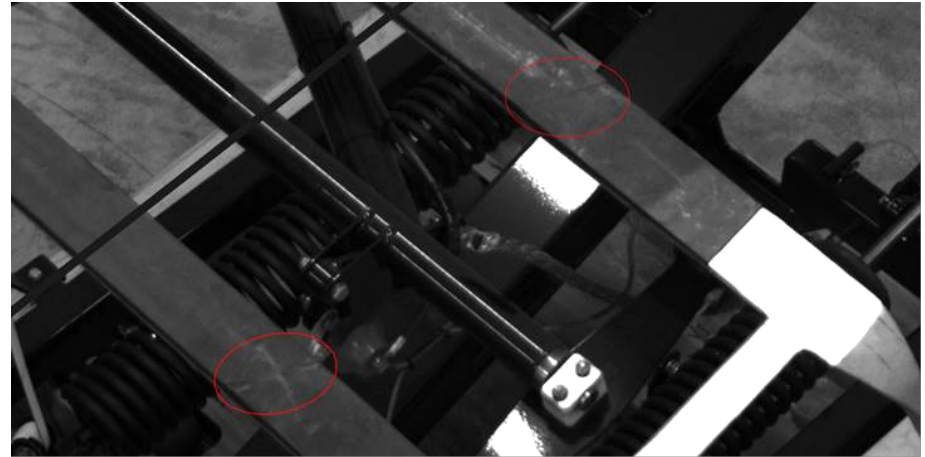
Legend

— Metrology Results
Anomaly Detection



apis[®] - 3d Automatic Pantograph Inspection System

- Dedicated **apis[®]** team
- Continuous R&D
- Accelerated Algorithm development for defects



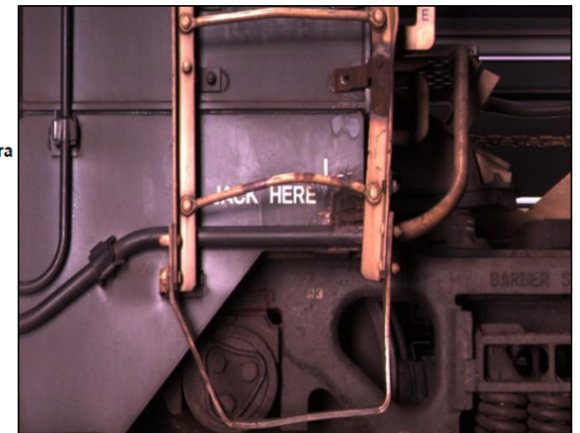
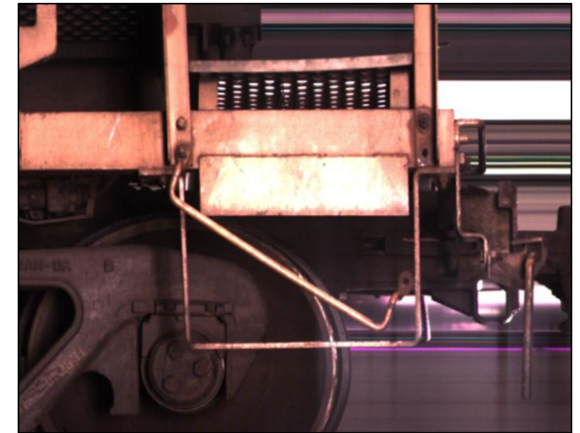
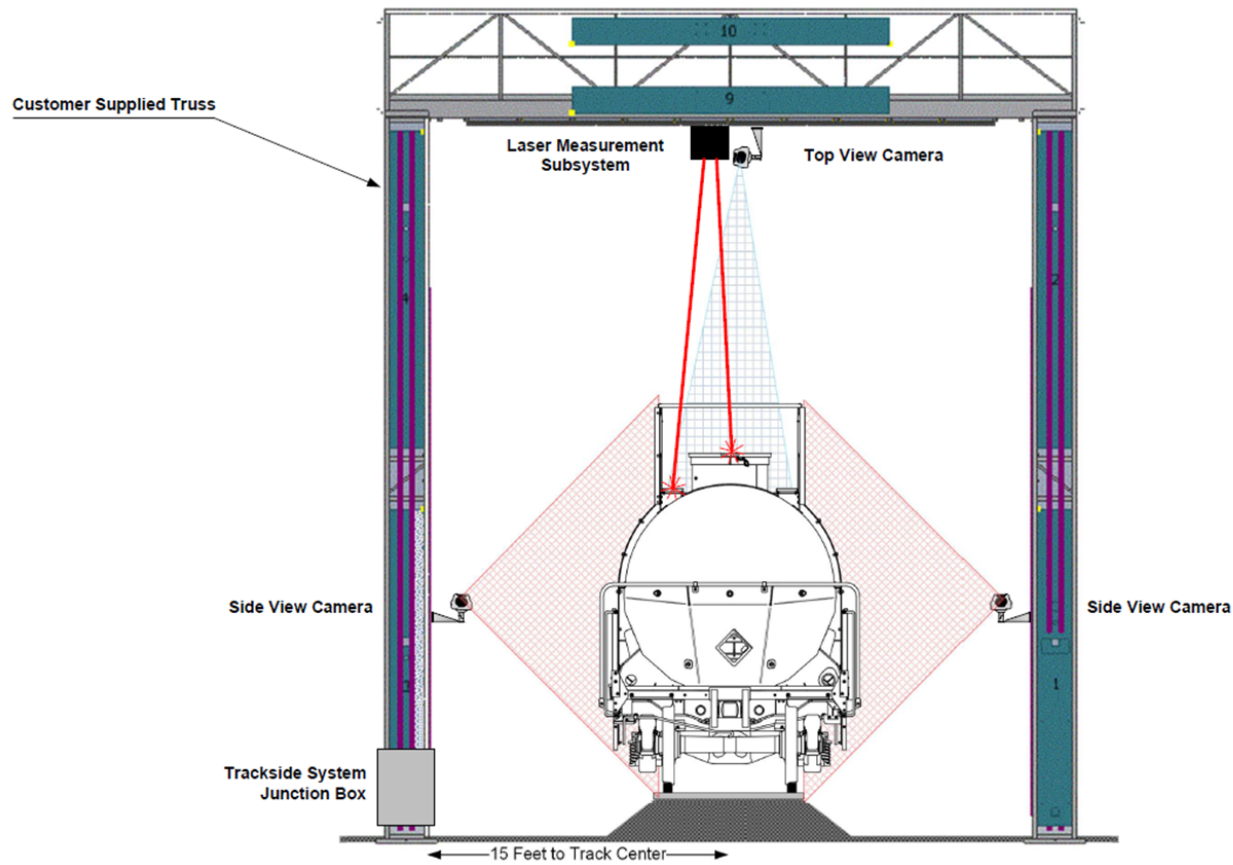
rip[®] Sample OCR Container Detection



Industrial Rail Car Inspection System



Industrial Rail Car Inspection System





Command and Control Inspection Workflow Software Platform with a user friendly interface

The screenshot displays the Centraco software interface. On the left is a dark navigation menu with the following items: Home, Sitemap, Video, Alarms, Autocheck, Events, Reports, Rip (highlighted), Search Trains, Search Railcars, Hazmat Placards, Reports, Car Reports, Detection Reports, Administration, Access Control, Help, Lpr, and Administration. The main area shows a 'train inspection portal' for 'Ferromex | Fresno' with a search bar and a list of inspection photos. The top right of the main area shows 'CBFX - 353864' and a red circle with '0'. A red arrow points from the 'Rip' menu item to a photo in the list, and another red arrow points from the photo to a detailed view of the defect. The detailed view shows a close-up of a train component with a blue box highlighting a crack. A 'Detection Toolbox' overlay is visible on the right side of the detailed view, containing the following information:

Detection Toolbox	
Inspector:	centraco
Location:	Far Side (truck)
Train Time:	2019-02-19 13:40:18
Inspection Time:	2019-2-19 16:11:50
AEI Tag:	CBFX - 353864
Car Type:	(unavailable for this car)
BO Classification:	BO Shop
Defect Selection:	Rules
	62 - Truck Side Bearings
Why Made:	
Comments:	Vertical Crack greater than 1 inch on constant contact side bearing
Save: Cancel:	



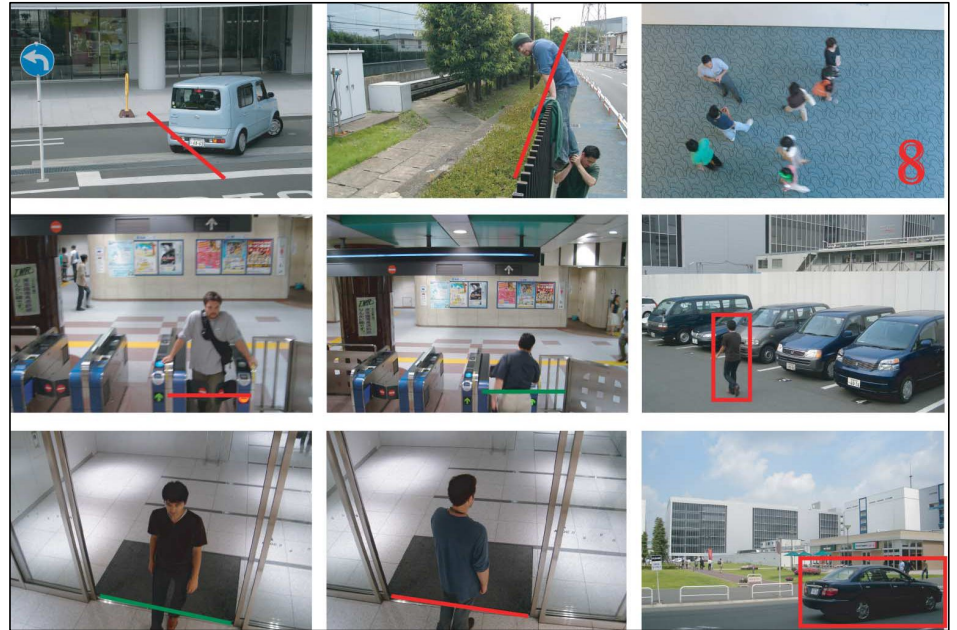
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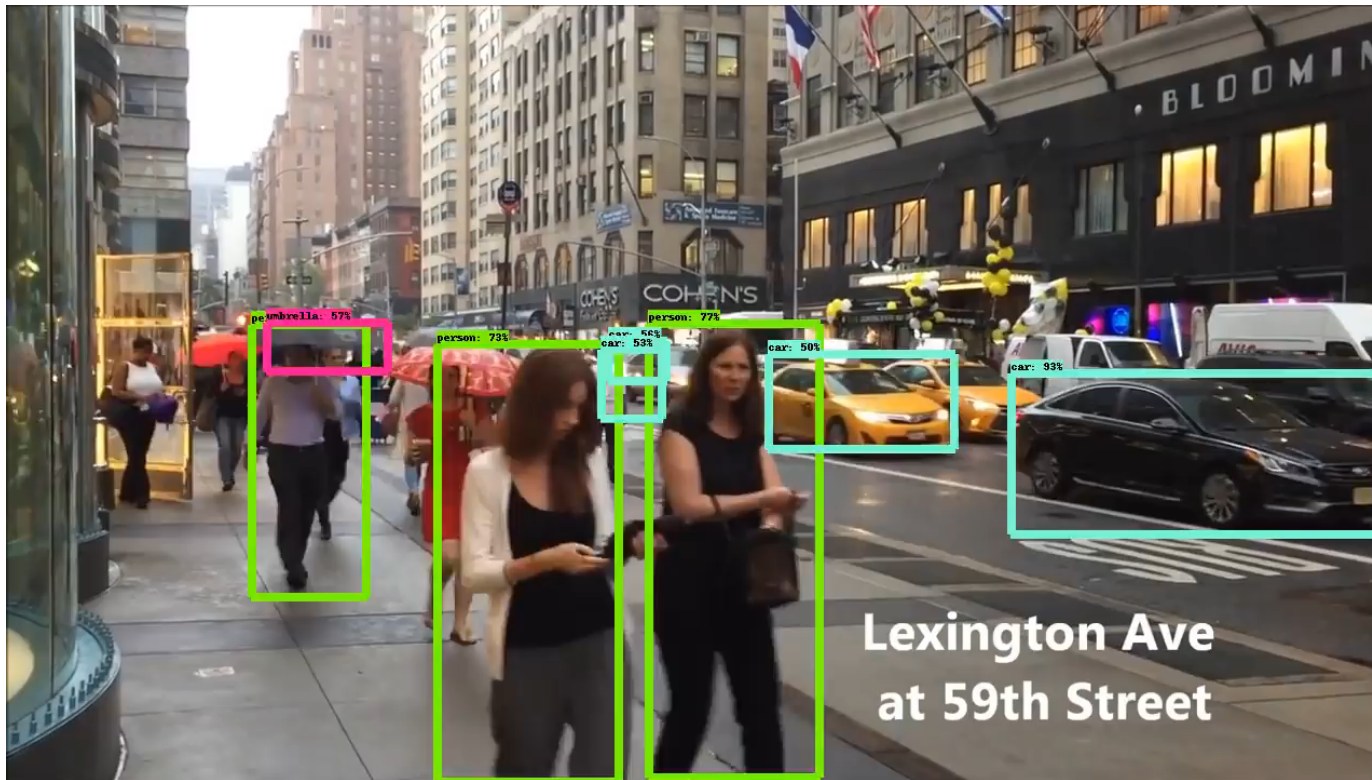
trackAware™ Intelligent Right of Way Safety System

trackAware™ Intelligent Right of Way Safety System

- Virtual fence, multiple zones
- Object classification
- Object tracking
- Directional movement
- Object counting per class
- Defect identification

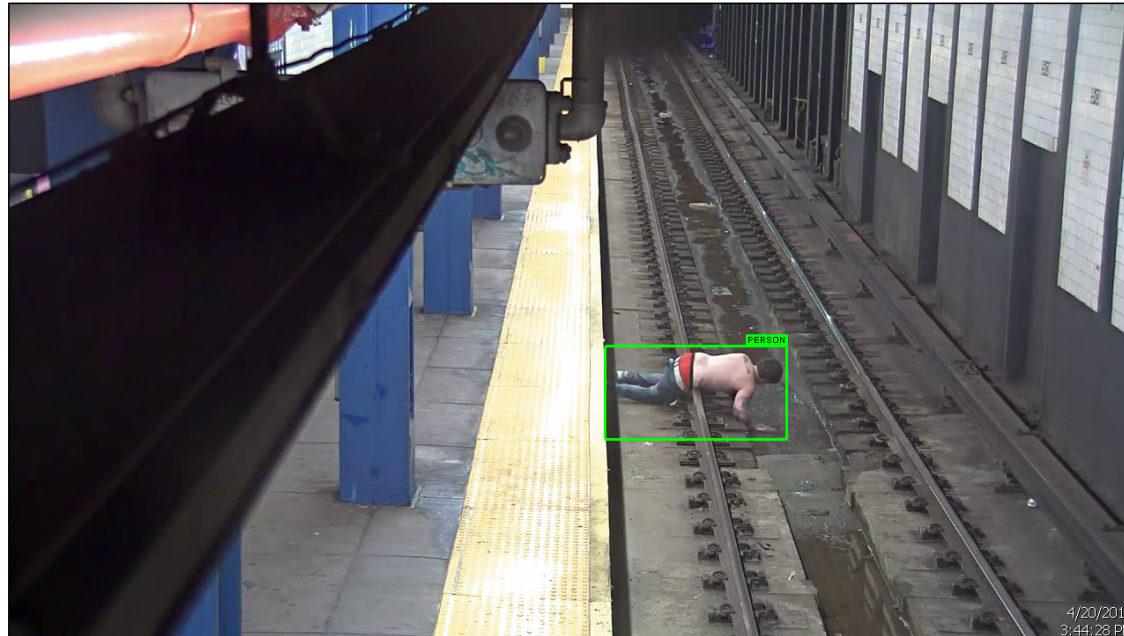


trackAware™ Intelligent Right of Way Safety System



trackAware™ Intelligent Right of Way Safety System

- 100% accurate human detection with proper pixels on target
- Distinguish/Identify specific markings (hardhat, safety vest etc.)
- People Counting



Track Aware Intrusion Detection – NYC Transit



[3]



trackAware™ Intelligent Right of Way Safety System

When the signaling system activates the gate arms to stop traffic, the system will automatically engage the distinct alarm zone. Whenever a pedestrian, bicyclist, object or motor vehicle infringes upon or is within the zone, the following will occur immediately:

- Automated Zone Obstruction Radio Message transmitted via the railroad AAR radio channel to the on coming train to take action using proper train handling
- An alarm will be transmitted visually and audibly to the OCC
- Real-time video will be automatically streamed to the OCC
- Potential to use cell notification within zone
- Locally, in addition to the existing bells from the gate arms, our system will begin to flash high intensity strobe lights and locally announce a warning message in multiple languages.

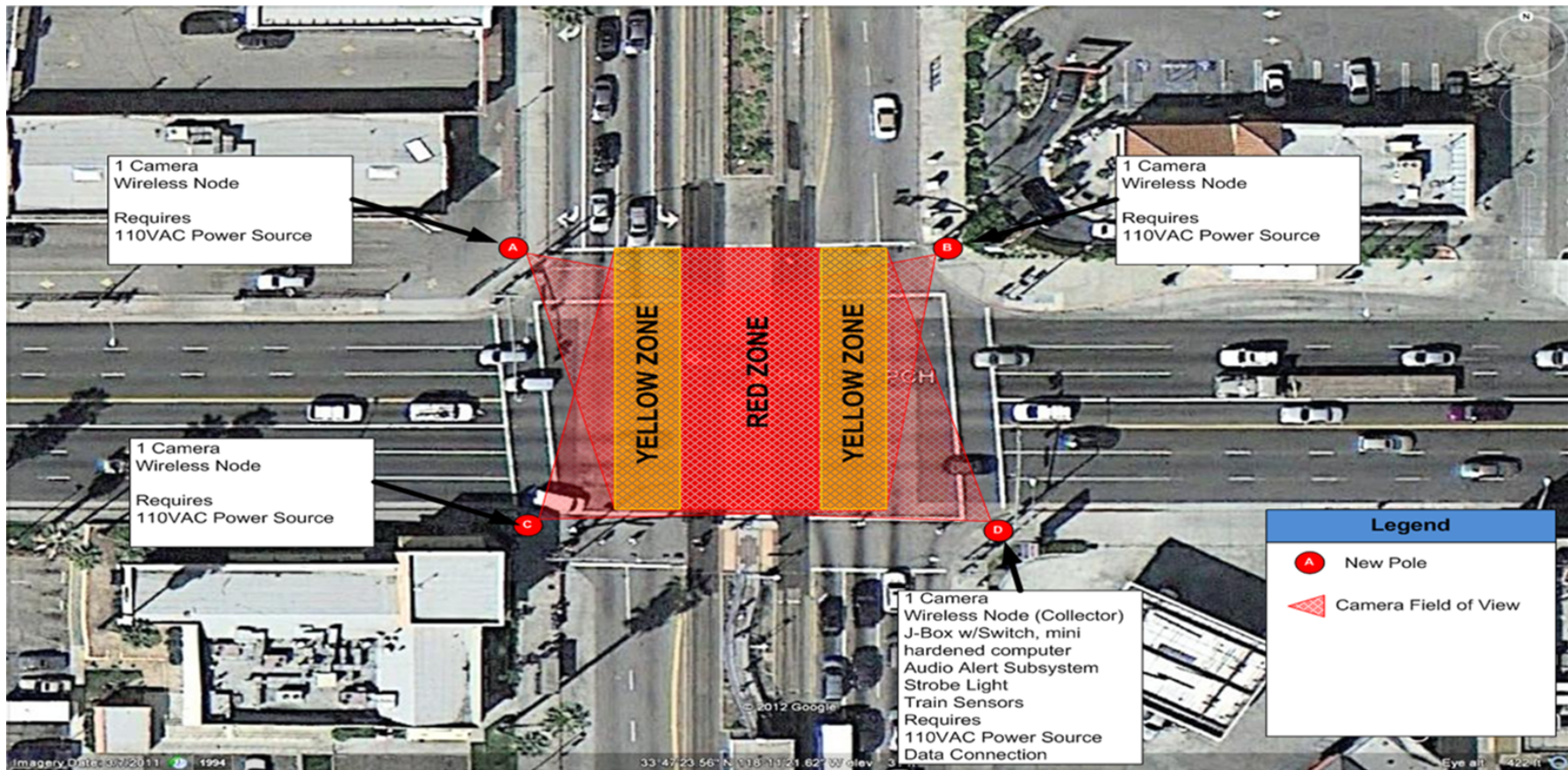
Table 3: Location of Pedestrian Trespasser Casualties, Excluding Suicides, November 2013 to October 2017

Distance from a Highway-Rail Grade Crossing (feet)	Casualties Nationwide		Casualties in Top 10 Counties	
	Cumulative Number	Cumulative Percentage	Cumulative Number	Cumulative Percentage
600 to 700	2,798	66 %	21	67 %
700 to 800	2,945	69 %	16	70 %
800 to 900	3,049	72 %	10	72 %
900 to 1,000	3,142	74 %	12	74 %
1,000 to 1,250	3,328	78 %	25	79 %
1,250 to 1,500	3,477	82 %	21	82 %
1,500 to 2,000	3,711	87 %	30	88 %
2,000 to 3,000	3,950	93 %	21	92 %
3,000 to 5,000	4,107	97 %	24	96 %
5,000 to 10,000	4,186	99 %	12	98 %
More than 10,000	4,242	100 %	11	100 %
Total Casualties	4,242		559	

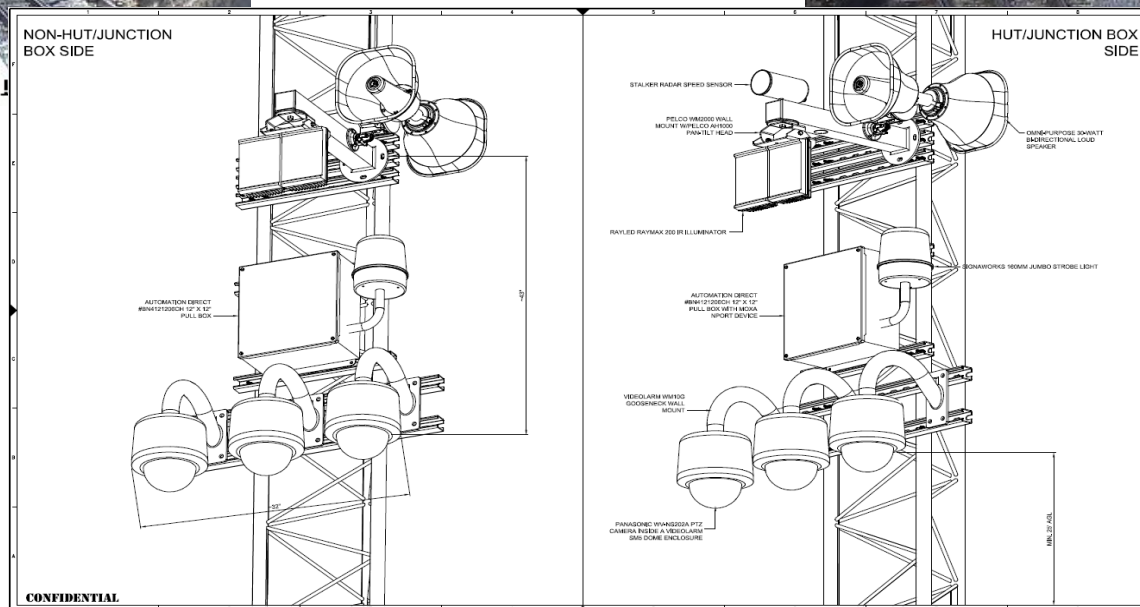
Source: FRA analysis.



trackAware™ Intelligent Right of Way Safety System



trackAware™ Intelligent Right of Way Safety System



trackAware™ Intelligent Right of Way Safety System

The Platform - Hardware

- It is an appliance,
 - **no cloud access is needed**
- Training can happen directly on the unit
- Inference on GPU and CPU
- Supports wide variety of hardware
 - **From single board to server class**



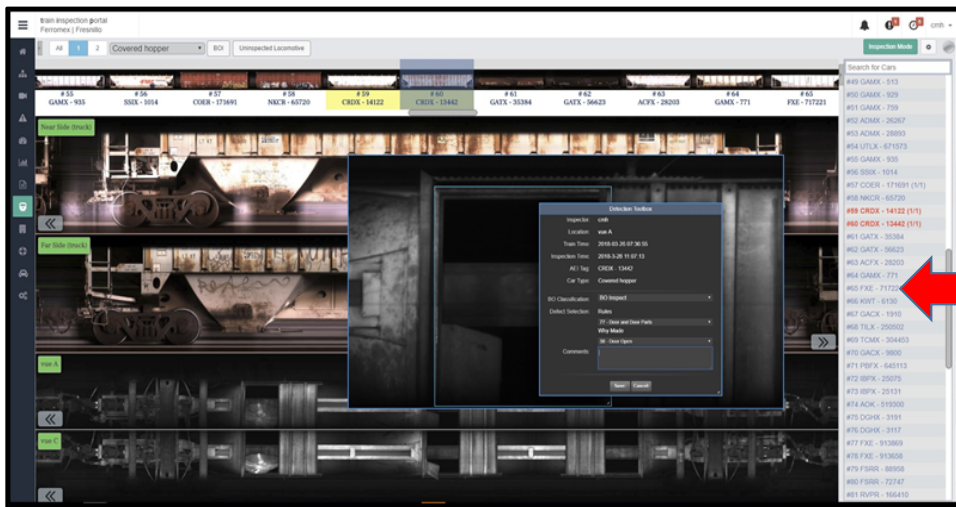
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The Development of Algorithm Mapping

The Development of Algorithm Mapping

- Improving the Confidence level with FRA 49CFR Rules
- **Performance** Statistics
- Low False Positive **Rate**
- **Consensus** Data
- Document Progression and Development from **Start to Finish**



The Development of 49CFR - Algorithm Mapping

Model Validation Checklist

NS AIP – Model Validation Checklist

Date:	<input type="checkbox"/>	Date Submitted for Training:	<input type="checkbox"/>
Submitted by:	<input type="checkbox"/>		
Reviewed by:	<input type="checkbox"/>		
Model Name:	<input type="checkbox"/>		
Application(s) in Model Name:	<input type="checkbox"/>		
Performance Metric Used:	<input type="checkbox"/>		
Metric level:	<input type="checkbox"/>		
False Positive Rate:	<input type="checkbox"/>		
False Negative Rate:	<input type="checkbox"/>		
False Negative Rate Details: (e.g., remedial action done, field validation done)	<input type="checkbox"/>		
Reason for Model Creation: (e.g., FRA requirement change, derailment cause, business request)	<input type="checkbox"/>		

Model Validation Checklist

Note: The purpose of this checklist is to provide high-level guidance as to the types of items that should be verified when mechanical inspection workflows, including all applications. This checklist is based on requirements to ensure models meet the same standards and have passed a gating process before being released into production. Please answer the below questions ranked from: 1-No Evidence | 2-Due Consideration Lacking | 3-Some Consideration | 4-Fully Evident

Item #	Question	Rationale	Rank (1-4)
1	To what extent was the appropriateness and the completeness of assumptions checked?	Consensus data will be analyzed in a cloud staging environment prior to being sent to a staging environment where the images will be further validated	
2	To what extent was it checked that all variables employed have been clearly defined and listed?	Variables will be defined per FRA requirements and the reference points will be adjusted as changes are made to these requirements. As the requirements are updated the new metrics will be fed into the system and the models will be re-trained to ensure the new guidelines are followed	
3	To what extent have the causal relationships between variables been noted?	To address the risk of causal relationships, the models will receive feedback in a gated process from application creation to model output	
4	To what extent has input data been assessed in terms of reasonableness, validity and understanding?	Model input data will be validated by comparing car-associated metadata information across different portal locations. The data being used is captured in a consistent format across the network	
5	To what extent has a comparison of model outputs against actual realizations been performed?	Outputs will be validated by comparing car-associated billings to the list of defects found by the portals	
6	To what extent are all results repeatable?	Repeatable results will be validated by having different trainers train each model to mitigate the bias that may be held by a single trainer	

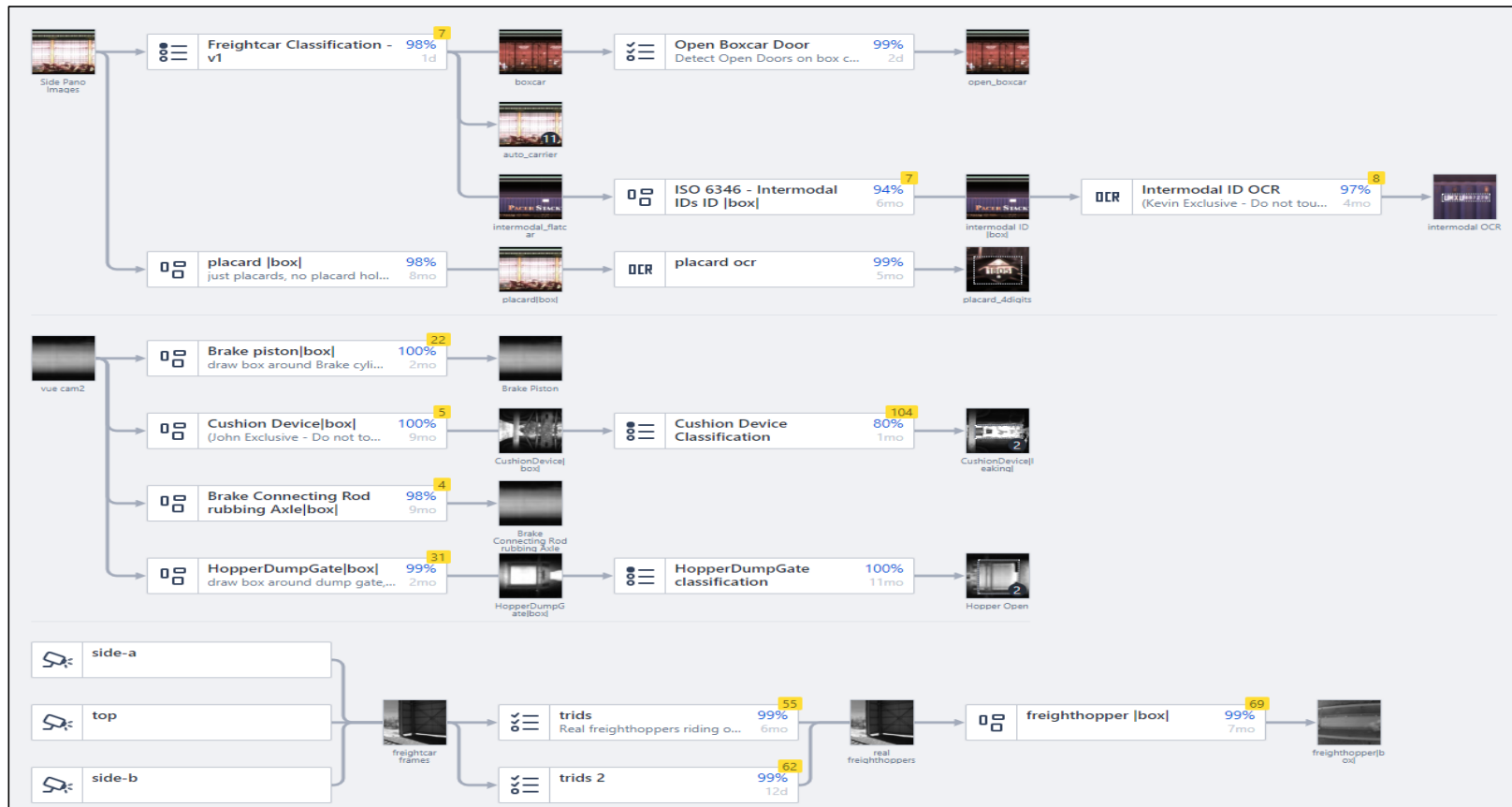
Model Validation Checklist

Note: The purpose of this checklist is to provide high-level guidance as to the types of items that should be verified when validating mechanical inspection workflows, including all applications. This checklist is based on requirements to ensure models meet the same standards and have passed a gating process before being released into production. Please answer the below questions ranked from: 1-No Evidence | 2-Due Consideration Lacking | 3-Some Consideration | 4-Fully Evident

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The Platform - Chaining



Case Study – Hazmat Placards

- 99% accuracy of localization and 100% accuracy on OCR

				
placard_4digits 1005 90% Nov 5, 2019 7:26:25 PM	placard_4digits 1005 91% Nov 5, 2019 7:26:25 PM	placard_4digits 1005 91% Nov 5, 2019 7:26:25 PM	placard_4digits 1005 90% Nov 5, 2019 7:26:25 PM	placard_4digits 1005 90% Nov 5, 2019 7:26:25 PM
				
placard_4digits 1005 90% Nov 5, 2019 7:26:25 PM	placard_4digits 1267 68% Nov 5, 2019 6:32:43 PM	placard_4digits 1267 68% Nov 5, 2019 6:32:42 PM	placard_4digits 1267 76% Nov 5, 2019 6:32:42 PM	placard_4digits 1267 74% Nov 5, 2019 6:32:42 PM



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What are the end results ?

Inspection Solutions Offer Immediate Value

The future of rail mechanical inspections

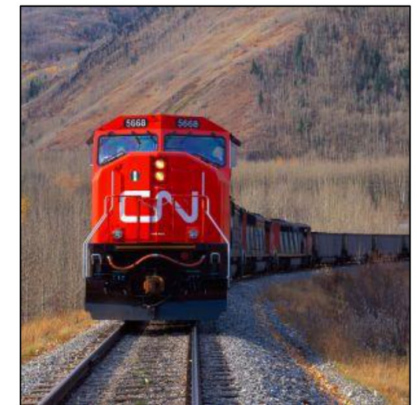
1. **Safety** – Reduction in Derailments & Employee Injuries
2. **Dwell Impact** – Significant Reduction in Cars Sitting Idle
3. **Capacity** – Creates Virtual Capacity
4. **Velocity** – Significant Increase
5. **Productivity** – teams become “*Fixers*” Instead of “*Finders*”
6. **Expense** – Reduction in Labor Expenses
7. **Train Accuracy** – Eliminate Ghost Containers/Cars/Assets
8. **Value** – Significant Impact on Operating Ratios
9. **ROI** – Immediate Return of Investment



Inspection solutions can offer immediate value

Application of automated hub inspection process on current class 1 operation yields immediate value

Automated Car Inspection Portals – Benefits		
2019 Estimated Benefits From Winnipeg Portals		
Benefits Drivers	Estimated Annual Benefits (in MS)	Estimated Timing
Roll-By Elimination Moving carmen off roll-by inspection	\$0.7	Q2 '19
Wheels Defect Cost avoidance of derailments due to wheel failures	\$0.7	Q2 '19
Derailments Prevention Cost avoidance of derailments with mechanical causes	\$0.4	Q3 '19
Dwell/Yard Delays Reduction Reduction in costs related to in yard delays	\$1.8	Q3 '19
Border Wait Time Reduction Reduction in border delays to due to mismatch with Manifest	\$0.3	Q2 '19
R&D Tax Benefits	\$0.2	Q2 '19
Total	\$4.1	



The background features a dark scene with several computer monitors displaying various data and charts. Overlaid on this is a network diagram consisting of blue nodes connected by thin lines, suggesting a digital or data network.

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Thank You - Q&A