Large Scale Data Analysis Techniques in Grinding Planning and Management

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HARSCO Rail

Data Acquisition Platforms


Geometry Car

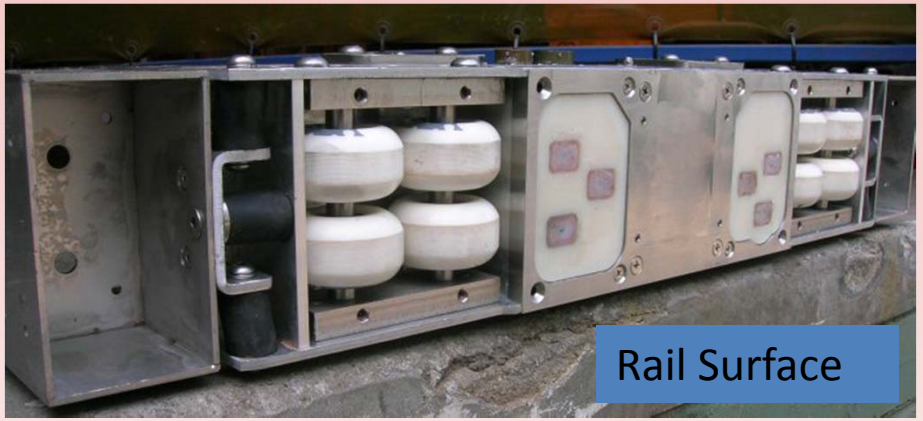

Grinder

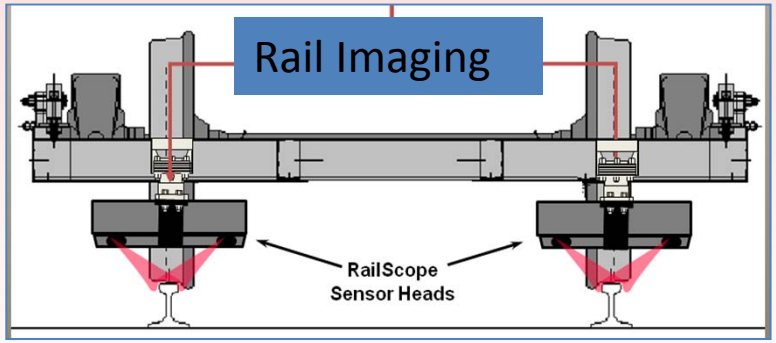
Pre-Grind Insp Vehicle

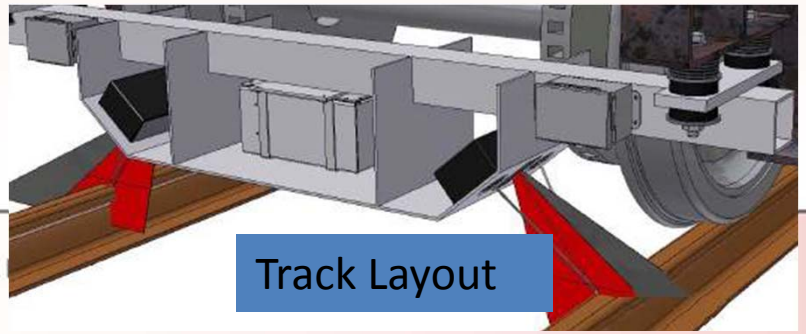
UT Insp Vehicle


Hand/Visual Measurements

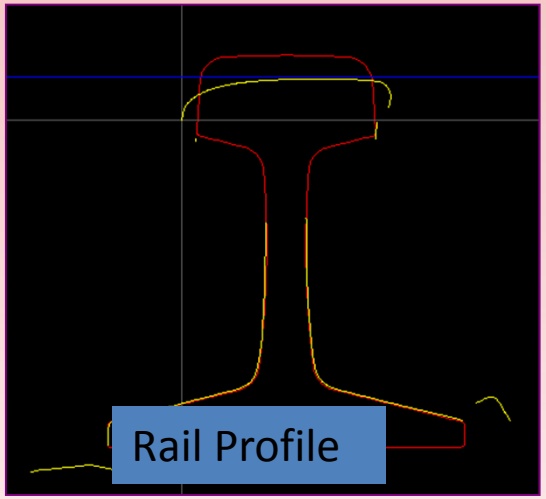
Diagnostic Systems

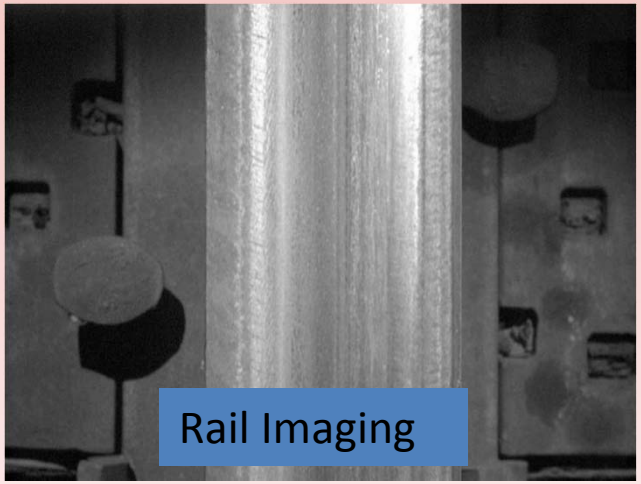


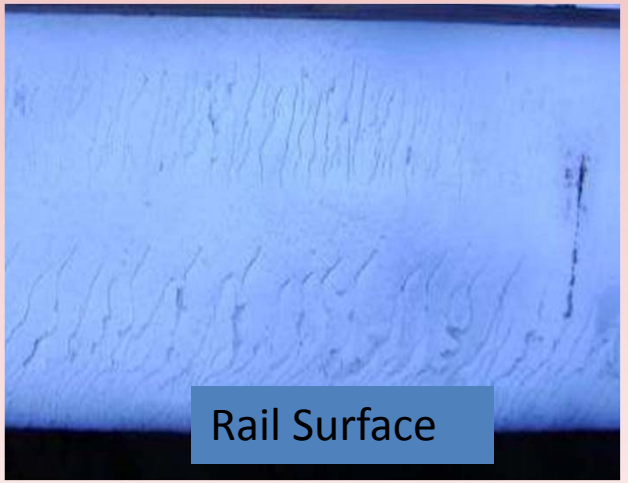


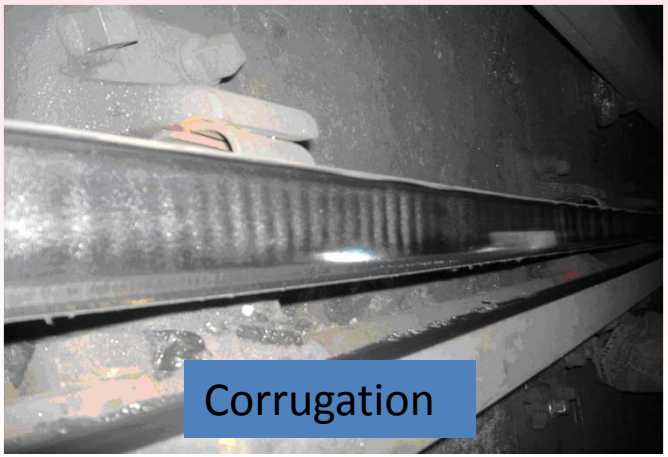


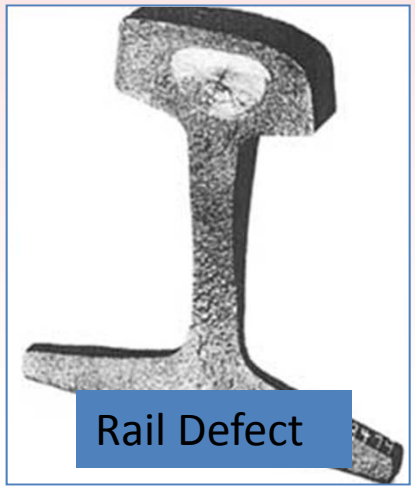
Data Elements

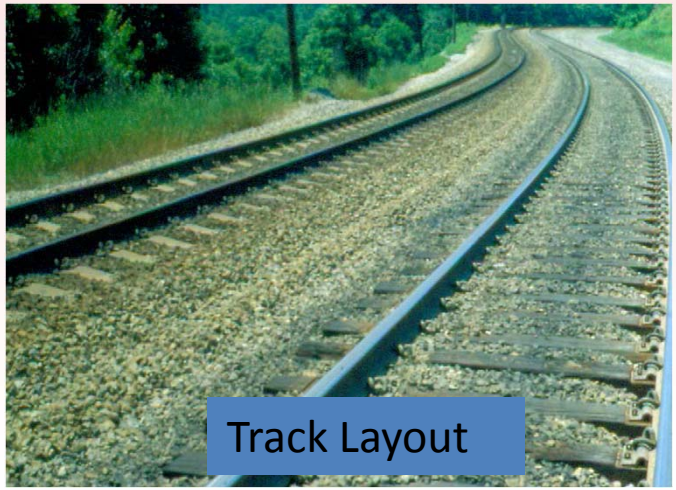












General Extent of Data – BIG Data

	Per Mi	20,000 mile RR
	Mbytes	Mbytes
Rail Defects	0.002	41
Track Layout	0.7	13,517
Rail Profile Data	3	50,688
Corrugation Data	14	282,962
Dense Profiles	304	6,082,560
Rail Images	3,244	64,880,640
Total	3,566	71,310,407
3 Insp/Yr (Mb)	10,697	213,931,222
for 20 years	213,931	4,278,624,441
Petabytes of Data		4.3

1000 kB kilobyte

1000^2 MB megabyte

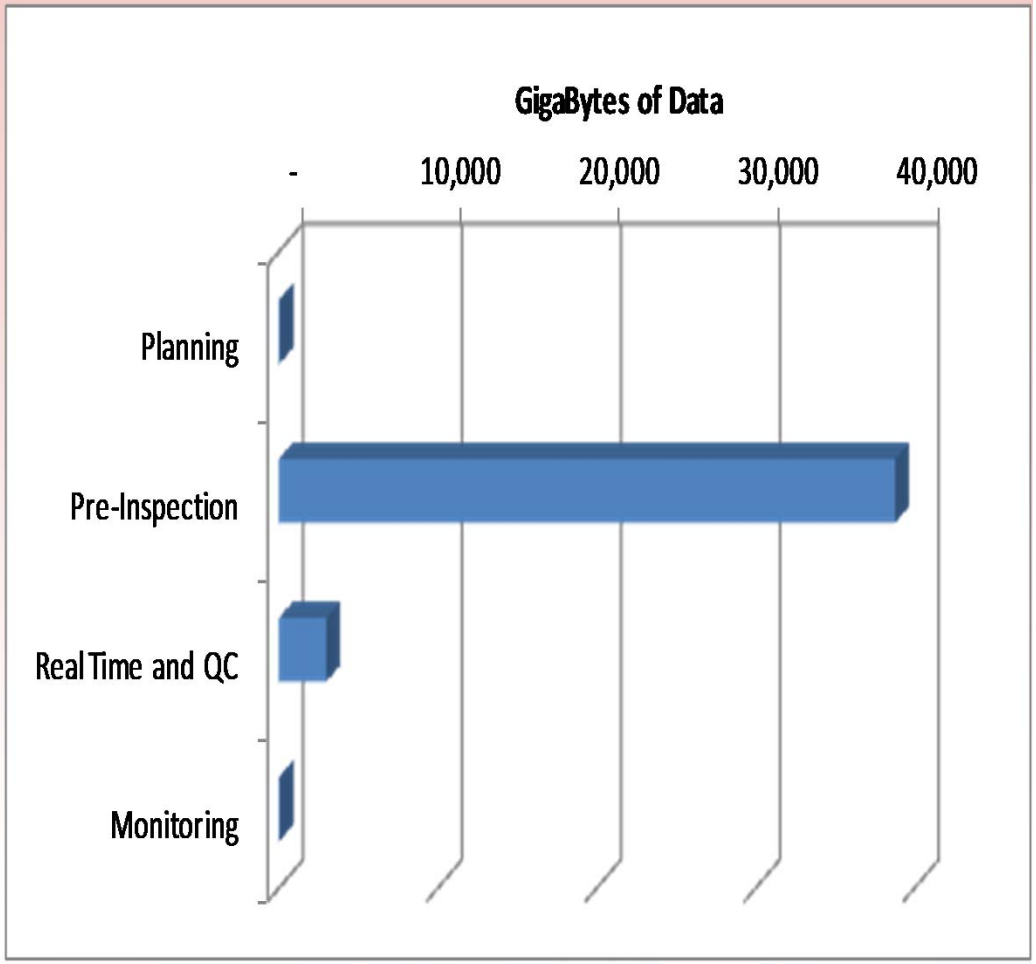
1000^3 GB gigabyte

1000^4 TB terabyte

1000^5 PB petabyte

Traditional Grinding Planning Activities

- Develop Grinding Plan
  - Performed offline
- Perform Grinding Pre-Inspection
  - Using hy-rail vehicle
- Perform Onboard Monitoring and QC
  - Onboard Grinder
- Monitor Effectiveness
  - Offline



Traditional Analytical Techniques

- Physical and Deterministic Techniques Employed
- Computationally Intensive
- Make Use of Readily Available Data
- Develop Indices for Large Data Sets for Data Reduction
- Provide Information to Railways from Large Data

		Rail Defects	Track Layout	Rail Profile Data	Corrugation Data	Dense Profiles	Rail Images
Planning		■	■	■			
Pre-Inspection					■	■	■
Real Time and QC				■	■		
Monitoring		■	■	■			

Grinding and BIG Data

- The Five V's of BIG data
  - Volume → 5 Petabytes
  - Variety → profiles, corrugation, track layout, defects, images, crack density, machine performance, etc.
  - Velocity → up to 2,500 Hz
  - Veracity → consistent data with some spread in accuracy
  - Value → North American rail budget = $2B
- While Big Data analysis is being performed, emerging techniques offer the ability to improve the current deterministic methods through advanced stochastic processes

Current Areas for Improvement

- Develop Grinding Plan
  - Use limited amounts of data
  - Simple statistical techniques
  - Only a rough plan
- Real Time Analysis
  - Computational limits
  - Disregard machine data
  - Missing condition elements
  - Missing asset properties
- Pre-Grind Inspection
  - Use limited aspects of data
  - Simple statistical techniques
  - Missing condition elements
  - Missing asset properties
- Effectiveness Monitoring
  - Use limited amounts of data
  - Simple statistical techniques
  - Not correlated to other inspection data

Future of BIG Data Analysis in Grinding

5 Petabytes of data available for mining and analysis

Utilize advanced techniques such as:

- MARS
- Markov Chain Monte Carlo simulation
- Bayesian Inference
- Machine Learning
- Many, many more

Expected improvements:

- Improved grinding pattern prediction
- Refined rail template definition
- Improved makeup of grinding stones
- Grinding cycle management
- Improved grinder utilization
- Many, many more

Improvements to Existing Techniques



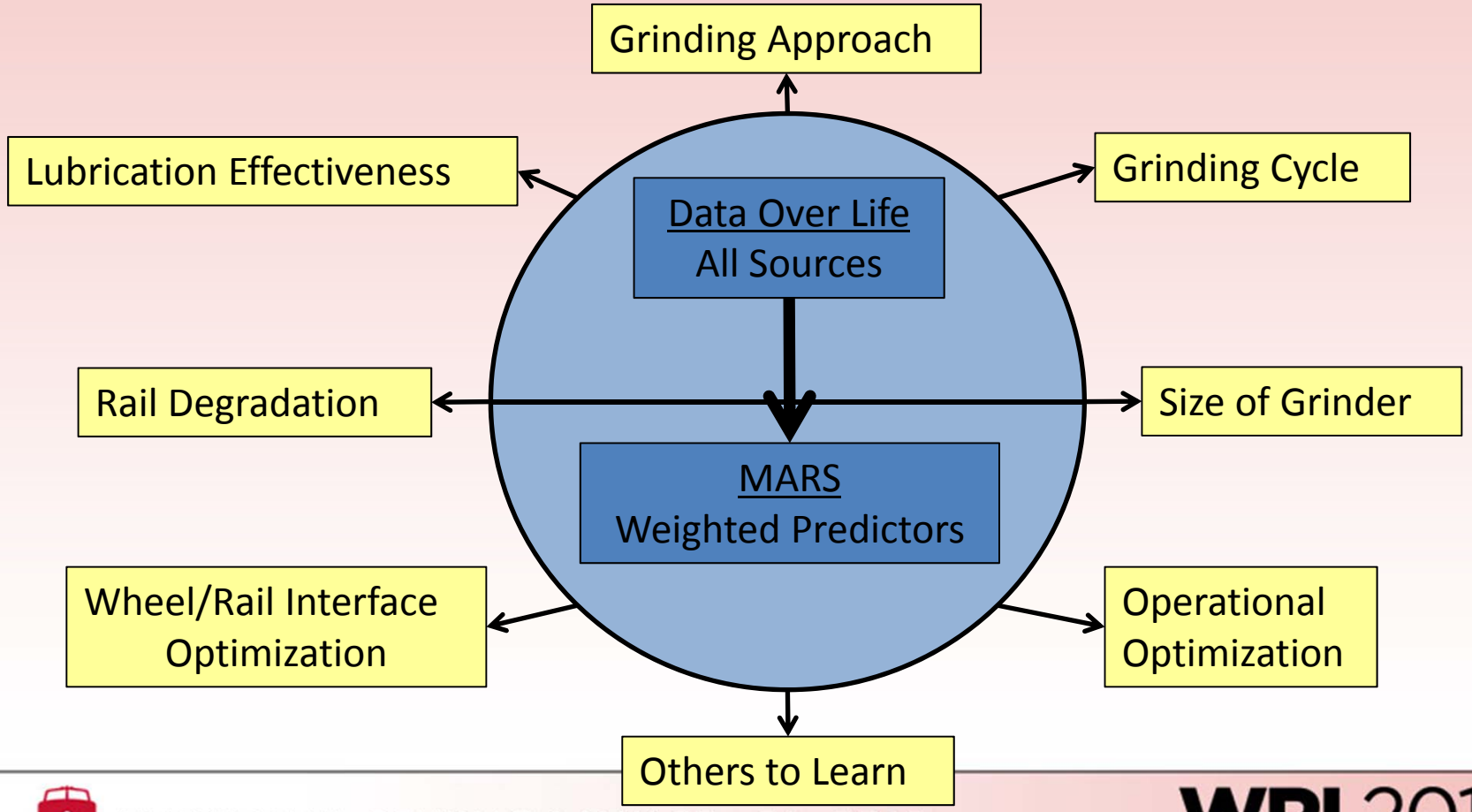
Advanced Statistical Models
-MARS
-MCML
-BI

Important Predictors
Predicator Relevance
Coefficient Correlation

Self Learning System
-Improved patterns
-Machine speed
-Dynamic patterns for changing profile in curves
-etc

Strategic Initiatives

- BIG Data available to define key relationships unknown to date



Conclusions

- Rail grinding planning and management is a Big Data exercise
- Current techniques are effective but do not make use of large amounts of data
- Emerging techniques can be applied to provide:
  - More effective results in the planning and management process
  - Further useful information regarding grinding and the rail asset in a more strategic manner