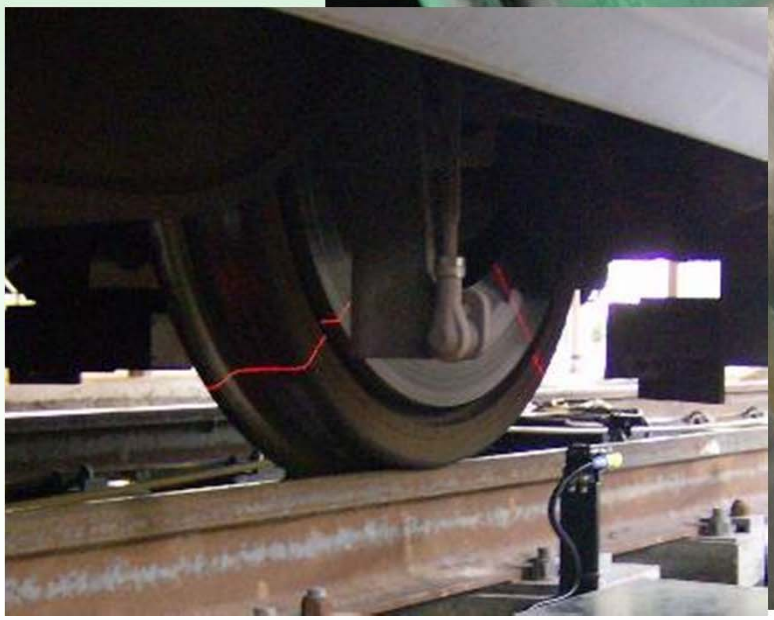
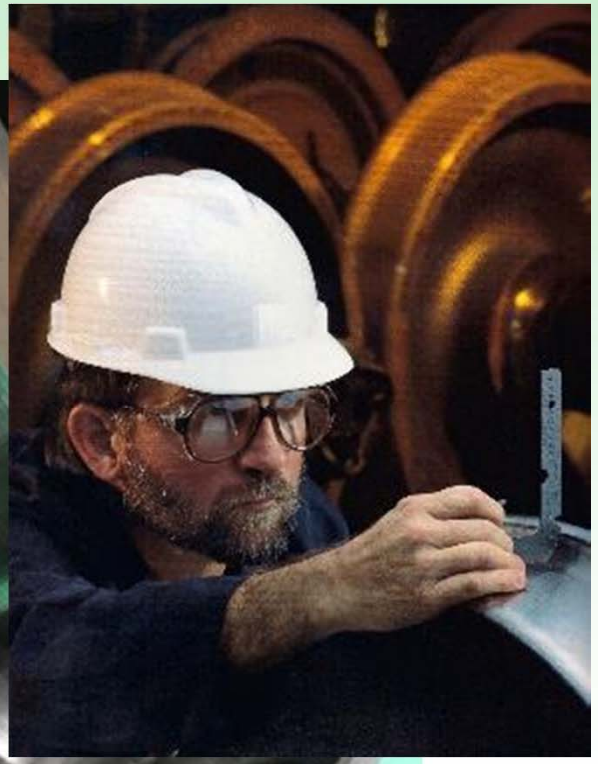
Wheel Maintenance

Roger D. Collen

What is Wheel Maintenance?

- Restore the profile of the tread by removing material
- FIRST - measure the profile





Presentation Preview

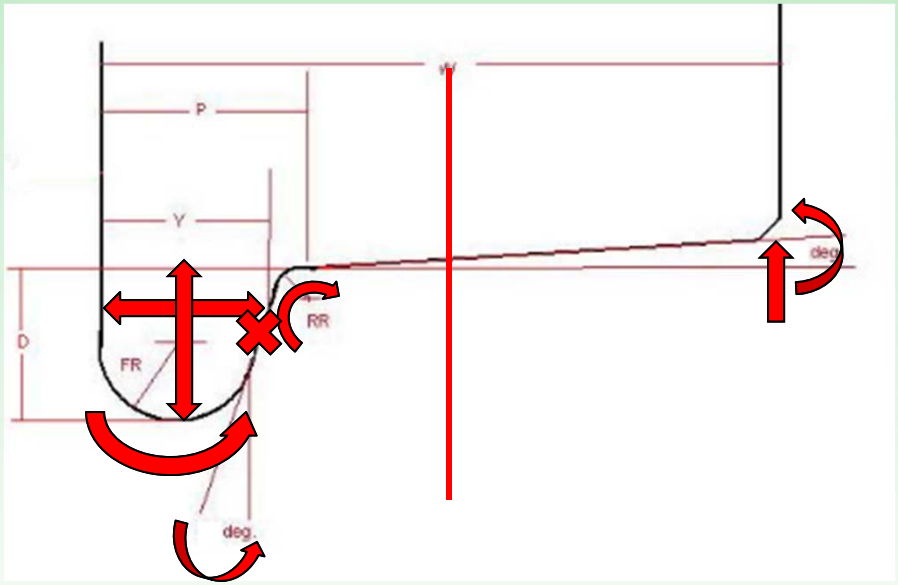
- Wheel Profile(s)
- Why True Wheels
- Truing Processes
- Wheel Measurement
- Truing Equipment Options
- Vehicle Application Notes

Wheel Profile

- Many different profiles in use
- Captive fleet operators determine profile
- Wheel Profile is part of a ***System*** that includes but not limited to;
  - Rail geometry and condition
  - Vehicle type and suspension
- Profiles have common features with uncommon dimensions

Wheel Profile

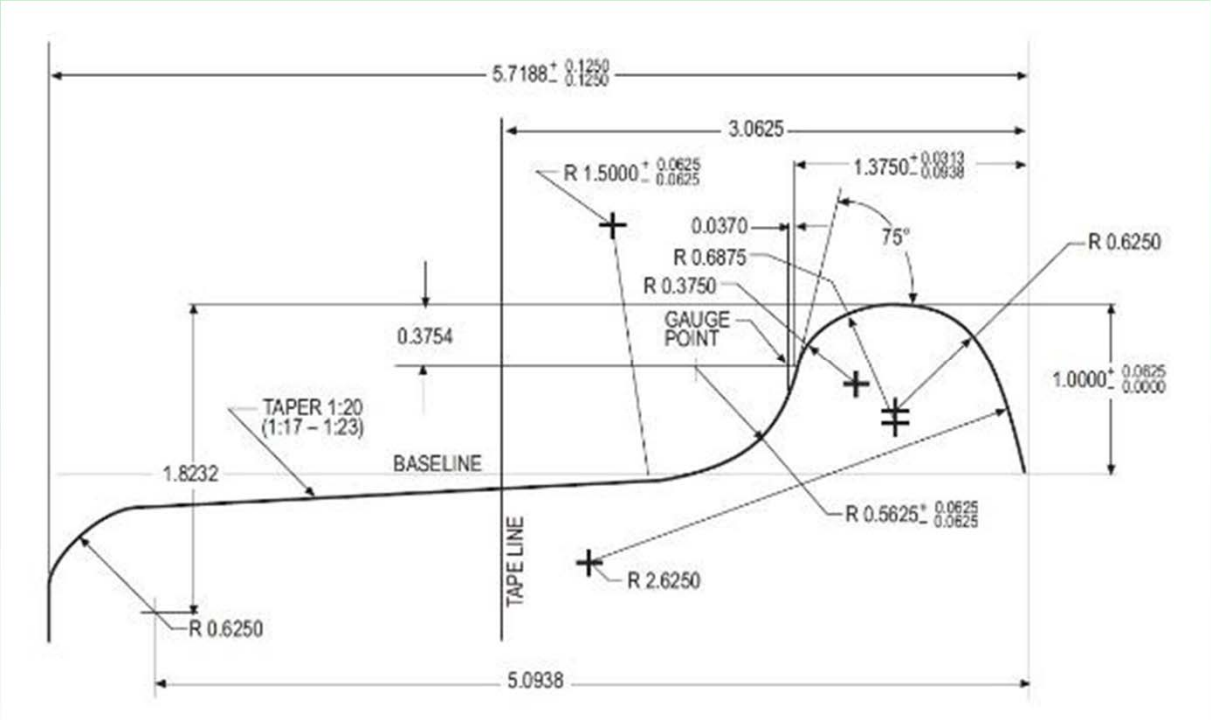
- Flange Width
- Flange Height
- Flange Shape
- Flange Angle
- Flange Tread Transition - throat
- Tread Taper
- Tape Line
- Gaging Point
- Tread Rim Face Transition – field side relief



Wheel Profile - AAR

- AAR Profile – Interchange mandated
- Current AAR 1B adopted in 1989 for new wheels and wheel profiling
- Two versions – Wide Flange and Narrow Flange

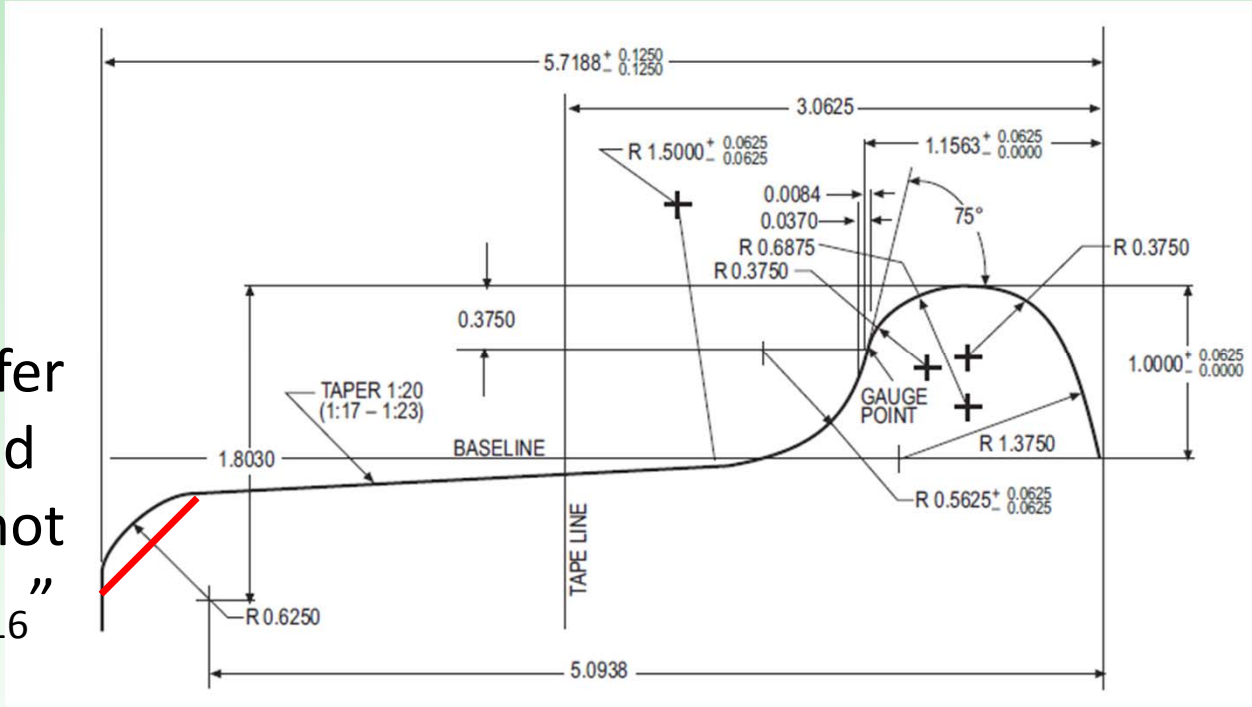
Wheel Profile - AAR



- AAR 1B Wide Flange Profile
- New Wheel Profile

Wheel Profile - AAR

Alternate chamfer allowed on field side transition not greater than $^{7}/_{16}$”

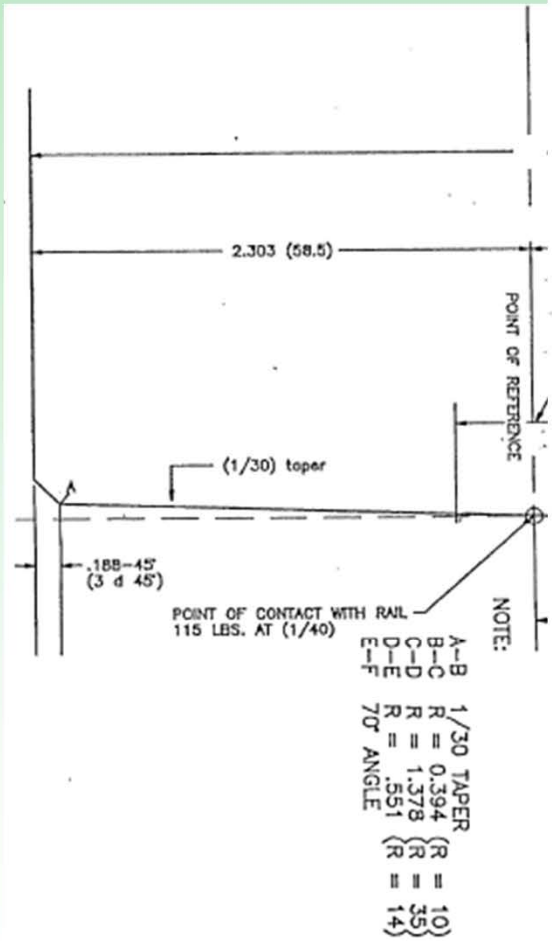


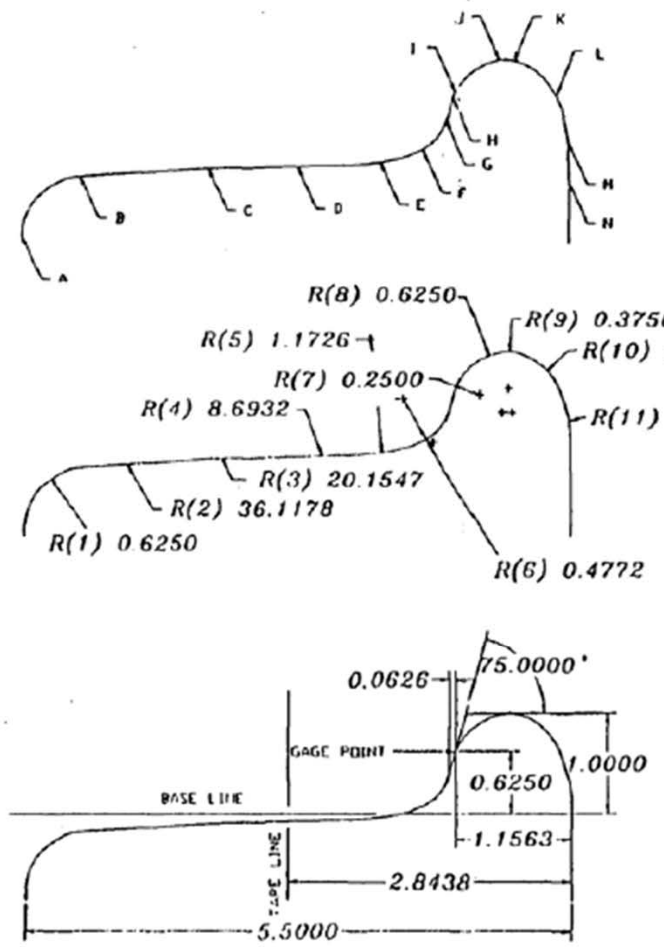
- AAR 1B Narrow Flange Profile
- Re-profiled Wheel

Wheel Profile

- Captive System Profiles can vary greatly as a result of System variables and experiences

Wheel Profile – Commuter Line

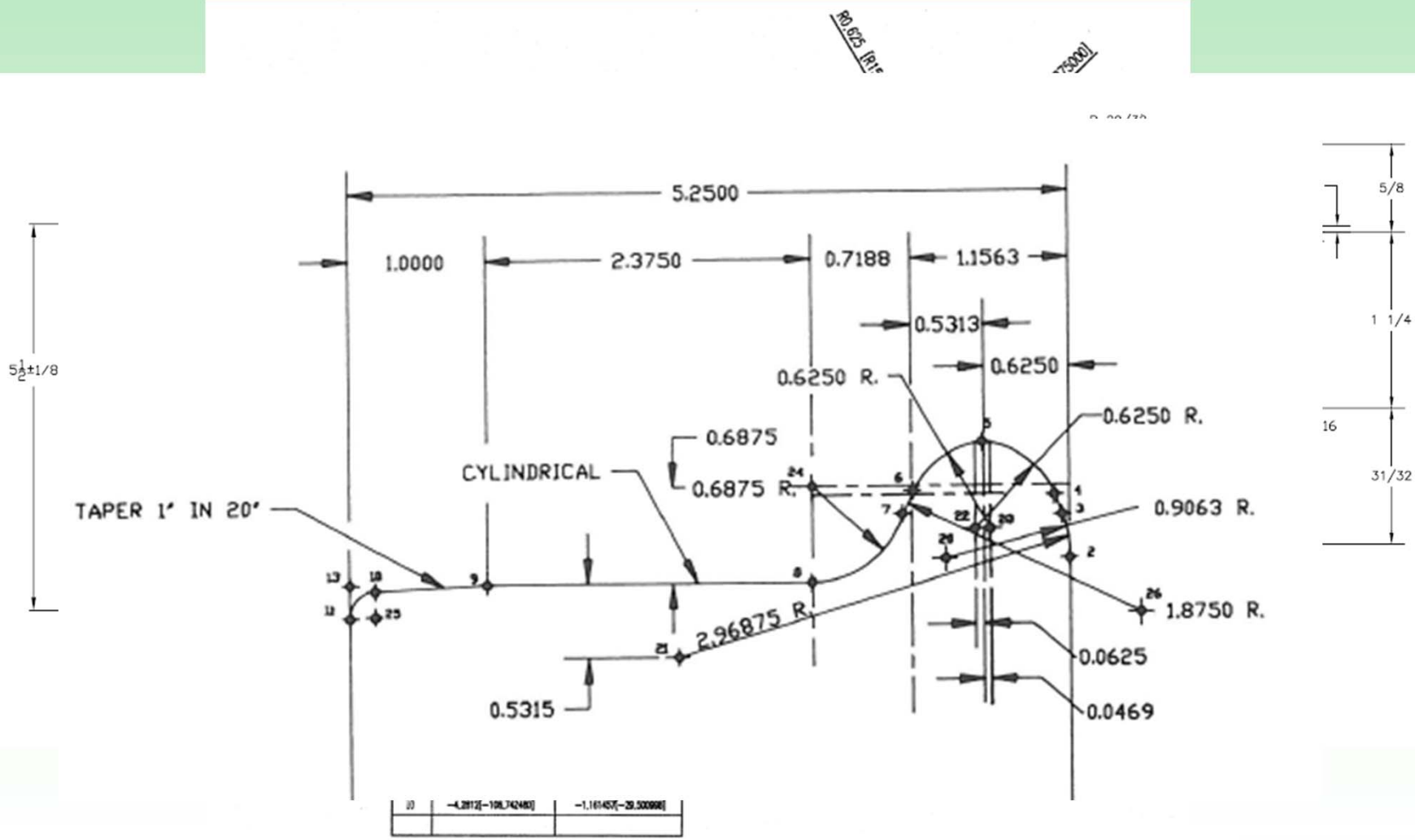




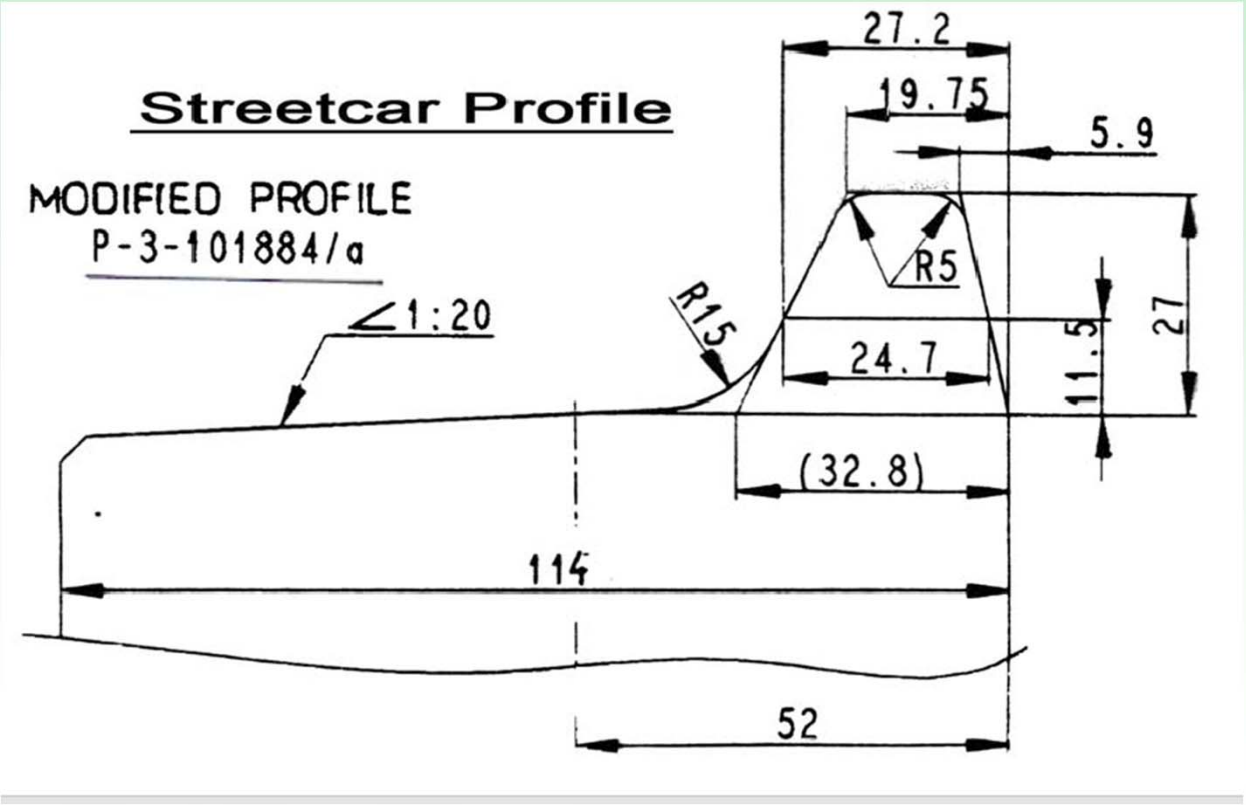
INTERSECTION POINTS

POINT	X	Y
A	-4.3438	-1.4255
B	-3.7692	-0.8025
C	-2.4666	-0.7207
D	-1.5664	-0.7005
E	-0.7322	-0.6604
F	-0.3030	-0.5333
G	-0.0626	-0.2336
H	0.0000	0.0000
I	0.0231	0.0569
J	0.4744	0.3707
K	0.6243	0.3633
L	1.0381	0.0158
M	1.1563	-0.4430
N	1.1563	-0.6250

Wheel Profile – Transit System



Wheel Profile – Streetcar

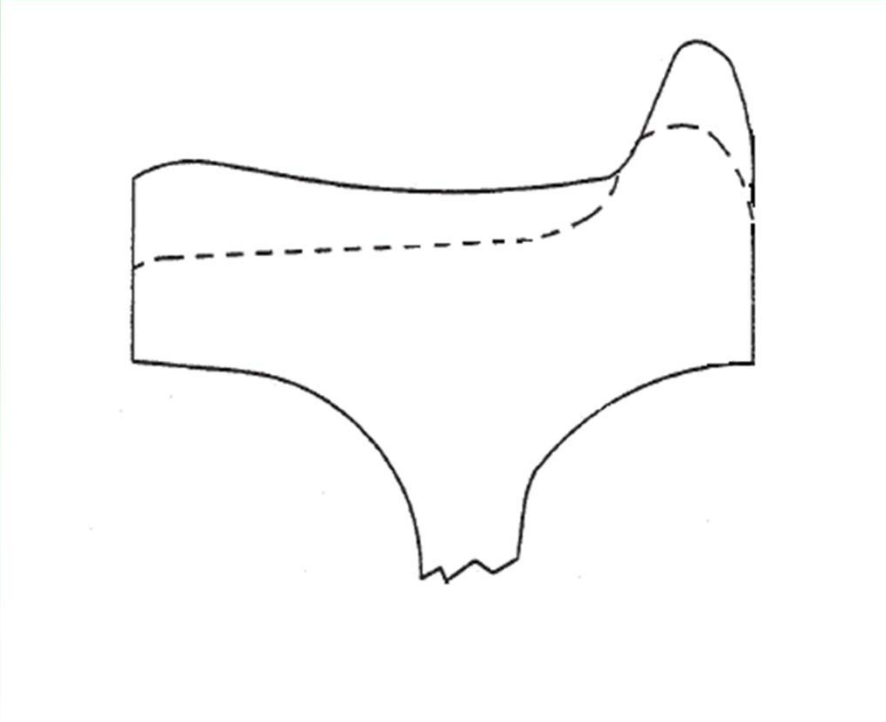


Why True Wheels

- Economics
  - Cost of replacement wheels
  - Cost of labor to produce and swap wheel sets from rail vehicle

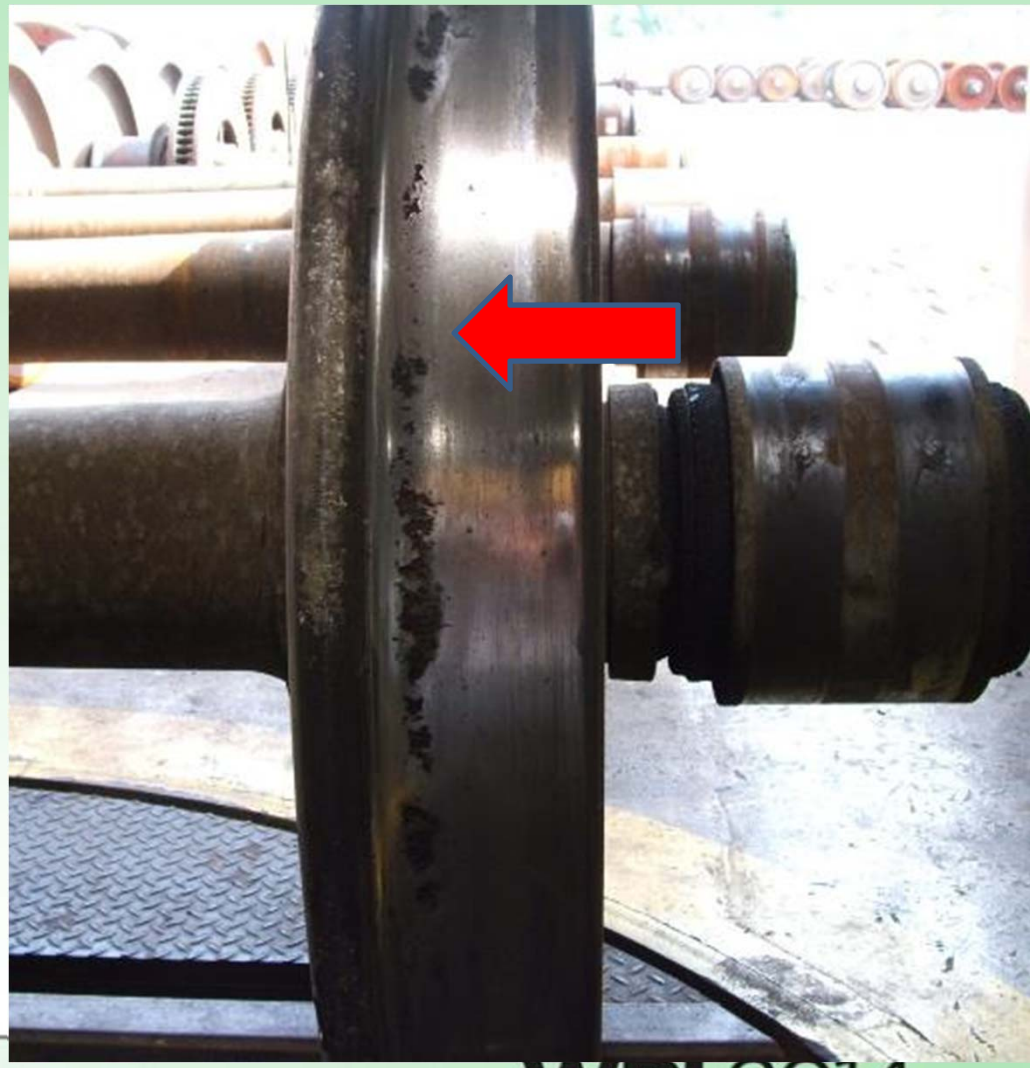
Why True Wheels

- Wear



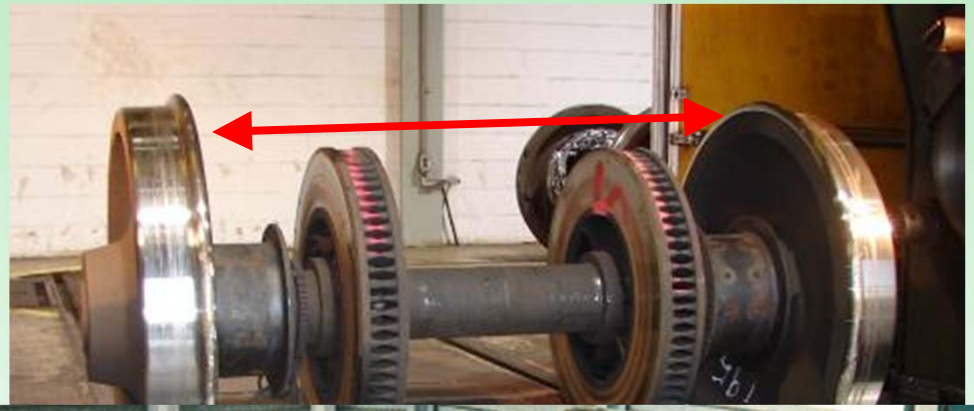
Why True Wheels

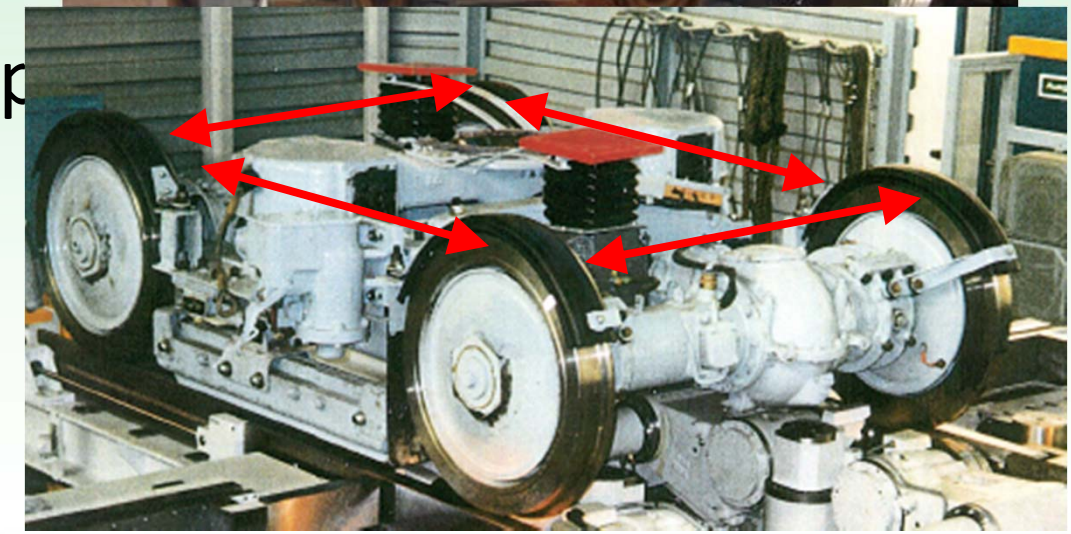
- Wear
- Defects
  - High / thin flange
  - Flat spots
  - Shelling / Built up
  - Cracks
  - Out of round



Why True Wheels

- Wear
- Defects
  - High / thin flange
  - Flat spots
  - Shelling / Built up
  - Cracks
  - Out of round
- Parity



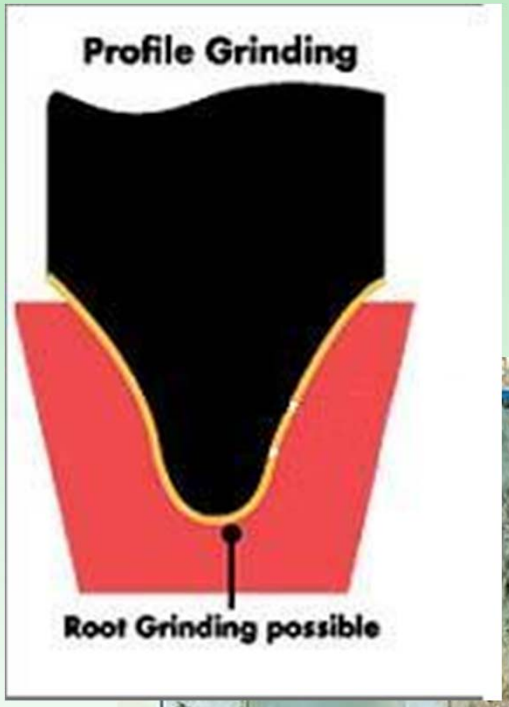


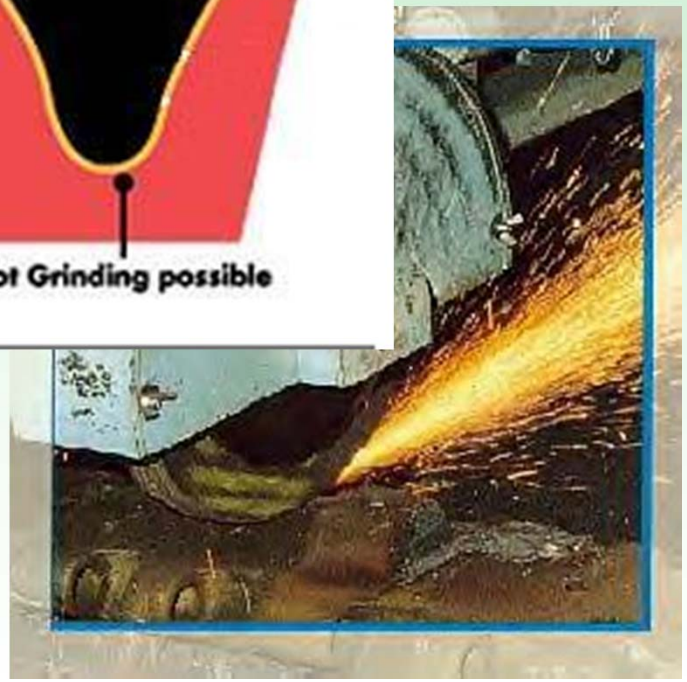
Truing Processes

- Grinding
- Milling
- Turning

Truing Processes

– Grinding

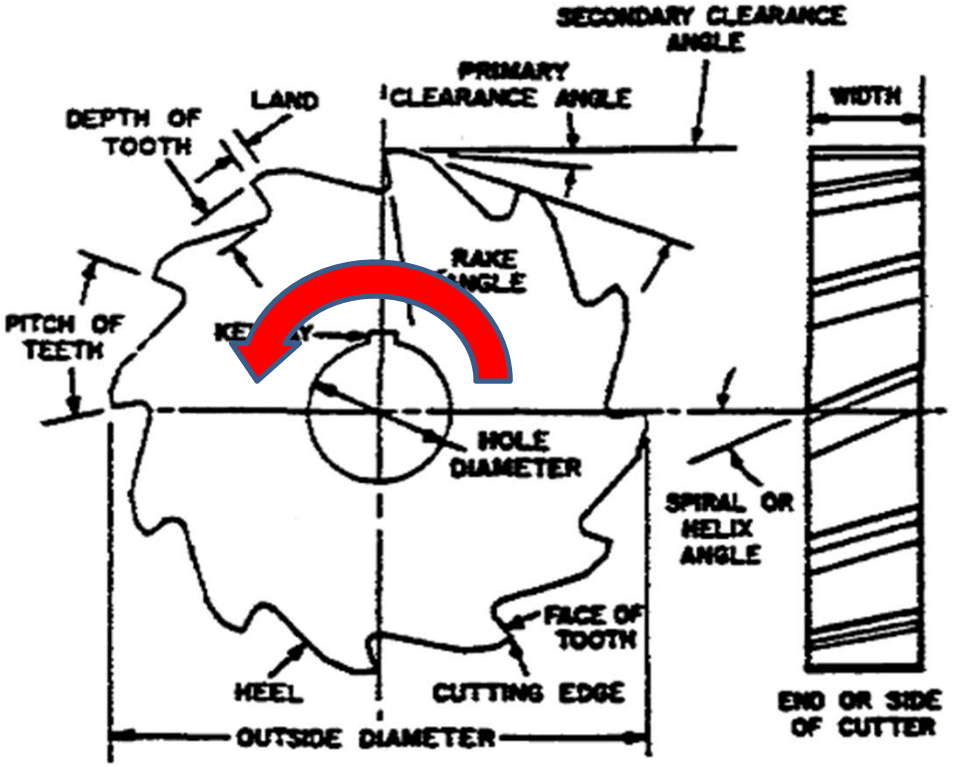


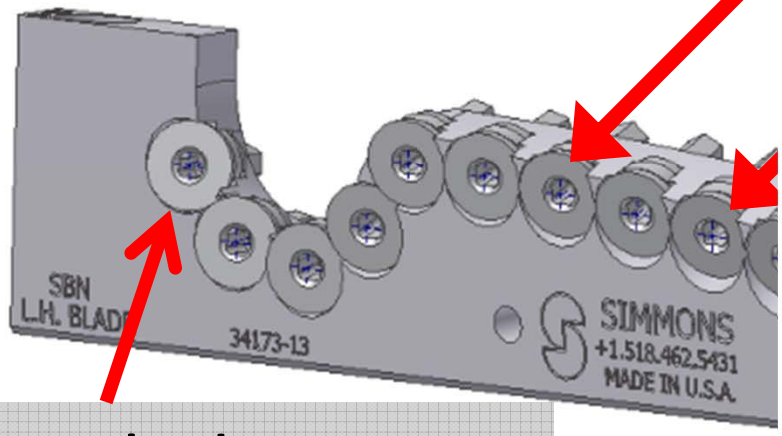


Process not used in NA for wheel profiling due to very low material removal rate resulting in low productivity

Truing Processes

- Grinding
- Milling



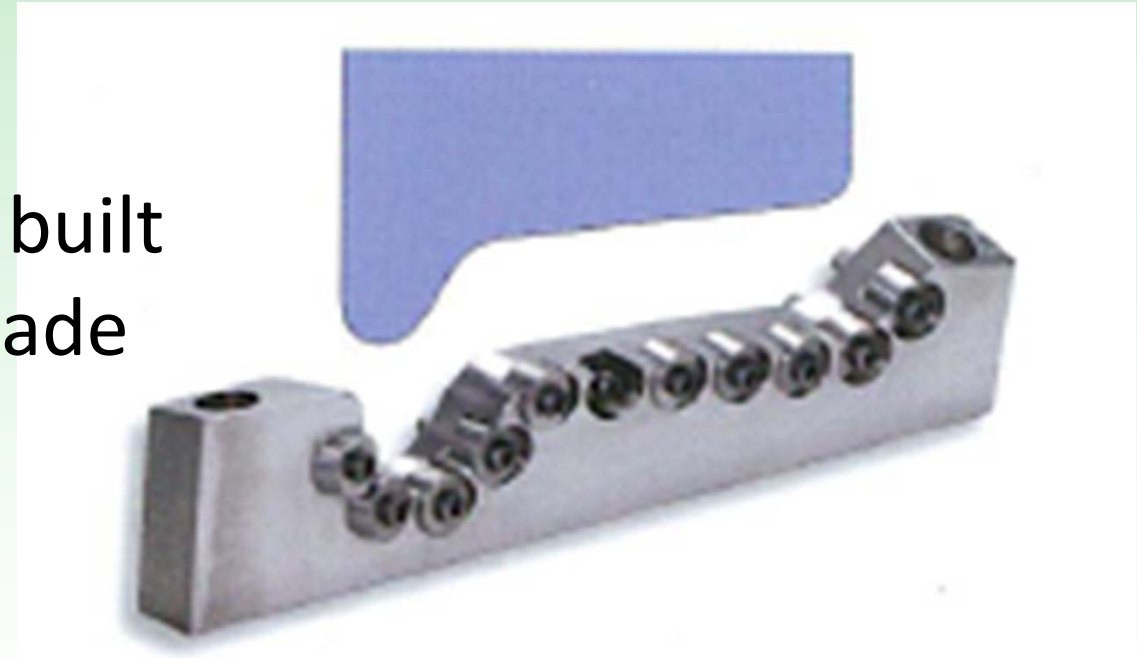


Carbide Inserts

Truing Processes

- Grinding
- Milling

Wheel profile built into cutter blade

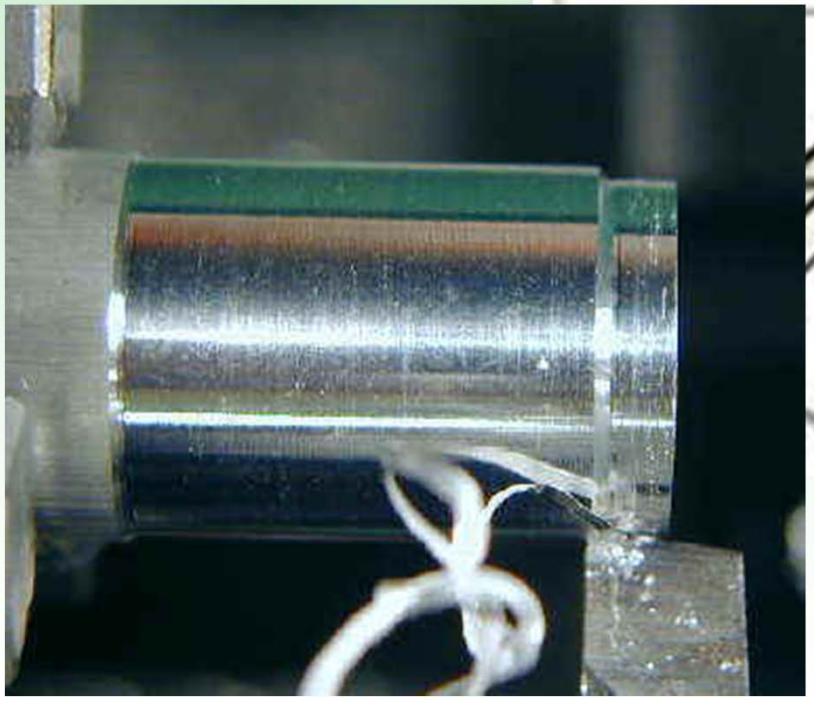


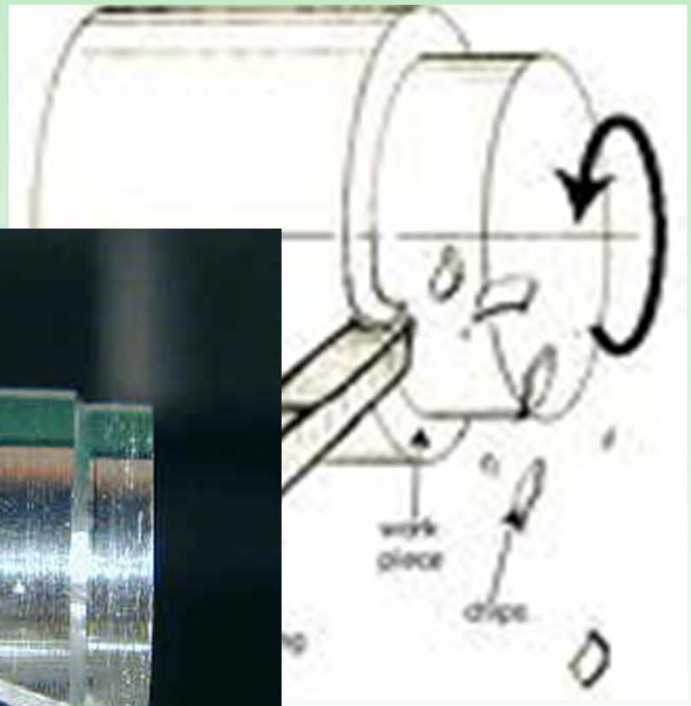
Truing Processes

- Grinding
- Milling

Truing Processes

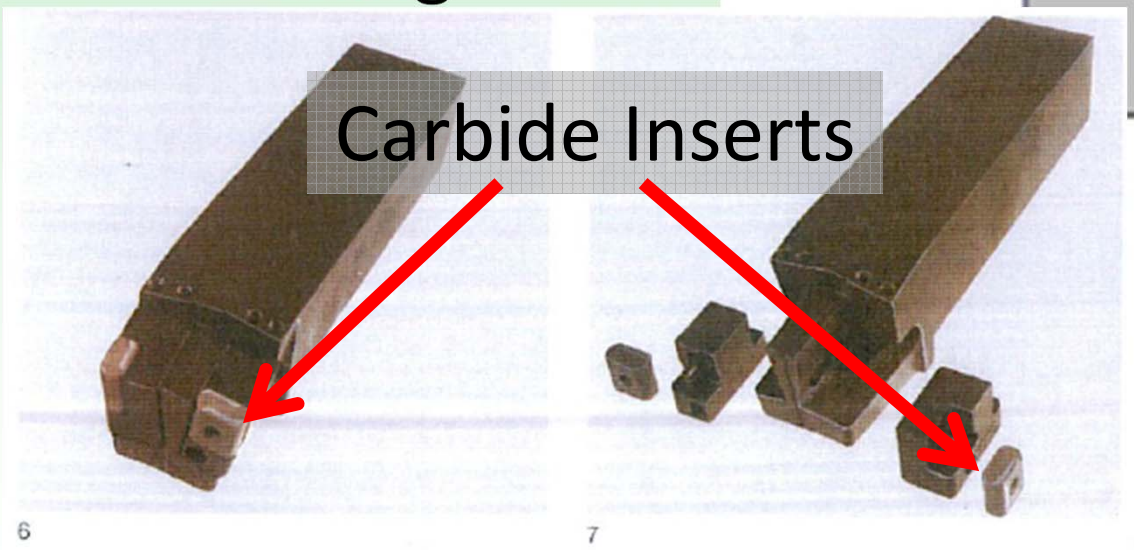
- Grinding
- Milling
- Turning

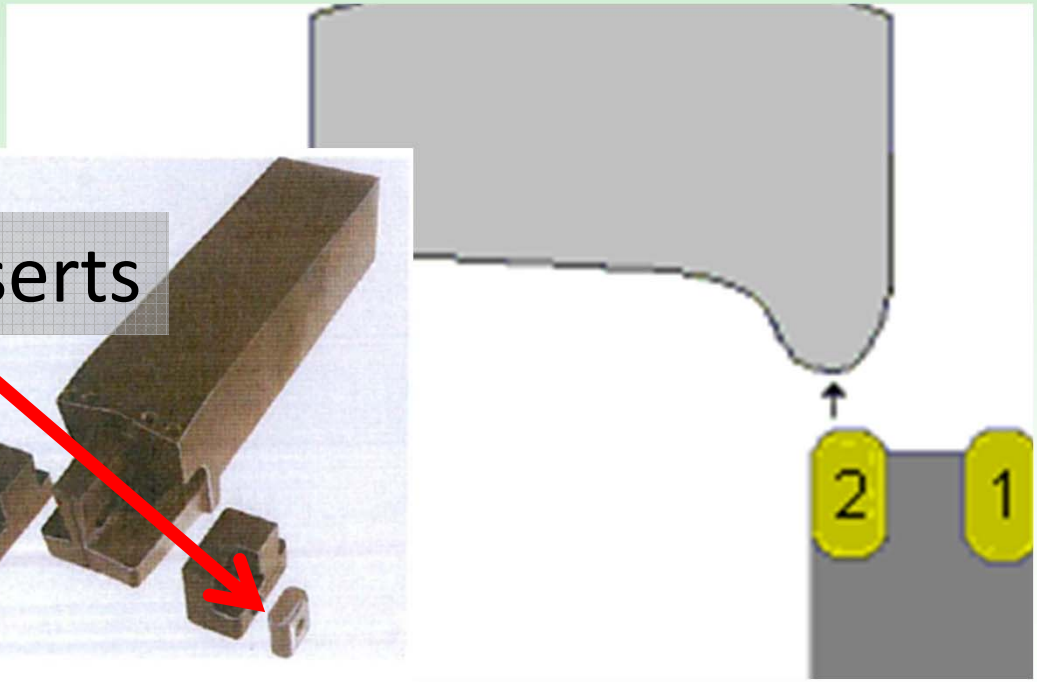




Truing Processes

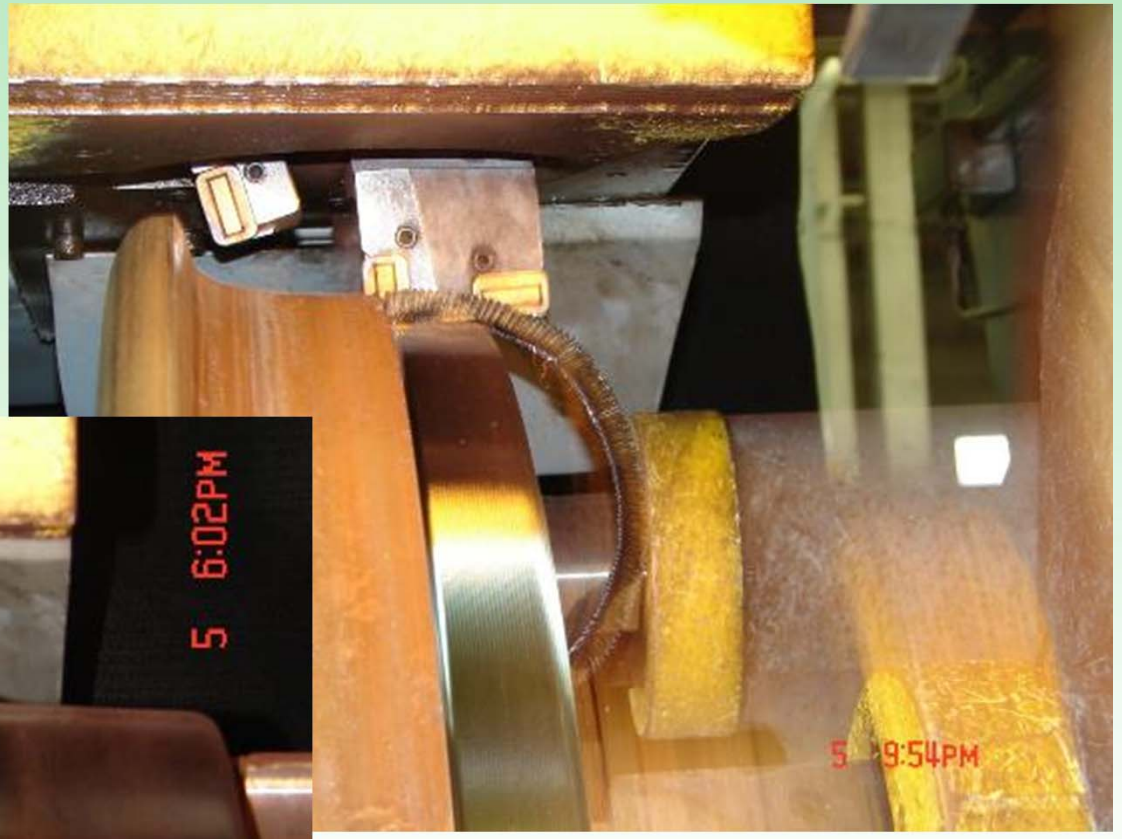
- Grinding
- Milling
- Turning

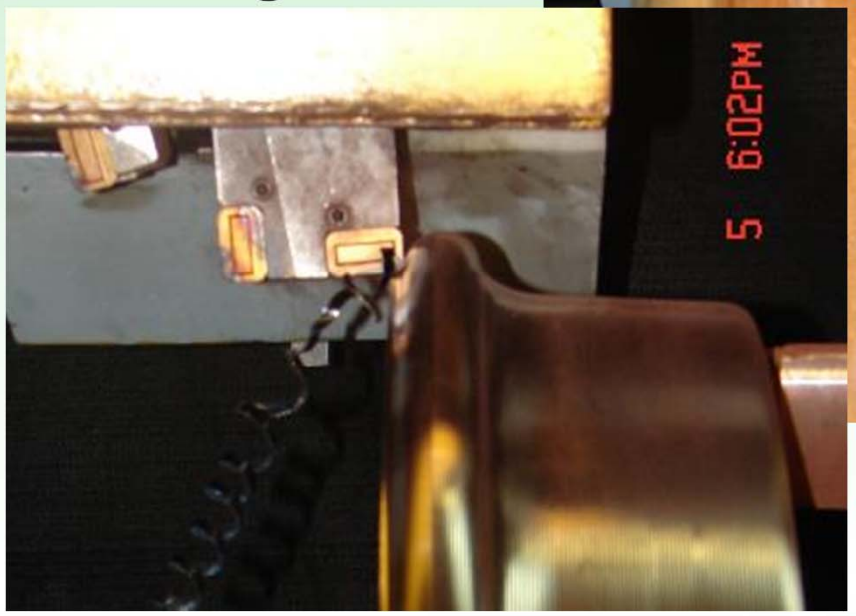




Truing Processes

- Grinding
- Milling
- Turning





Truing Processes

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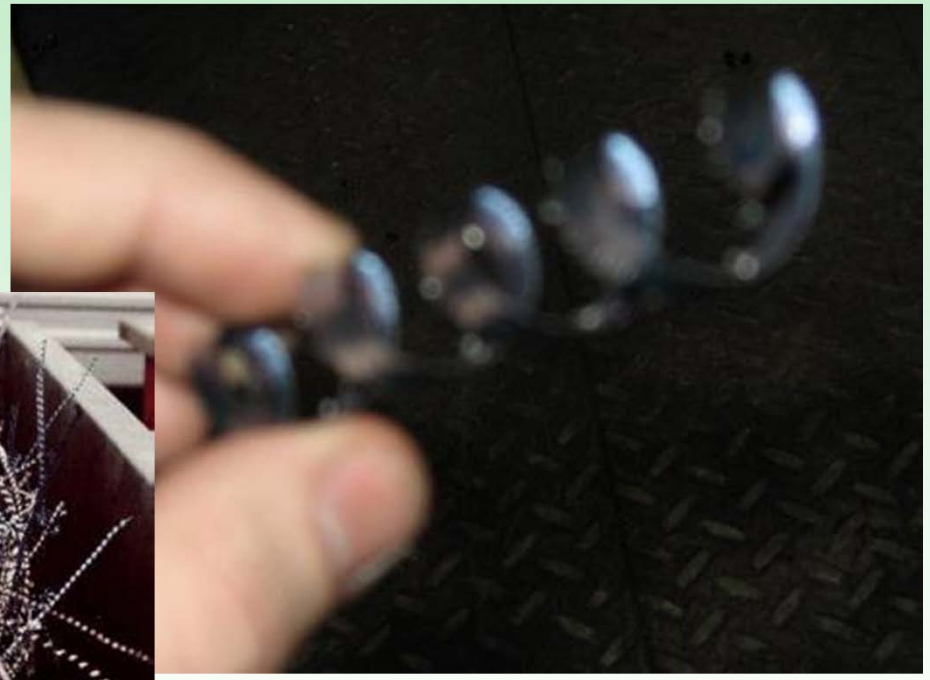

Truing Processes

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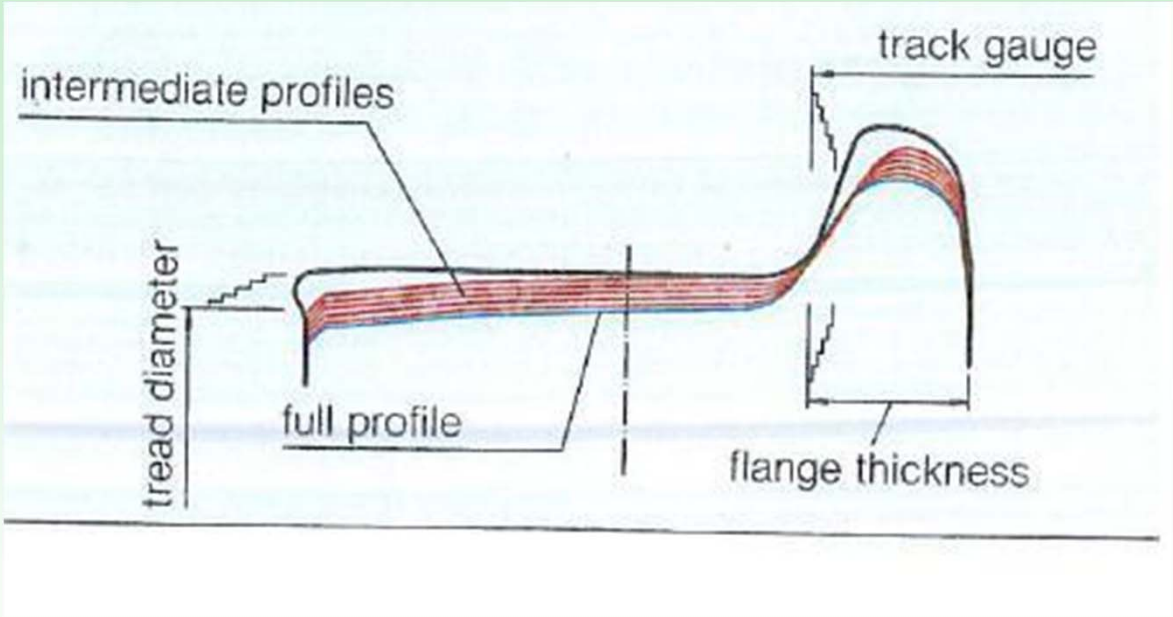
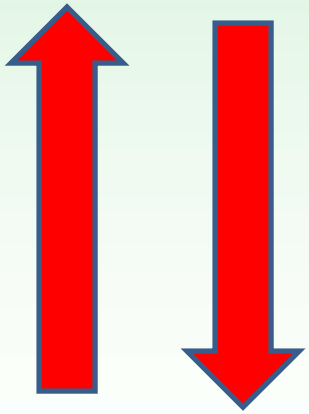


Major Advantage of Turning Process

Truing Processes

- Surface Finish
  - Grinding – 16 micro inch
  - Milling – 150 to 200 micro inch
  - Turning – 60 to 150 micro inch

Improved Surface Finish



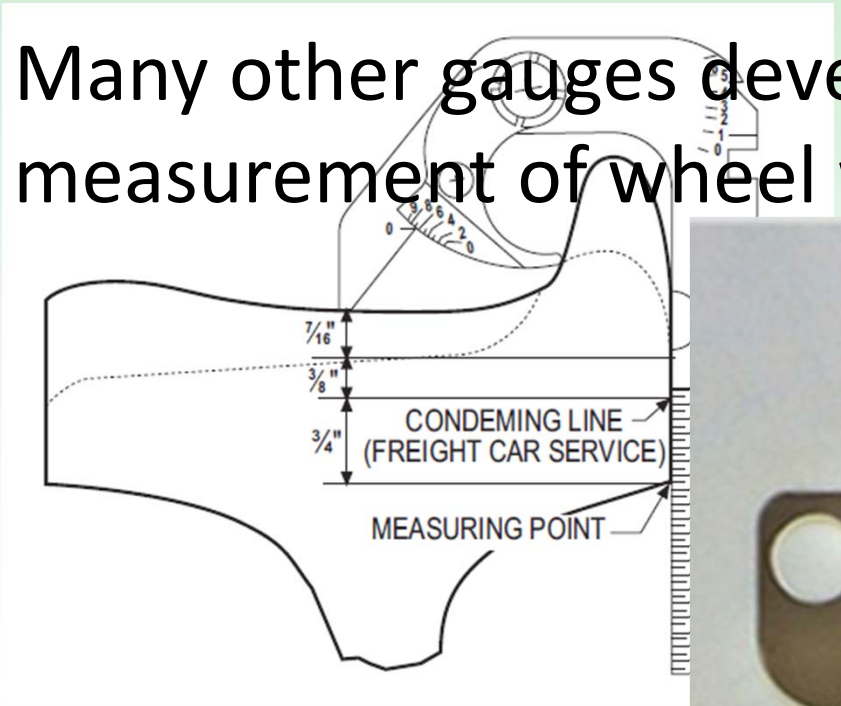
Productivity Reduced

Wheel Measurement

- Past practice involved manual measurements on periodic basis generally process driven
- Manual measurements are prone to human induced errors
  - Incorrect placement of measuring instrument
  - Incorrect reading of measuring instrument
  - Incorrect measuring instrument
  - Errors recording measurements or from transfer of recorded measurements
- Unsafe process

Wheel Measurement - Wear

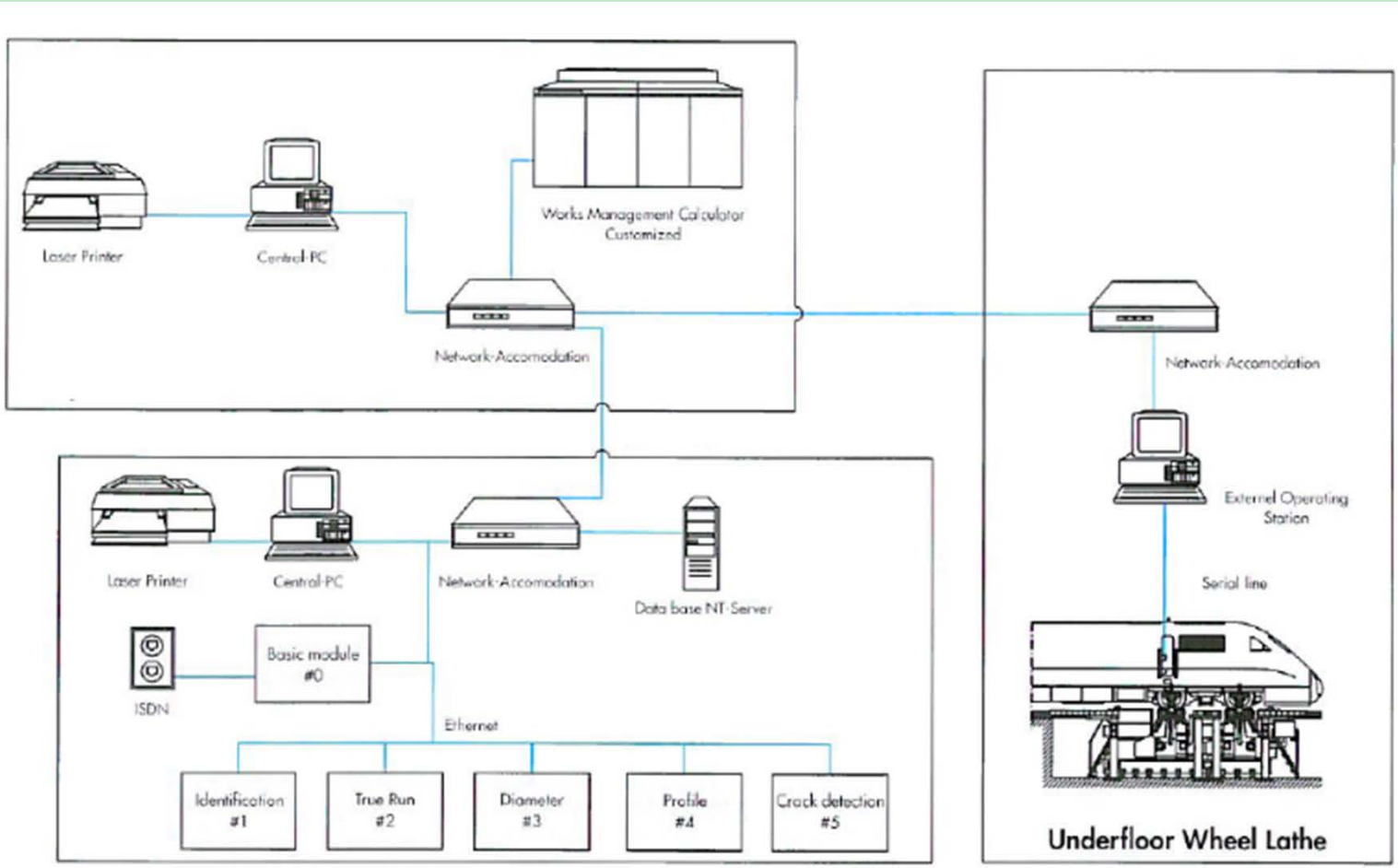
- Using a wheel gauge to determine depth of material to remove
- Many other gauges developed for measurement of wheel wear



Development of Automated Wheel Measurement

- Safety – remo
- Economical - collection
- Accuracy - M human capab consistent wh
- Explosion of systems and capabilities

In-Rail Wheel Inspection Systems



In-Rail Wheel Inspection Systems

- Wide range of capabilities
  - Profile
  - Diameter
  - Rim thickness
  - Roundness - defects
  - Cracks
- Other than wheels
  - Brake components
  - Bearings

In-Rail Wheel Inspection Systems

- Some noteworthy points for selecting a system
  - Numerous systems available
  - Purchaser must determine ***System*** requirements – what will the data be used for?
  - Accuracy drives vehicle velocity
  - Vehicle velocity drives installation location

Individual Wheel Set Inspection

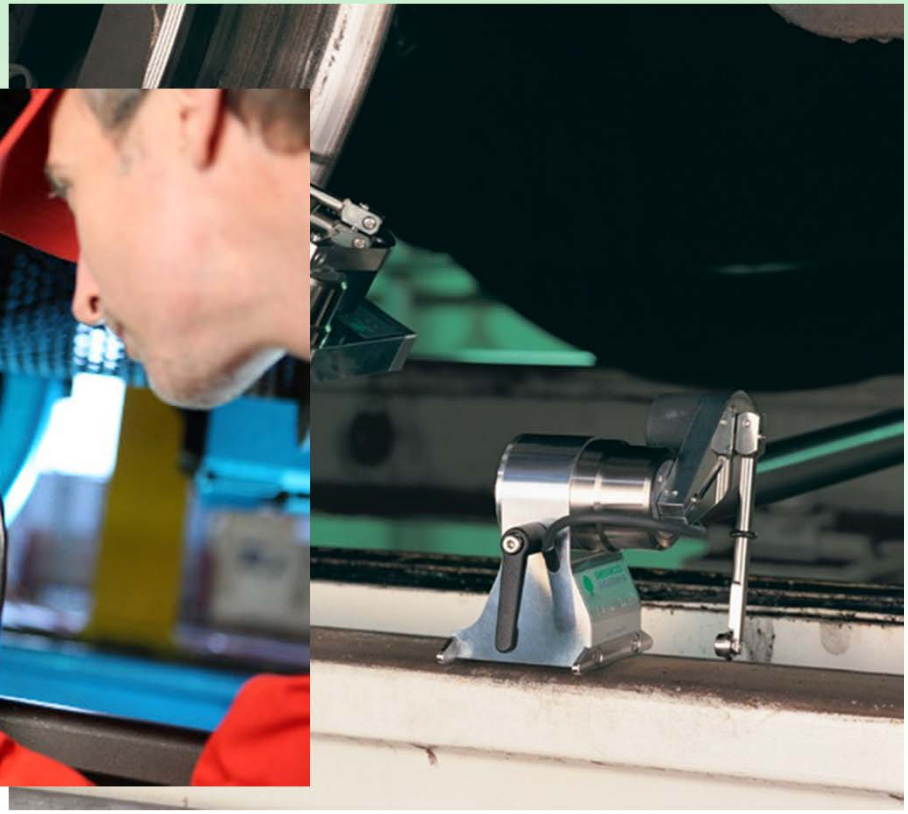
- Processing Individual Wheel Sets offers the same challenges and opportunities as in-situ wheel sets
  - Safety – remove operator
  - Economical - Highly efficient method of data collection
  - Accuracy - Measuring capability exceeds human capability and measurements are consistent which drives quality

Individual Wheel Set Inspection

- Automated measurement of wheelsets

Portable Wheel Inspection

- Portable equipment available for wheel profile measurement



Automated Wheel Measurement Data

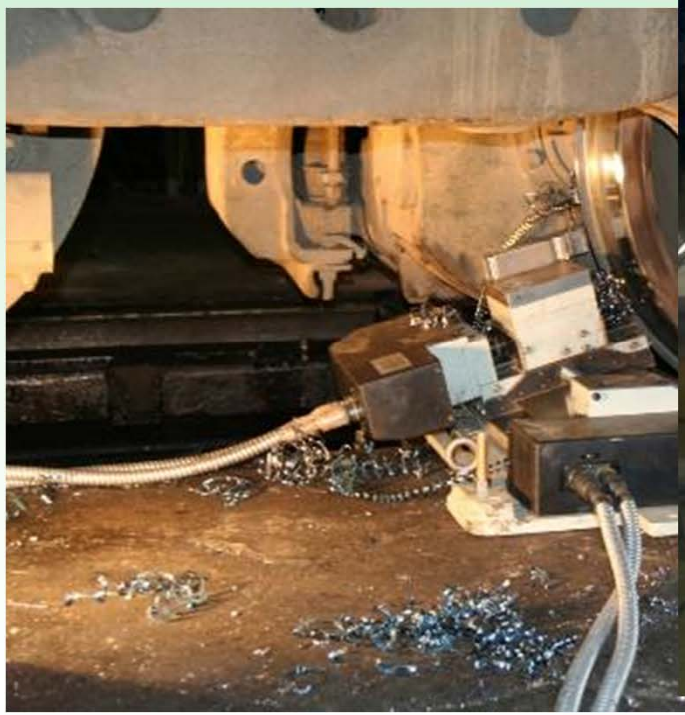
- Greatest potential benefit is for using the collected data to analyze the ***System***
- Data Mining
- Finding trends [illegible] hanges in the ***System***

Wheel Truing Equipment Options

- Portable
- Above floor
- Under floor

Wheel Truing Equipment Options

- Portable
  - Individual wheel unit

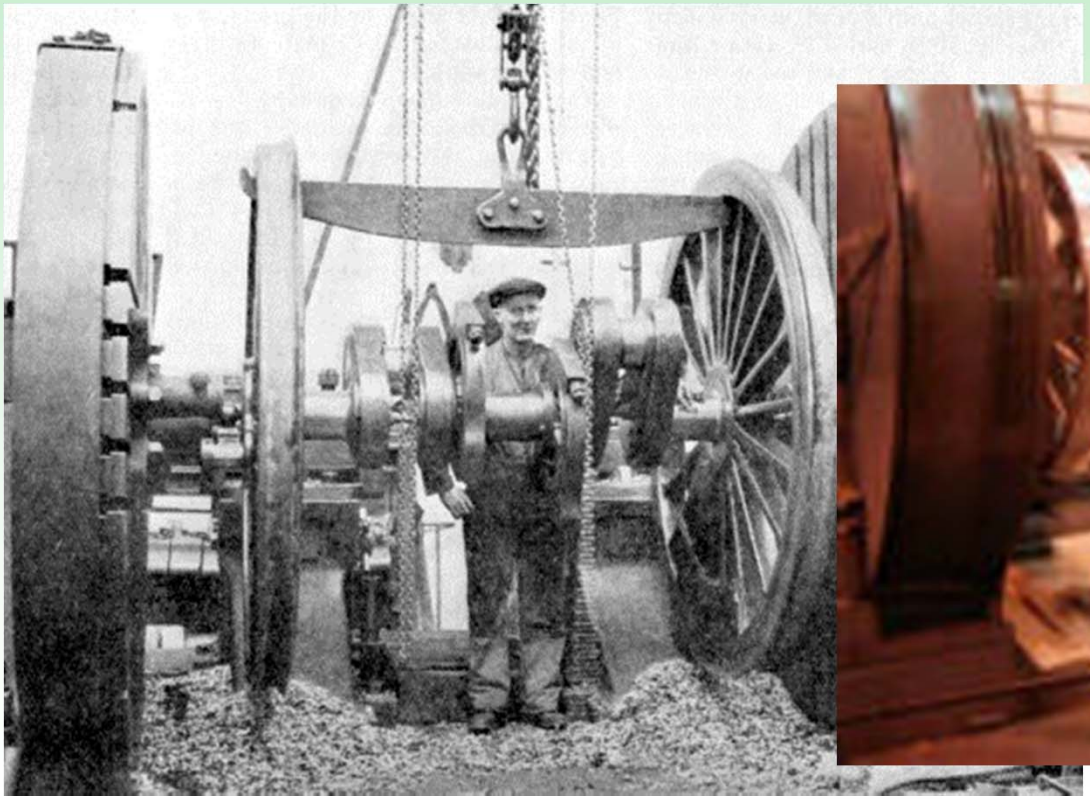


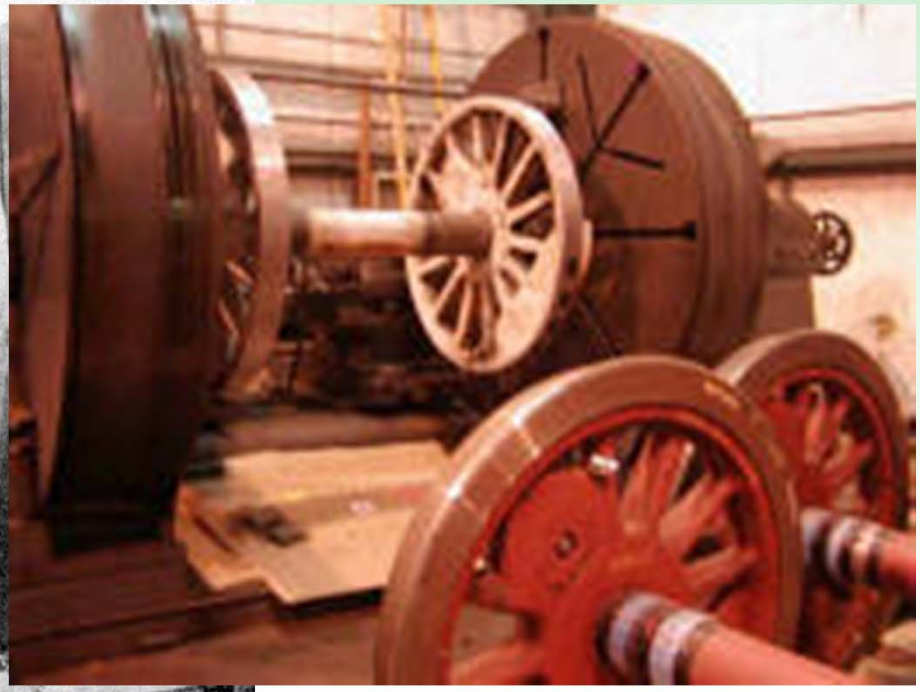
Wheel Truing Equipment Options

- Portable
  - Mobiturn®

Wheel Truing Equipment Options

- Above floor





Wheel Truing Equipment Options

- Above floor

Wheel Truing Equipment Options

- Above floor – Portal style

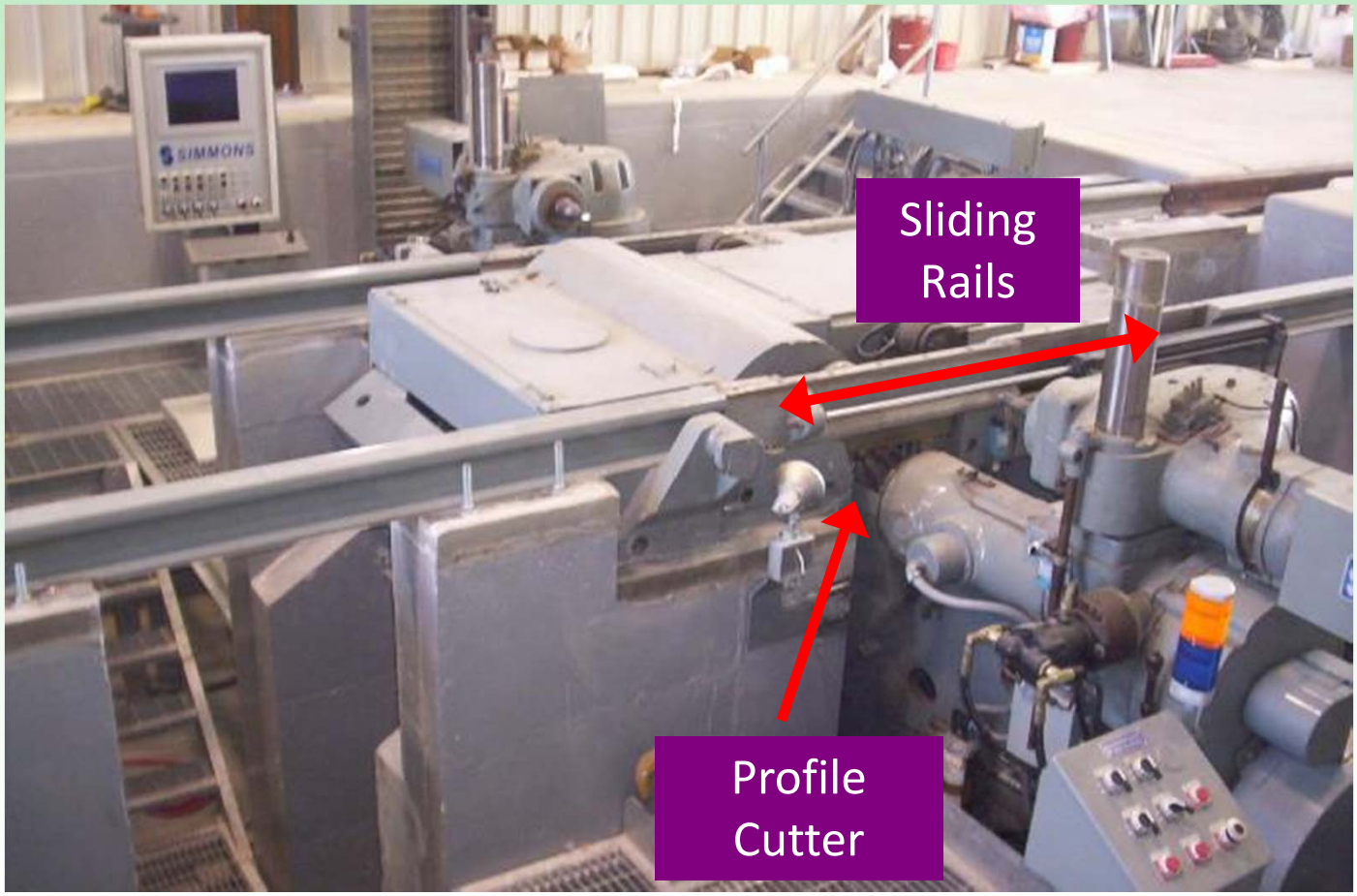
Wheel Truing Equipment Options

- Under floor in-situ
  - Milling – Wheel Truing Machine
  - Turning – Underfloor Wheel Lathe

Wheel Truing Equipment Options

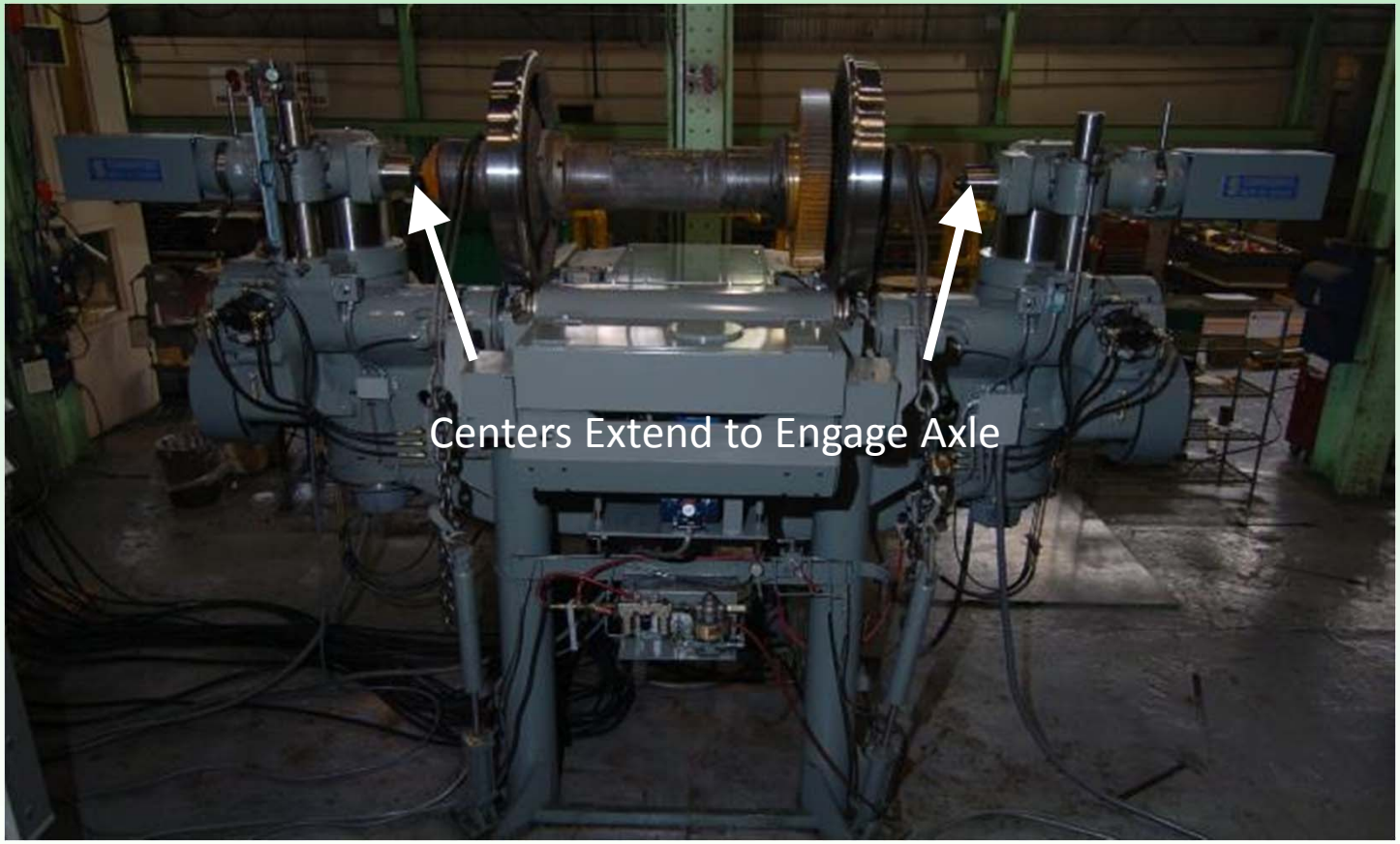
- Under floor
  - Milling – Wheel Truing Machine

Wheel Truing Equipment Options



Wheel Truing Equipment Options

Wheel Truing Equipment Options



Wheel Truing Machine in Test Stand at Manufacturing Facility

Wheel T Options

Wheel T Facility

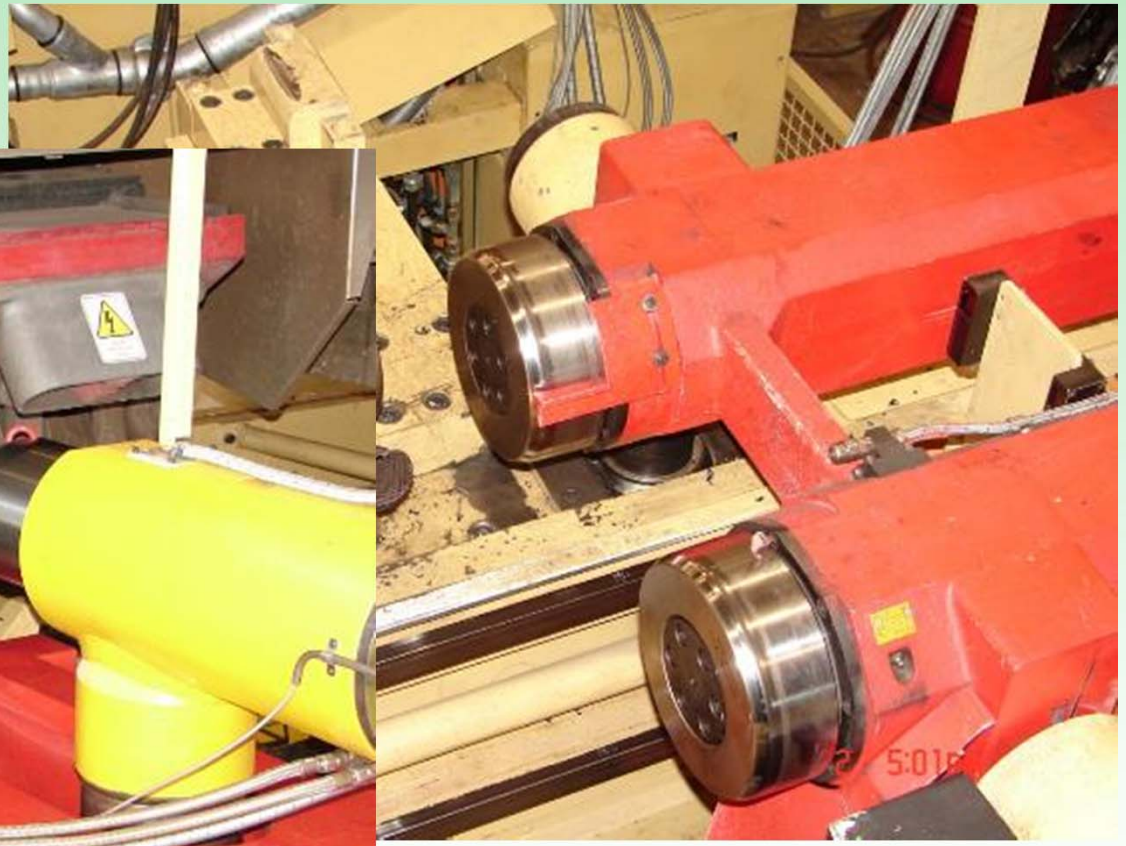
Wheel Truing Equipment Options

- Under floor
  - Lathe – Underfloor Wheel Lathe

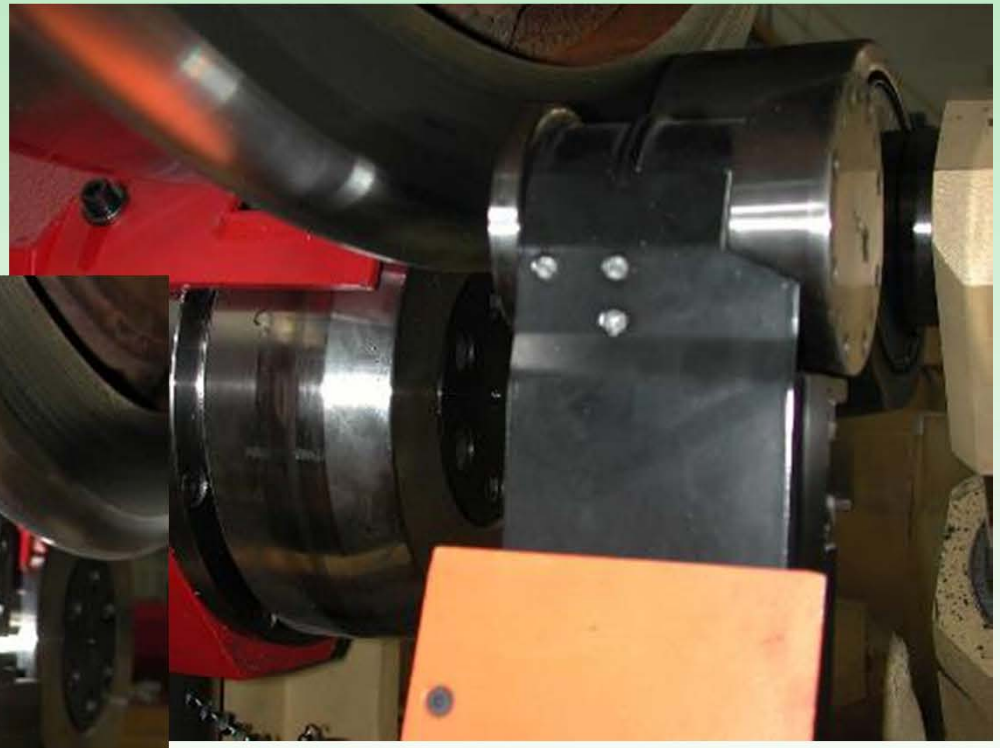
Wheel Truing Equipment Options

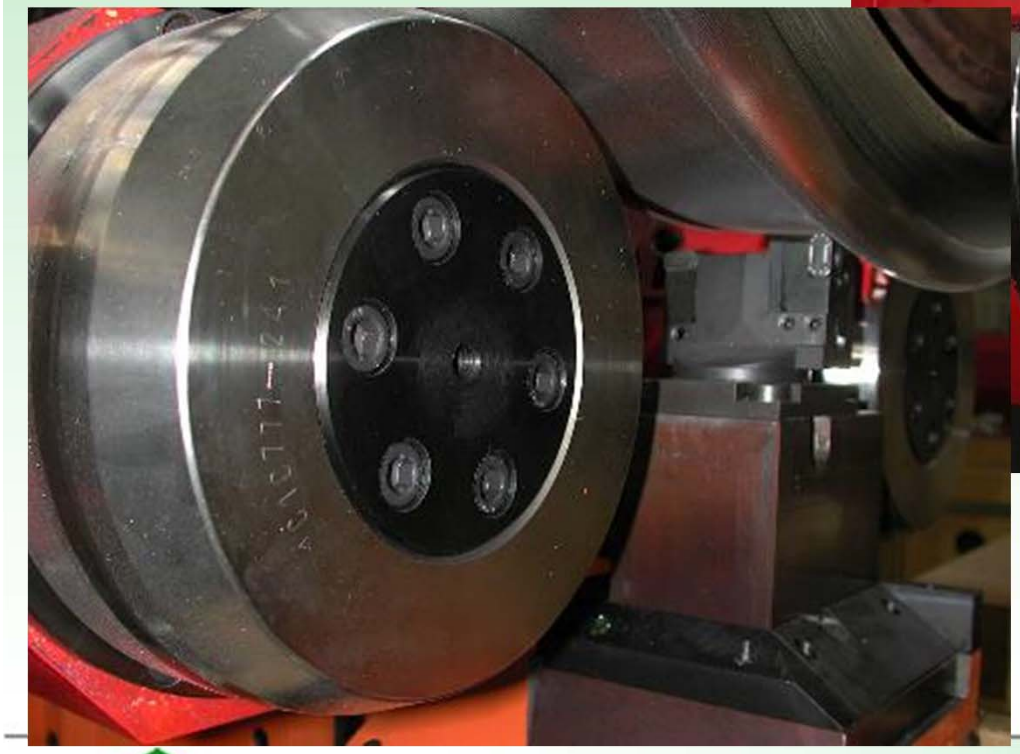
Wheel Truing Equipment Options

Wheel Truing Equipment Options



Wheel Truing Equipment Options





Wheel Truing Equipment Options

Some Vehicle Application Notes

- Wheel Truing Machine requires access to the axle centers of the wheel set
- Underfloor Wheel Lathe can be “centerless” requiring no access to axle centers
- Low floor vehicles have obstructions to axle centers and independent wheels

Wheel Maintenance Review

- Wheel Profile(s)
- Why True Wheels
- Truing Processes
- Wheel Measurement
- Truing Equipment Options
- Vehicle Application Notes

Questions

SIMMONS
MACHINE TOOL CORPORATION




WRI Basics: The Rail

VERY Basic

Goals

Methods

Tools

WRI Basics: Rail Goals

Work with wheels:

Compatible profile(s)

Steer axles

Avoid Flange Wear

Avoid/Prevent Rail Corrugation

Long service life

Compatible Profiles:

- Closed System (captive fleet): Design wheel and rail profiles to optimize WRI
- Open System: Design rail profile to accommodate AAR
- High and Low Rails of Curves: Shift Contact Bands to enhance conicity
- Tangents: enhance stability & avoid flanging

Close-Up WRI new wheel

Steering Axles with Rail Profiles

- Tapered wheel treads
- Distance Travelled: Outside Rail is Longer
- Rigid wheel/axle Set
- Effective wheel diameter varies depending on contact band:
  - Closer to flange: larger diameter, travel further each rotation
  - Further from flange, smaller diameter, travel less

Avoid Flange Contact

- Reduce Wear & Noise
- Uniform, mirror image profiles on tangent
- Shift contact band on curves
  - Toward gauge corner on high rail
  - Toward field side on low rail

Fight Corrugation

- Not Fully Understood
- First Symptom may be noise
- Good steering reduces Angle of Attack
- Bad Angle of Attack causes “slip stick”
- Flat profiles have undefined contact bands

Long Service Life of Rail

- Maximize Return on Investment in Rail
- Wear: “Loss of Section”
- Poor Profiles: Excessive grinding to correct
- Deep Corrugation: Excessive grinding
- Fatigue Life & Rail Fractures
  - Grind to remove crack initiation sites
  - Grind to remove surface damage

Costs of Premature Rail Replacement

- Purchase of the rail
- Installation of the rail
- Affect on Systems
- Interruption of Service
  - Quality of Service: Revenues, Competition
  - Public/Political Pressures
  - Constrained, inefficient work periods

Rail Maintenance Tools

- Grinders
- Milling Machines

Rail Grinders: Rail Head Details

- Groups of vertical axis electric drive surface stones
- Groups or individual stones can rotate about longitudinal axis: make any rail profile
- Repeated passes to smooth out facets
- Metal Removal in 0.001” per horsepower
- Must be stable: vibrations = new corrugations

Grinding Head Sample

Rail Grinding

- Contracted or In-House
- Types of Machines
- Management Challenges
- Contracting Challenges
- Multi-Year Strategies

Note spark angles

96 Stone Machine

16-Stone Machine

12-Stone Hy Rail Grinder

In-House Grinding

- Because contract grinding is difficult to specify as to quality and to unit price bidding
- Direct control and adjustments to needs
- Operations, MofW, and Technical groups develop territory and methodology skills
- Predictable Costs

In-House Grinding ?

- “Locked In” to purchased technology
- Sometimes issues with labor organizations
- Appears to be a controllable cost?
- Procurement, hiring, training, and promotion protocols confined to organization’s policies

Contracted Grinding

- Usually best solution for largest and smallest properties
- Large: Can efficiently dedicate months and years duration and mobilization.
- Large: Can use largest, most efficient machines
- Small: Can achieve rail profile maintenance without capital investment

Contracted Grinding ?

- Difficult to Specify Production and Pay Quantities
- Very difficult to procure under public works “low bid” rules
- Requires motivated Engineering Staff to guide contracts through process
- Requires qualified and equipped CM team

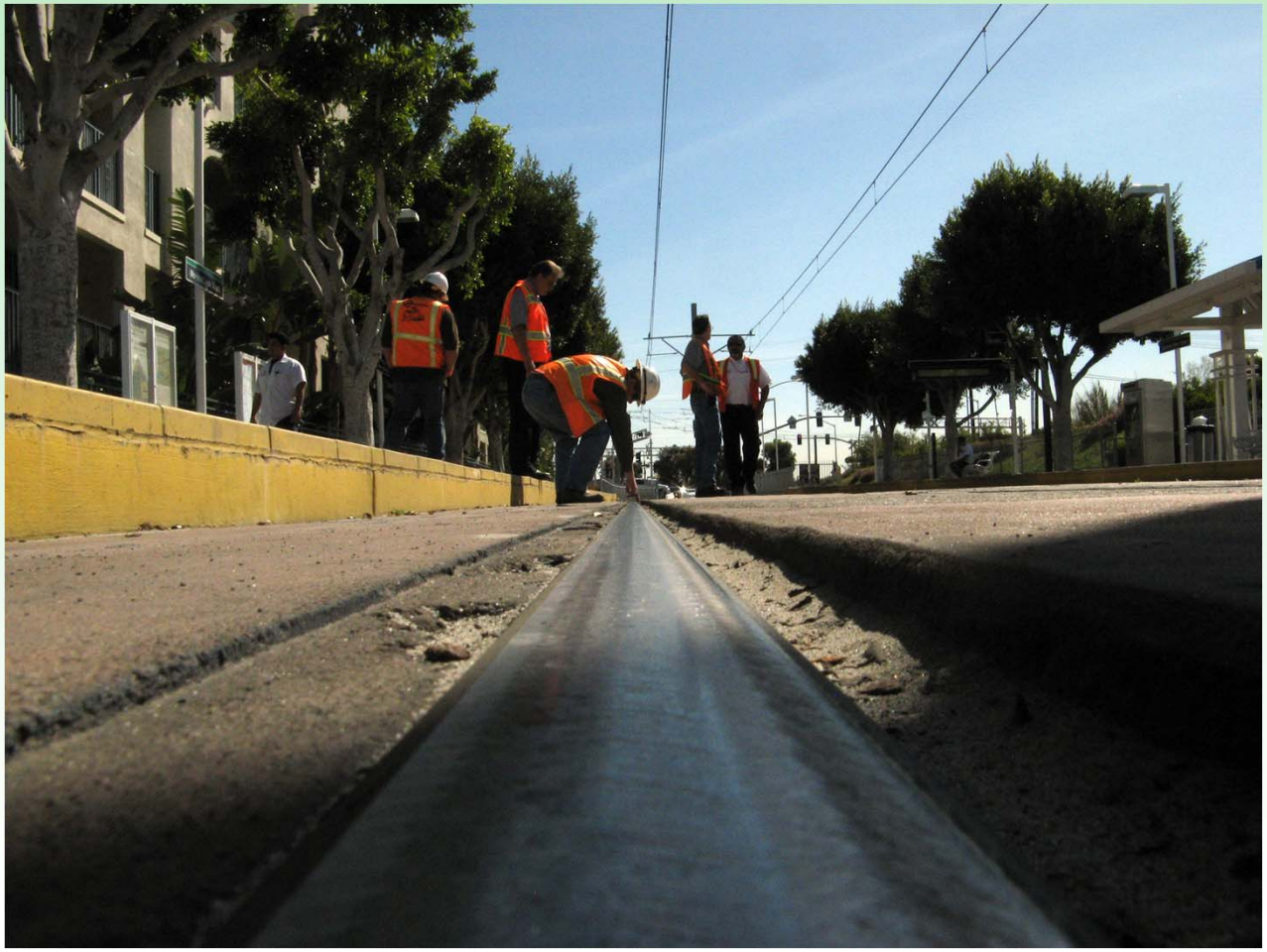
Running a Grinding Program

- Just an overview
- Determining Need
- Physical Realities
- Planning & Coordination
- Hourly Supervision
- QA

Determining Grinding Needs

- Input from direct staff observation and hand instrument data
- Peer Review, prior staff experience
- Public complaints
- Rail Profile Survey
- Rail Survey Data Compilation

Staff Inspection
Hand Tools, Visual



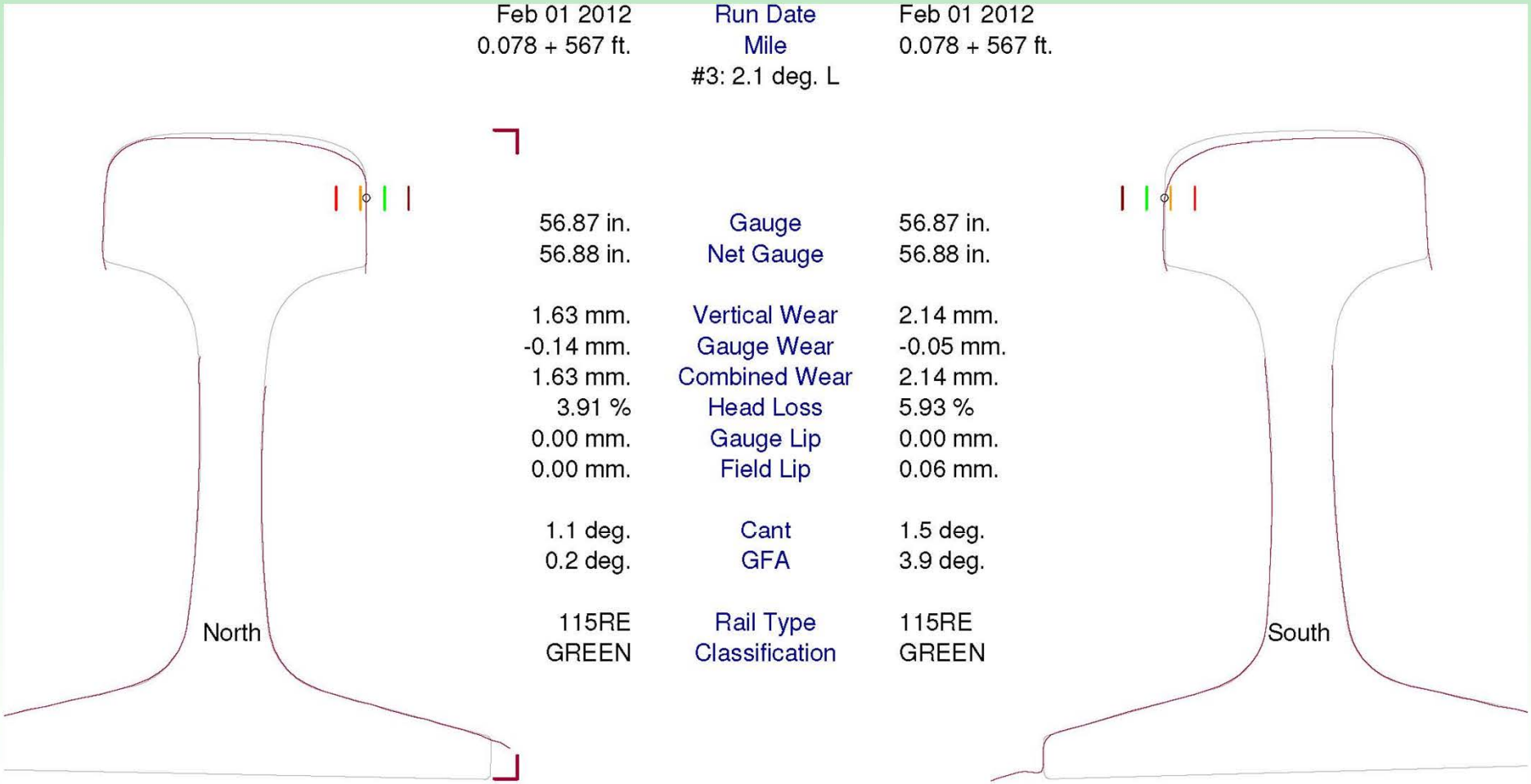
Inspection: Paint on Rail

Inspection: Rail Gauge

Inspection: Head Radius

Optical Rail Scan

Sample Optical Rail Scan



North		South
Feb 01 2012	Run Date	Feb 01 2012
0.078 + 567 ft.	Mile	0.078 + 567 ft.
	#3: 2.1 deg. L	
56.87 in.	Gauge	56.87 in.
56.88 in.	Net Gauge	56.88 in.
1.63 mm.	Vertical Wear	2.14 mm.
-0.14 mm.	Gauge Wear	-0.05 mm.
1.63 mm.	Combined Wear	2.14 mm.
3.91 %	Head Loss	5.93 %
0.00 mm.	Gauge Lip	0.00 mm.
0.00 mm.	Field Lip	0.06 mm.
1.1 deg.	Cant	1.5 deg.
0.2 deg.	GFA	3.9 deg.
115RE	Rail Type	115RE
GREEN	Classification	GREEN

Rail Scan Data by Mile

Realities of Grinding

- Track space to stage, store, and maintain
- Resources: water, fuel, supplies, employee access
- Grinder Impacts:
  - Noise
  - Dust, smoke
  - Sparks: fire risks, public concerns

Engineering Planning & Coordination

- Determine Target Rail Profiles
- Determine exceptions to target rail profiles, by priority locations
- Estimate the amount of work needed
- Determine constraints on equipment, if any
- Estimate time required (depends upon equipment choice and rail condition)
- Special considerations very new, very old rail

System Planning

- Preferred Work Periods, adjustments
- Blackout periods
- Support groups: C&S, Security, Safety
- External Factors:
  - Public notice “no surprises”
  - Public Safety: fire and police
  - Public Regulations: Underground, fire,

Other Details

- Support:
  - MofW Forces “just in case”
  - Communication Links

Safety:

- Training of contractor & consultant staff
- CFR 214 Railroad Workplace Safety
- Territory Qualification: Mountain Grades?

Alternatives to Rail Grinding

- European railroad supply vendors have developed other specialized machines to suit conditions.
- High speed grinding units pulled at track speed to maintain profiles: very light cuts
- Milling machines to remove significant metal depths more efficiently than grinders
- See them for details

Linsinger Milling Machine

“The Third Half”

- Discussion of the WRI is not complete without the “third body”
- Lubricants to reduce flange contact friction
- Friction Modifiers to reduce the effects of slip-stick on low rail without impairing traction
- Can have system efficiency benefits

Gauge Lub and TOR Sites

Questions?