Instrumented Revenue Vehicles for Heavy-haul Track Defect Monitoring and In-train Force Validation

Rob Lambert, Senior Business Manager
Monash Institute of Railway Technology
Melbourne, Australia

Agenda

1. Introducing Monash IRT
2. Introducing the Instrumented Revenue Vehicle
3. Examples of benefits
4. Further development

Monash Institute of Railway Technology

- **Monash University is the largest university in Australia, ranked in the top 1% of Universities internationally**
- **Monash IRT is a centre delivering applied and translational research, dedicated to servicing railways**

IRT History

1972 – Founded as in-house department of BHP research labs

2000 – Established as Institute at Monash University

2002 – First implementation of IRV technology

2013 – Highest industry funded research income at Monash University

2016 – Recognised in parliament as the "Premier Track and Vehicle Research Centre in Australia"

2021 – Team now totaling 40+ staff continue to deliver industry focused research and technology for railways

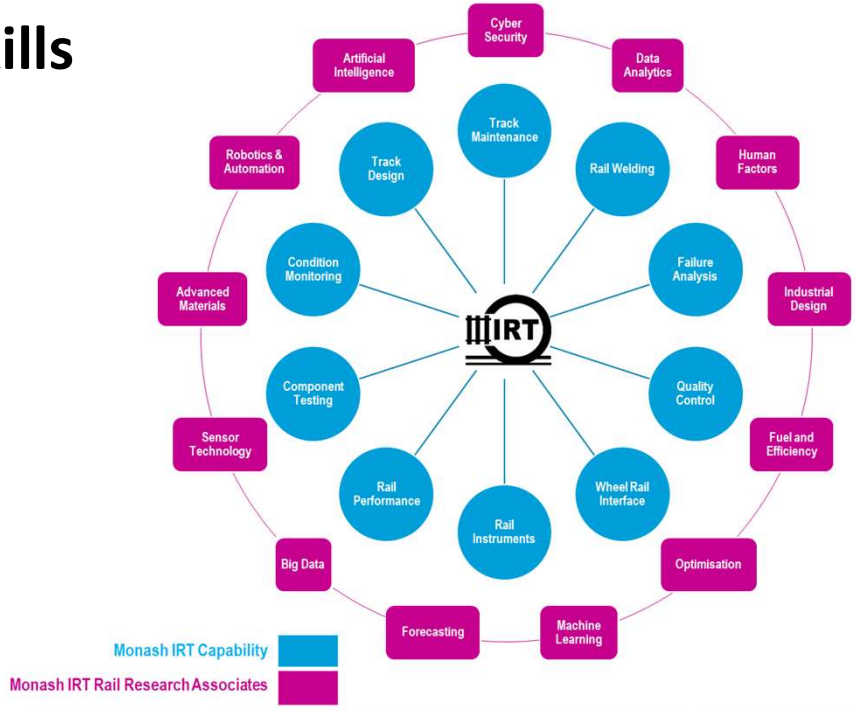
IRT Services over 160 Clients

IRT Capabilities

- Materials Analysis and Physical Testing
- Condition Monitoring
- Data Analytics
- Wheel-Rail Interface
- Vehicle Dynamic Simulation
- Track Performance
- Welding Process Development
- Novel Technology Implementation

Broader Academic Capabilities

- **Links to world class academic skills in:**
  - **Accident research**
  - **Human factors**
  - **AI and Machine Learning**
  - **Sustainable Materials**
  - **Industrial Design**
  - **Robotics and Automation**



Instrumented Revenue Vehicles

Instrumented Revenue Vehicles

- Autonomous structural health condition monitoring system on revenue service rollingstock
- Over 90 instrumented vehicles have been installed by IRT
- Near real time reporting of the condition of the track and rolling stock performance
- Effectiveness of maintenance activities

IRV System Examples





- Mature technology, since 2002
- Ruggedized integrated monitoring system
- Passenger and freight applications
- Local and self powered solutions

IRV Sensor Examples

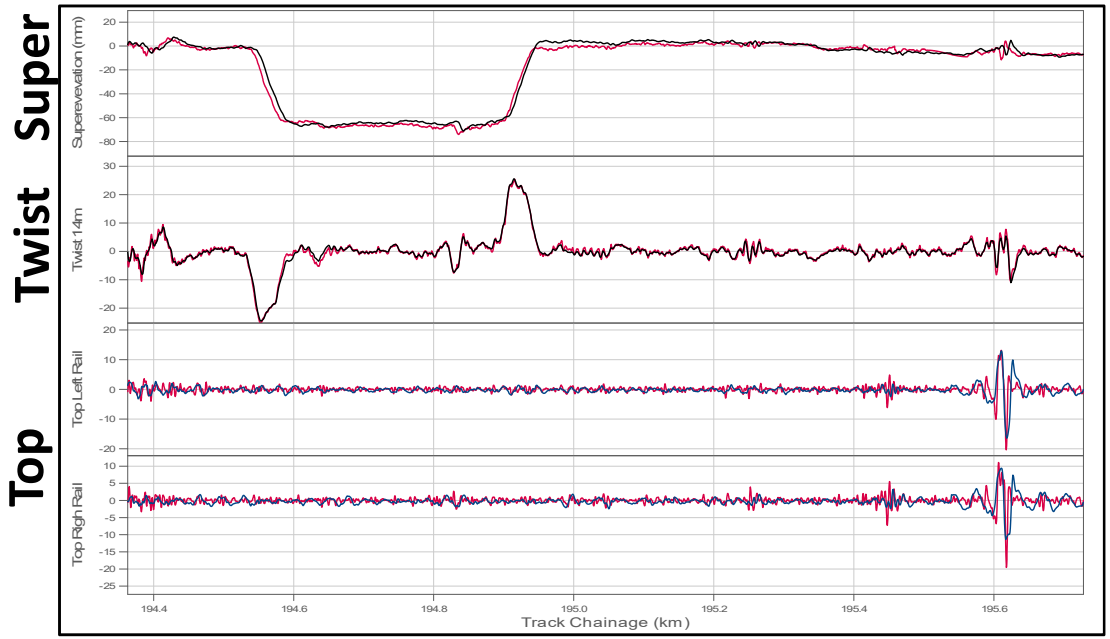
• Wagon Stability	• Roll, Yaw and Pitch
• Bogie Stability	• Primary Spring Displacements • Bogie Vibration Modes • Hunting Detection and Steering • Spring Binding Detection
• Passenger Comfort	• Peak Accelerations, Ride Index, Ride Comfort, Ride Safety based on acceleration Jerk (g/s) • Noise monitoring

IRV System Benefits

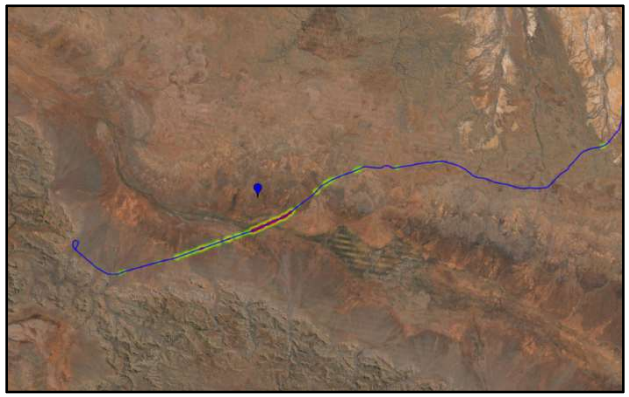
	IRV	Geometry Car
Rail Running Surface	✓	✓
GPS Position	✓	✓
Altitude	✓	✓
Vertical Alignment (Top / Surface)	✓	✓
Lateral Alignment	Bogie Steer	✓
Twist	✓	✓
Curvature	✓	✓
Measures Under Dominant Vehicle Loading	✓	
Vehicle Dynamic Response to Track	✓	
Vehicle Hunting	✓	
Vehicle In-Train Force	✓	
Requires Separate Train Path & Operators		✓
Track Measurement Interval	~20-150 per week	~1-3 months

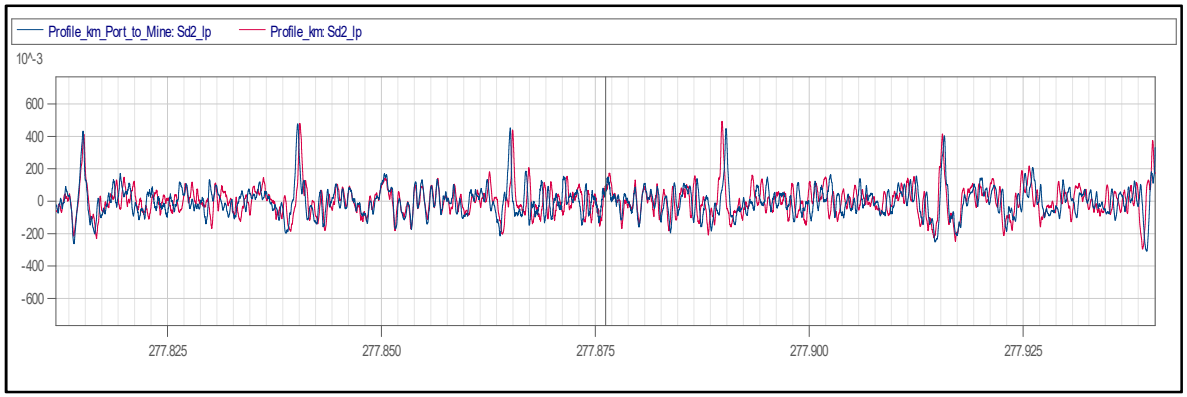
IRV Track Geometry vs Track Geometry Car (TGC)

- TGC data (red line) and IRV data (black line) shows close correlation
- From actual vehicles, at operating speed, multiple times per day



Example – Weld Condition

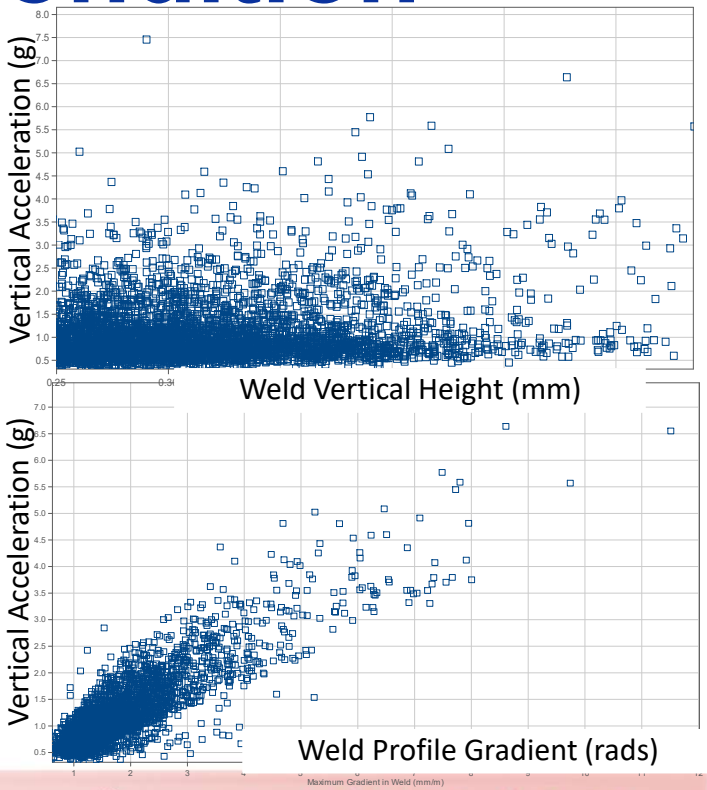




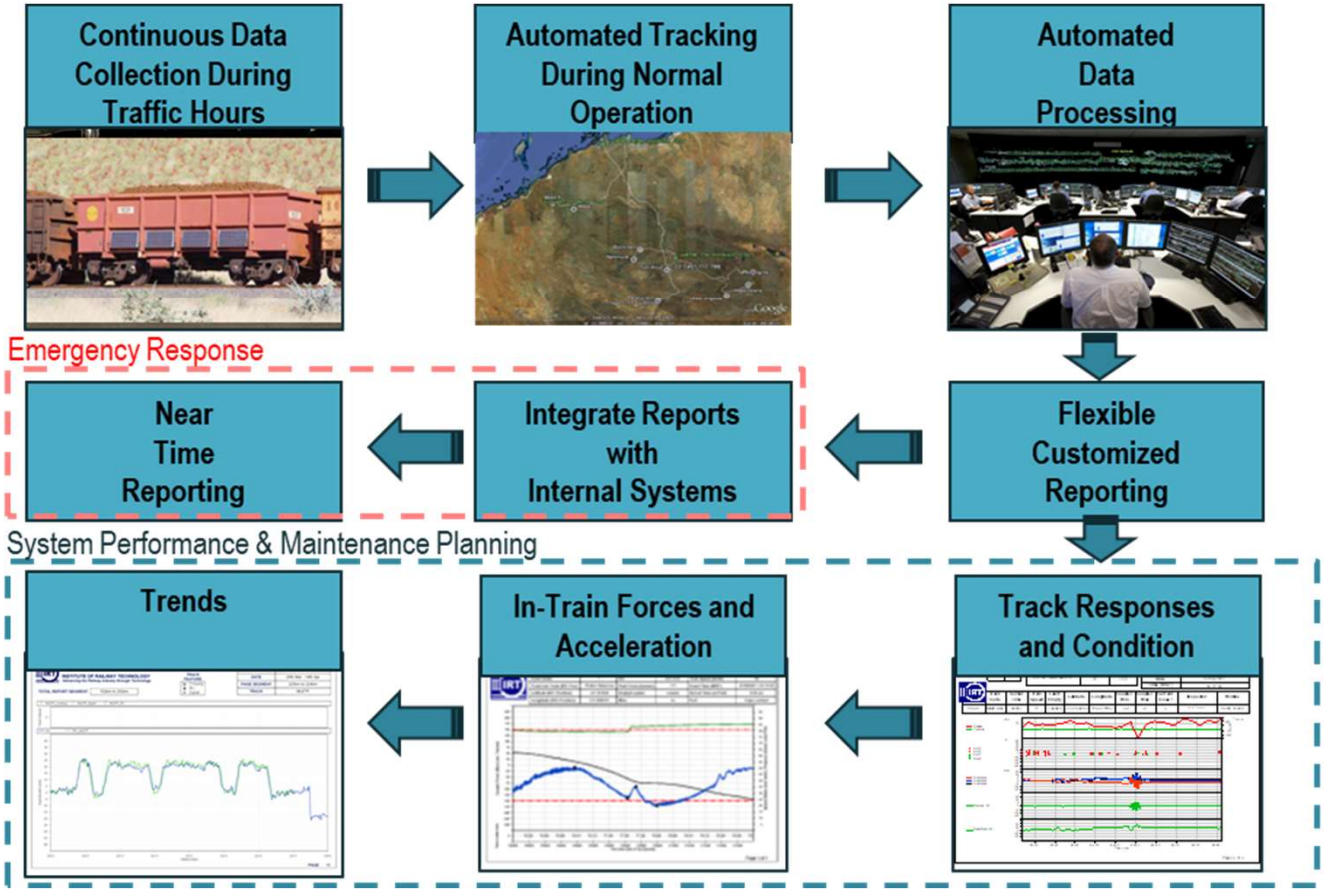
- Rail longitudinal profiles sampled to 5mm increments along the track
- Running surface information can be extracted
- Dipped and peaked welds can be identified as well as vehicle dynamics due to weld condition

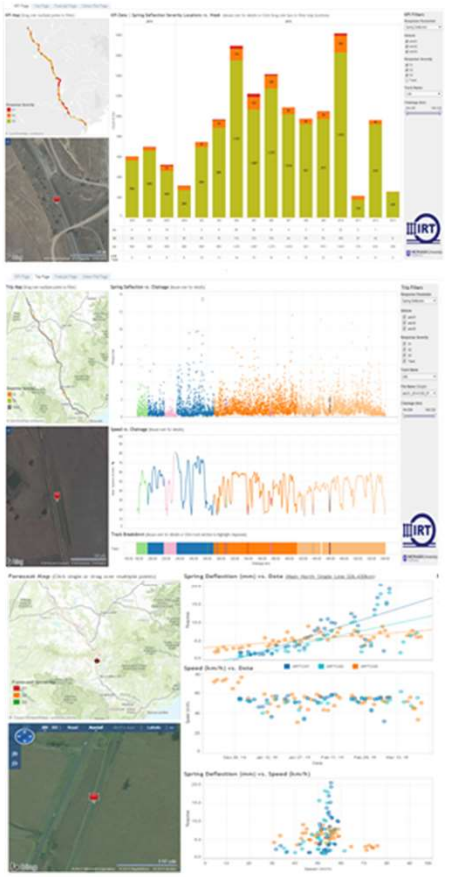
Example – Weld Condition

- View system wide weld profile data
- Convert results to system of choice (e.g. dip angle)
- Assess actual vehicle response to defects to produce standards relevant to safe operations

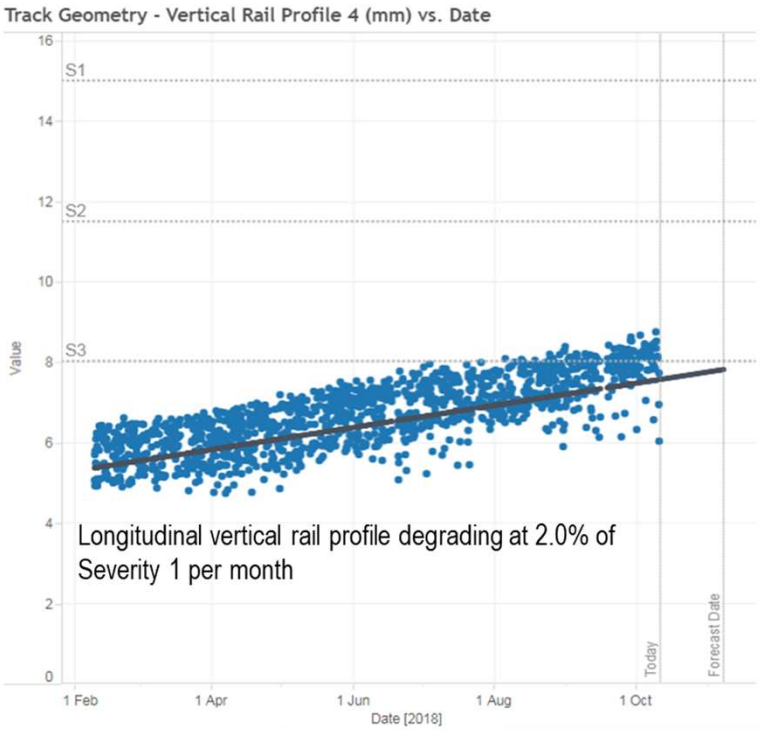


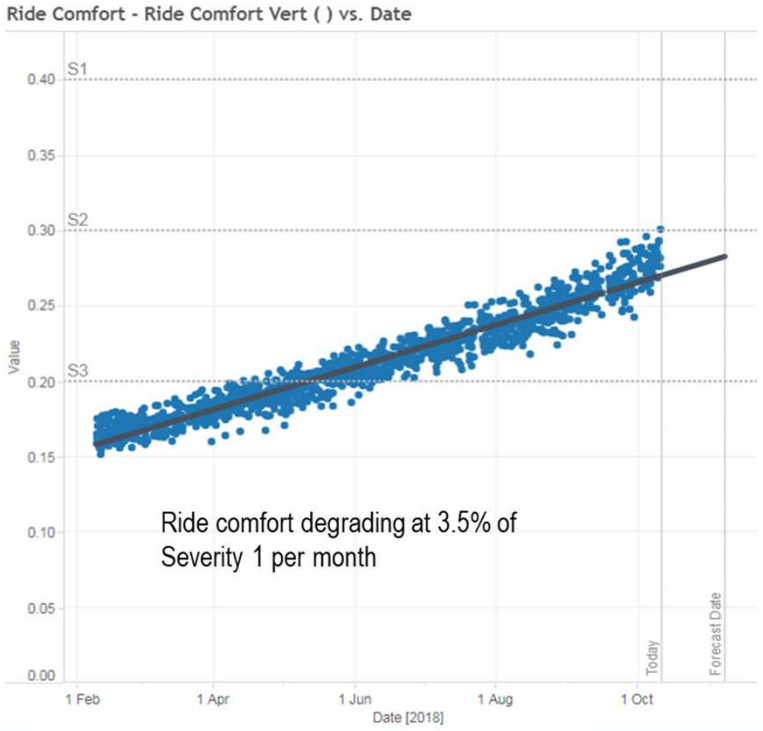
How is it Delivered?



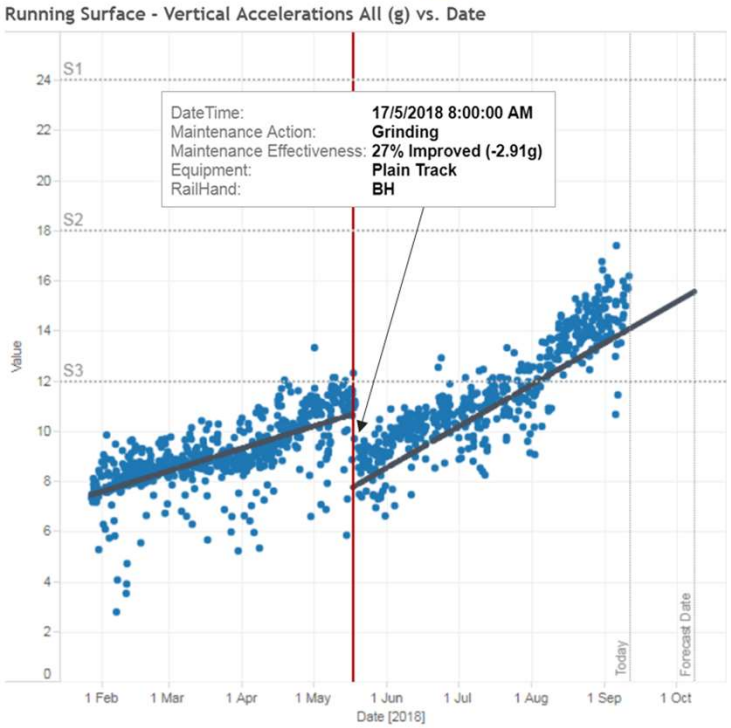


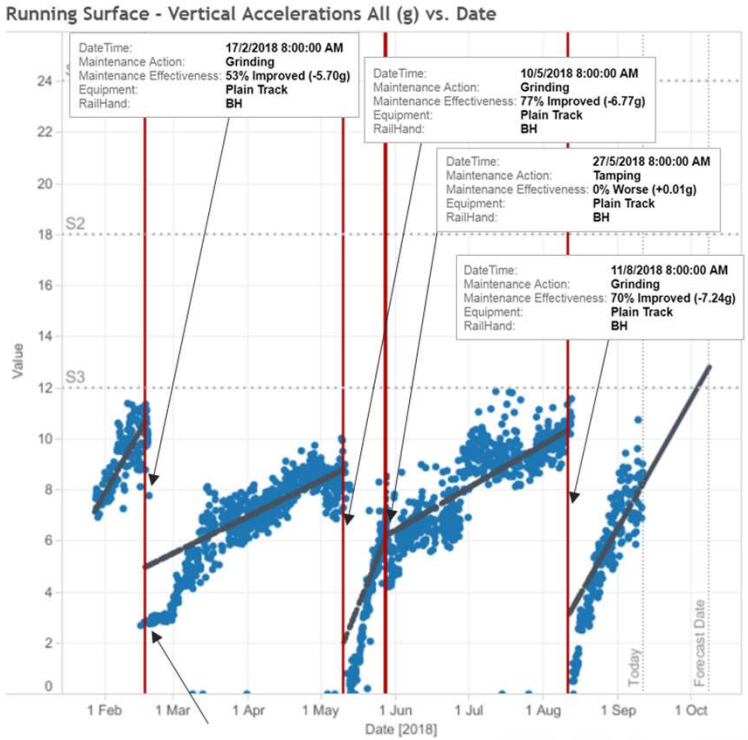
Long Term Trending



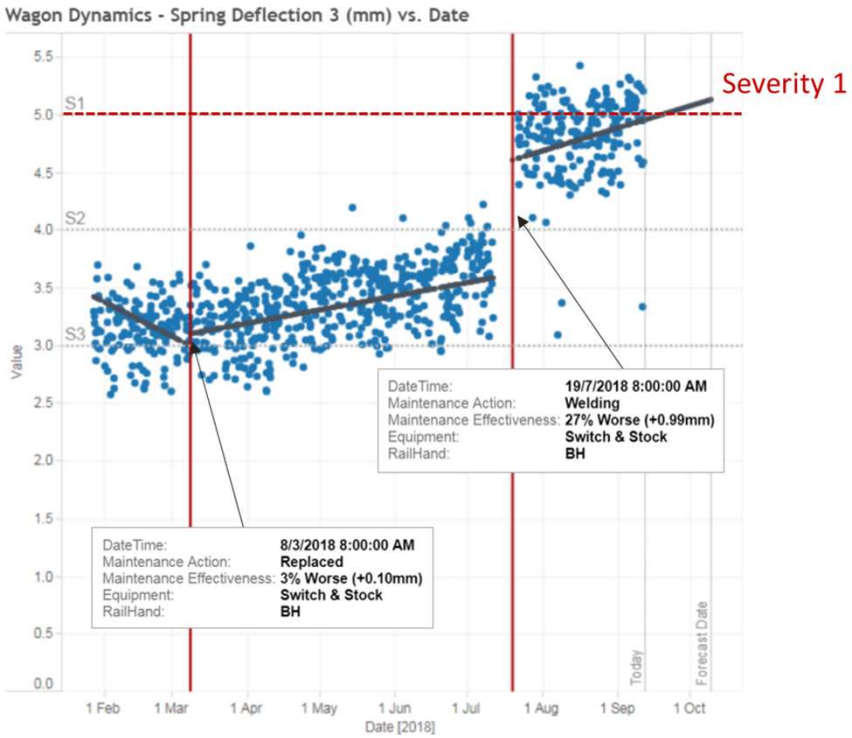


Adding Maintenance Data



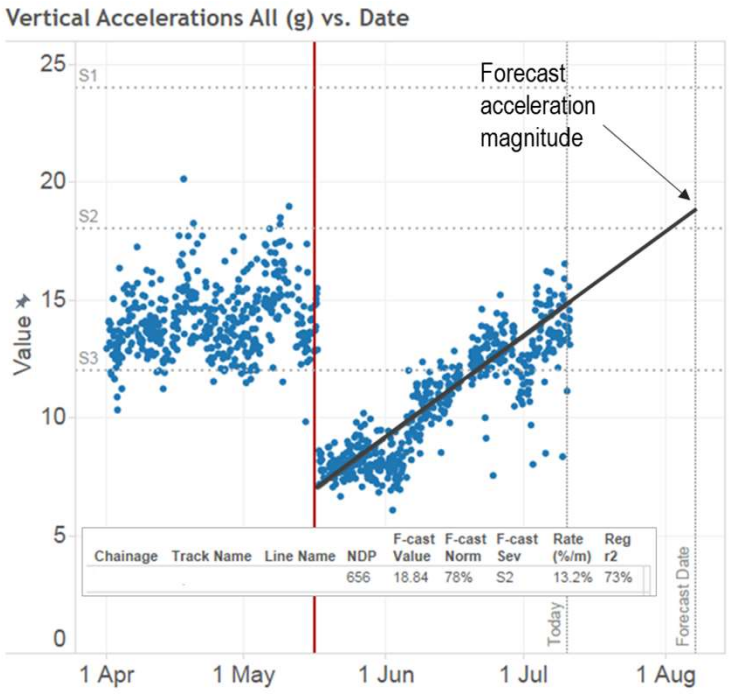


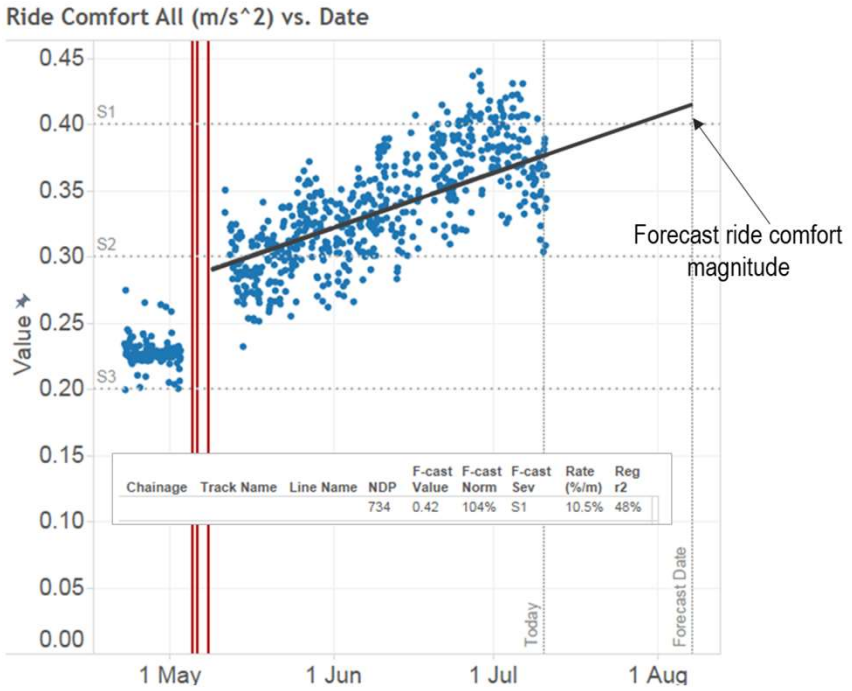
Detrimental Maintenance?



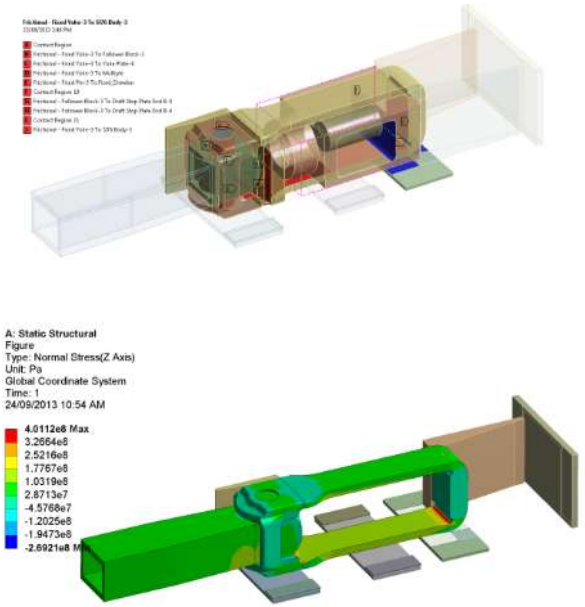
- **Welding a crossing resulted in worse performance**
- **IRV can form an essential part of RAMS engineering processes**

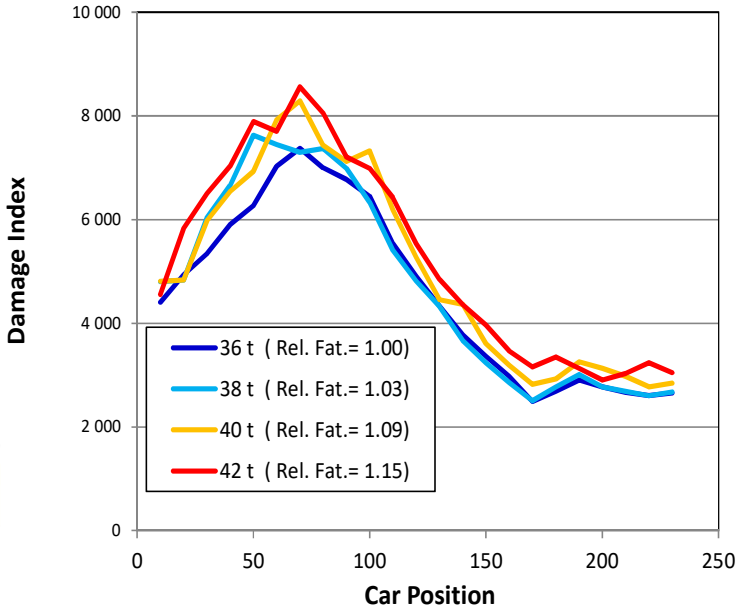
Forecasting of Maintenance





In-train Forces



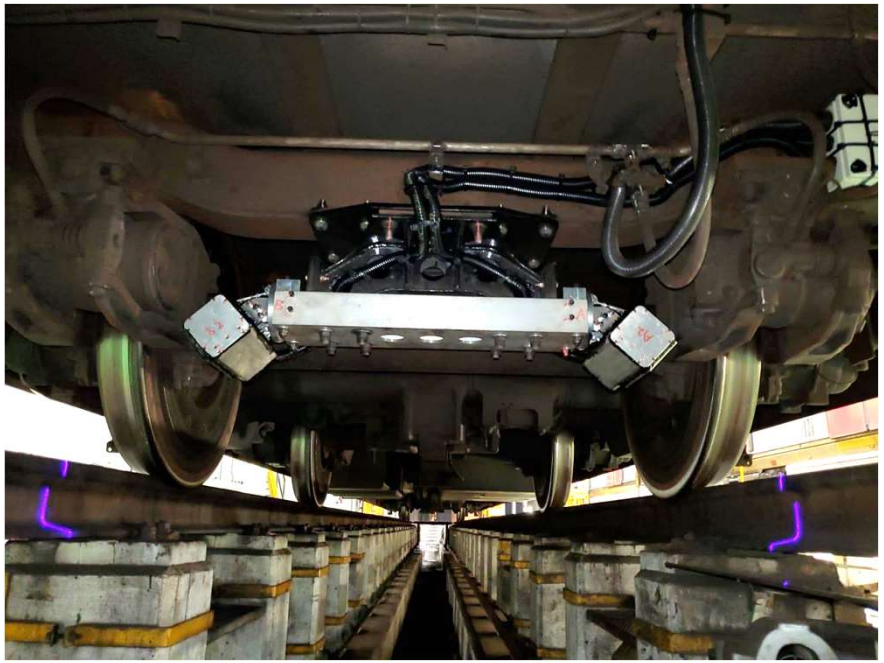


Instrumentation ⇨ Dynamic Model ⇨ Prediction of maximum Fatigue Damage

Further Developments

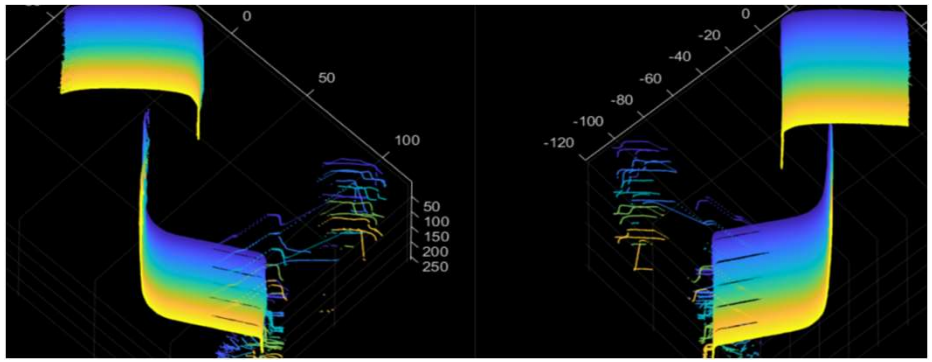
Dynamic Track Gauge

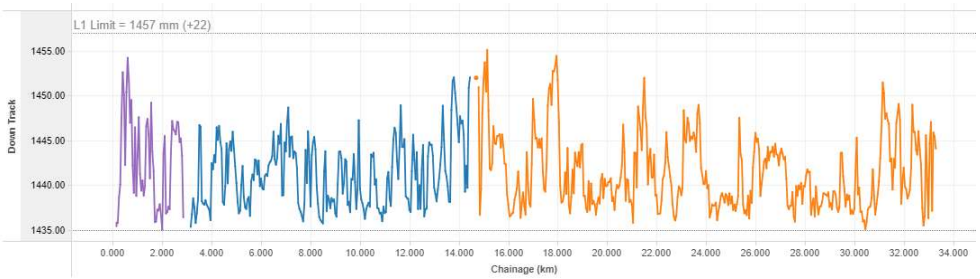
- Installed as part of the IRV system in a revenue car
- Continuously measures gauge during normal traffic hours
- Satisfies EN 13848-1:2003+A1:2008 "Railway applications – Track Geometry Quality"



Dynamic Track Gauge

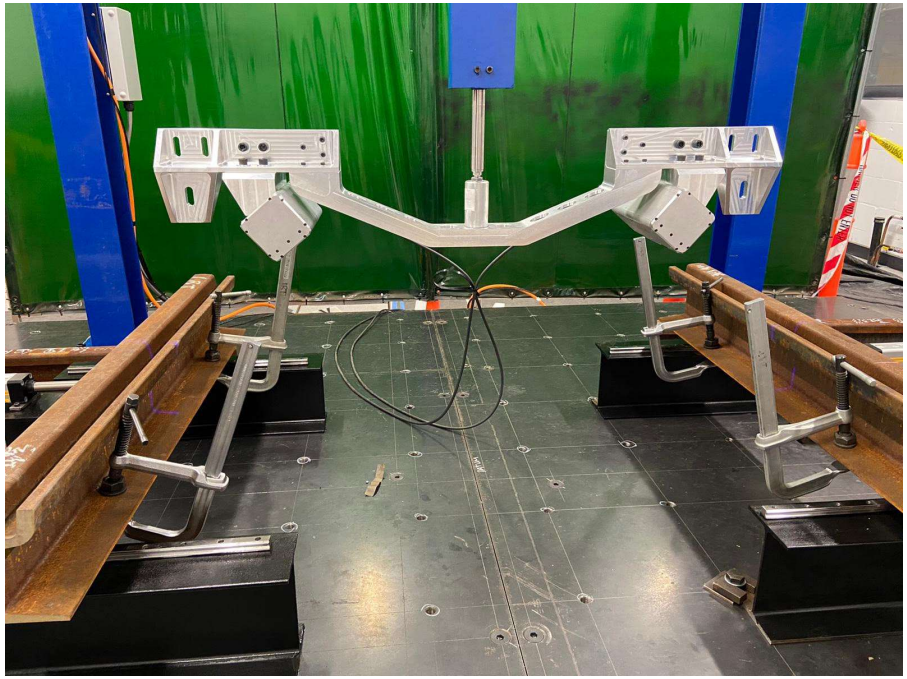
- Twin lasers used to calculate gauge
- Reported down to 1m when required
- Revenue vehicle loading so representative of any dynamic movement under heavy axle load





Expansion in Capability

- Work ongoing to expand to cant and other geometry measures
- Rail wear calculation
- Grooved light rail



Summary

Instrumented Revenue Vehicles

- Lower cost, rugged, revenue vehicle monitoring
- Provides near real-time track, vehicle and component performance
- Forecasting of maintenance and improvement of standards
- Growing capabilities


IRT
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Railway Technology
www.irt.monash.edu