Obtaining and Maintaining State of Good Repair (SOGR)

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Obtaining SOGR

Best use of resources given budget & work window constraint for:

- Safety
- Service reliability
- Ride quality
- Lowest life cycle cost
- Acceptable noise & vibration thresholds.

No one will ever tell you congratulations. You will be the first to know if you blew it!

Maintaining SOGR

Move to preventive maintenance & capital replacement strategy:

- Eliminate slow orders and track-related delay
- Implement work order records in field
- Track defect and performance histories
- Specify longest life, premium components where payback demonstrated
- Tighten construction & maintenance-of-way (MoW) standards
- Change grinding/lubrication, tie renewal, surfacing, ditching, pad renewal & undercutting from reactive to proactive.

Background

High level drivers to establish and continue SOGR program:

1. SOGR – FTA encourages use of turnkey EAM system “one size fits all”.
2. MAP-21 funds integrated GIS/PS coordinates that can be overlaid with schematic track map.
3. WO management enables identification of cluster failures, design issues, performance evaluation, backlog.
4. Data easily accessed for Management and Board.

What is Different with SOGR Lately

FTA increasingly requires MoW & Capital Work Order records, locations & conditions with an Enterprise Asset Manager (EAM):

Objectives

- Optimize
- Plan
- Program asset renewal and replacement.

Eventually *every* transit will be required to produce *foot by foot* inventory and condition data with the touch of a button.

How is SOGR Defined

SOGR ratings generally map well with MoW Standards:

FTA SOGR	MoW Limits	
Class I	Red	Restrict or Close Track – Immediate Repair
Class 2 Class 3	Yellow	Run at MAS[1] – Program Work
Class 4 Class 5	Green	Operate at MAS for Track Class

1. Maximum Allowable Speed

Using Asset Management Tools

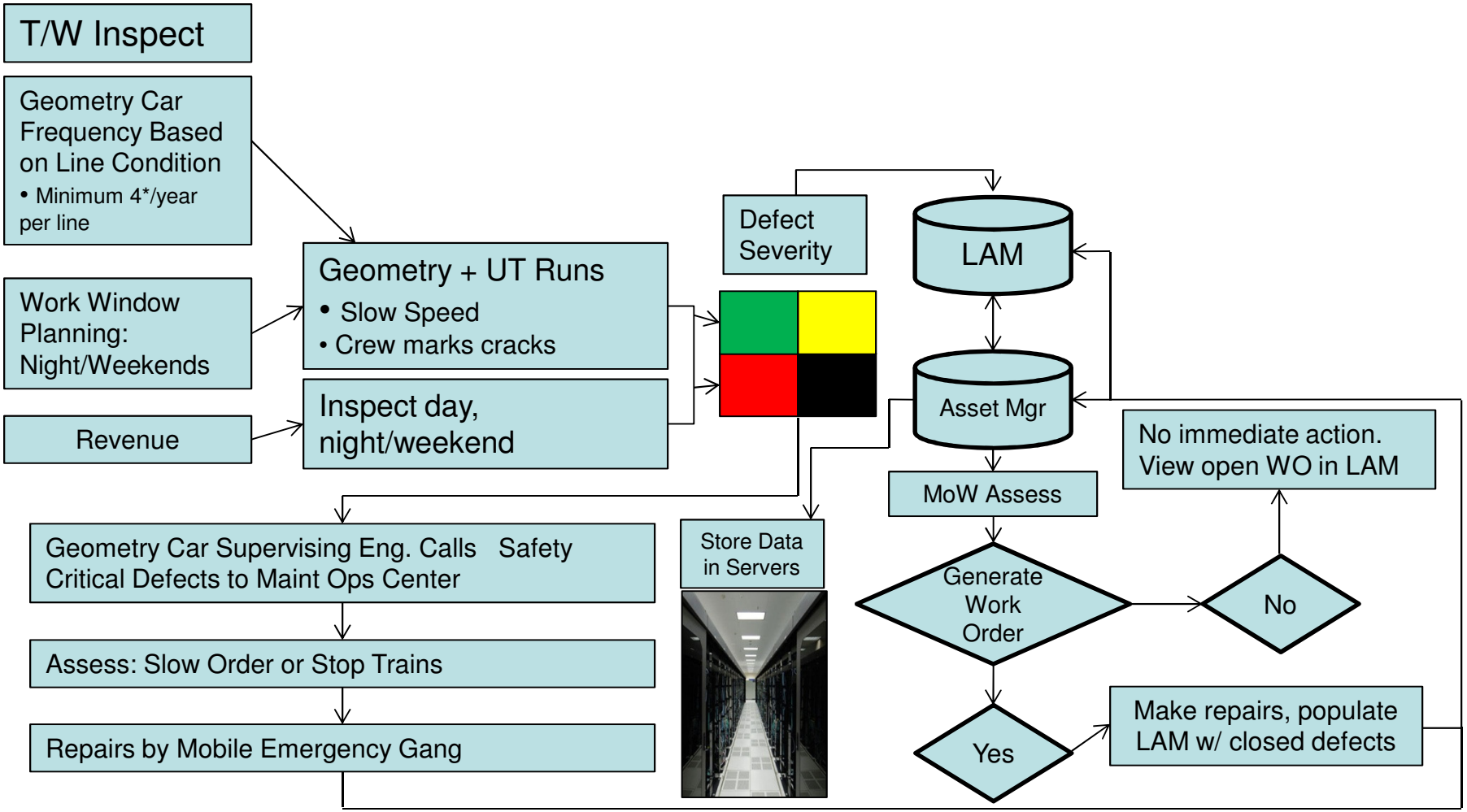
EAM/LAM systems often sold as “do all and end all” systems as shrink-wrapped, out-of-the-box products. Significant customization required, regardless of vendor:

1. EAM/WO systems come from vehicle/bus side – not rail which is linear asset to be viewed in time and space.
2. Linear Asset Manager important – can be stand alone or have Work Order Management interface.
3. Build track chart first as Phase I with component inventory/limits.
4. Add maintenance and 3rd Party production data as Phase II.

EAM/LAM & Automated Track Inspection Evolving Rapidly

- Always clearly define the business case up front. Example: Rail Management.
- Who are the users? This will influence the way you build the system as you map Work Orders.
- Produce a Functional Requirements Document before buying.
- Ask yourself “What is my SOGR timeline” and build program out accordingly.
- Drive your own requirements at Departmental Level.

Map Business Process



Devise Work Window Plan to Achieve SOGR within 3-5 Years

Lay out scope, schedule & budget clearly to sell SOGR Program to Board. Include analytical, production and IT requirements and dedicated staff required:

1. Assess condition/benchmark.
2. Develop SOGR Program scope, schedule and budget.
3. Backlog + Useful Life Remaining = Workload.
4. Target SOGR needs by track, line & job type.
5. Devise Production Plan for rail, ties, fasteners, undercutting, pad renewal, etc.).

Fear & fear alone sells SOGR programs. Make sure existing EAM/LAM/ 3rd Party Software tells the story about what happens if you DON'T get funding.

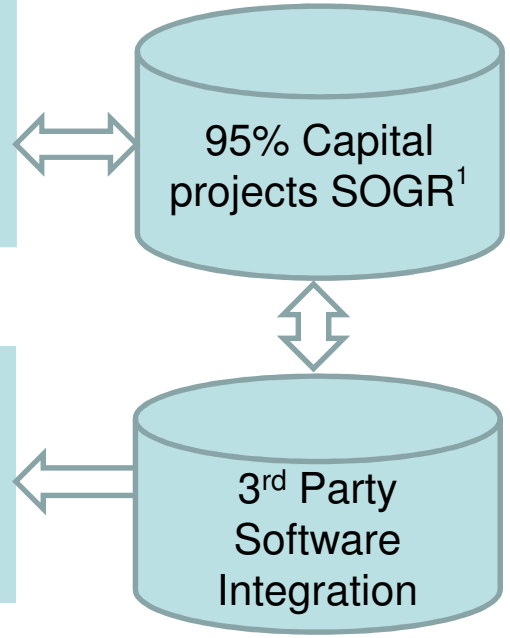
How EAM/LAM Works

EAM - Enterprise Asset Management:

- Asset Useful Life
- Inventory – plant and field
- Work Orders – based on defect priority
- Work Window Planning/Piggyback.

LAM - Linear Asset Management:

- Database & LAM interface development
- Basis for analytics



At MBTA, 95% of all Capital Projects Approved to Achieve SOGR

Automated Track Diagnostics

Typical third party condition assessment outputs become inputs to LAM system:

- Trackwalker Visual Inspection – rail, ties, fastener, geometry defects, frog/ point cracks – 2/week mainline
- Track Geometry (4*/year - mainline, 2*/year - yard/lead tracks):
  - Line, gauge, surface, twist, cross-level
  - Run over run degradation rate used for surface, undercutting & tie replacement cycles
- Rail Wear measurement – non–contact, pushcart or vehicle
  - Side wear – maps to red yellow, green conditions
  - Top wear
  - Angle of attack
  - Head area loss
- Ultrasonic Defect Detection – internal rail flaw defect detection (1/year)
- GRMS – to detect weaknesses in lateral restraint (1-2 times/year)
- Ride Quality - WILD, accelerometers, acoustical bearing (Ongoing)

Automated Track Diagnostics

Additional and emerging tools:

- Machine vision – tie failures, concrete rail seat abrasion
- Ground Penetrating Radar – subsurface investigation
- Infra red – 3rd rail and pots that are “hot”
- Tunnel measurement – laser based for actual tunnel limits
- CWR residual stress measurement.

These tools allow the MoW Manager to better target resources where specific work can be done along trouble spots.

Apply Risk-Based Approach to Manage Rail

Attack “low hanging fruit” first:

1. Pull Aparts – put in plug and adjust RNT.
2. Put in place CWR management program.
3. Record rail plug locations in field with RNT, ambient temperature, etc.).
4. Keep installation records in Track Department – LAM or Log – not EAM.
5. Use monitoring devices in real time monitoring – like WILD, rail residual stress, etc.

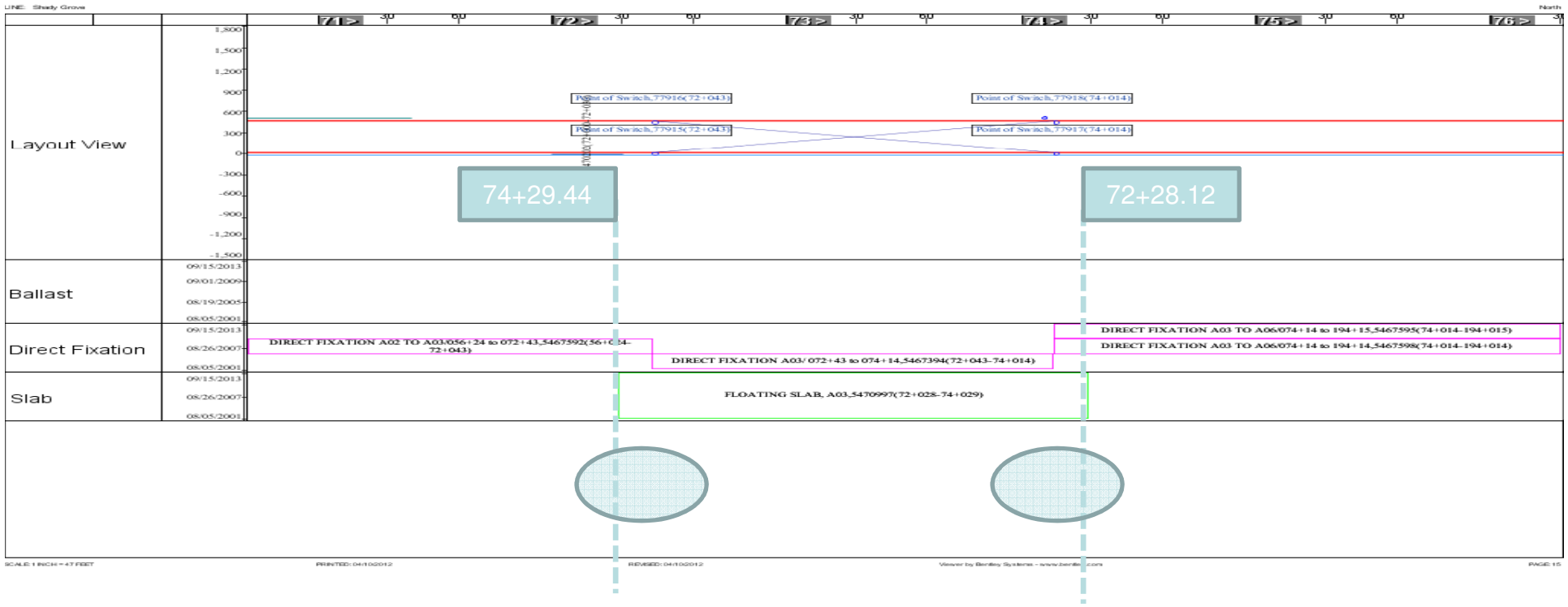
Linear Asset Management

To create virtual baseline “map” (curve, tangent, special work, bridge, etc.):

1. Fly Over Mapping LIDAR
2. Geometry Car
3. Push chart with GPS
4. Autonomous data collection
5. Paper Track Chart Data Extraction

Linear Asset Management

Virtual baseline “map” swim lanes show curve, tangent, special work, bridge limits by station number. DF-FS transition shown:



FMECA: Repair Low Hanging Fruit First

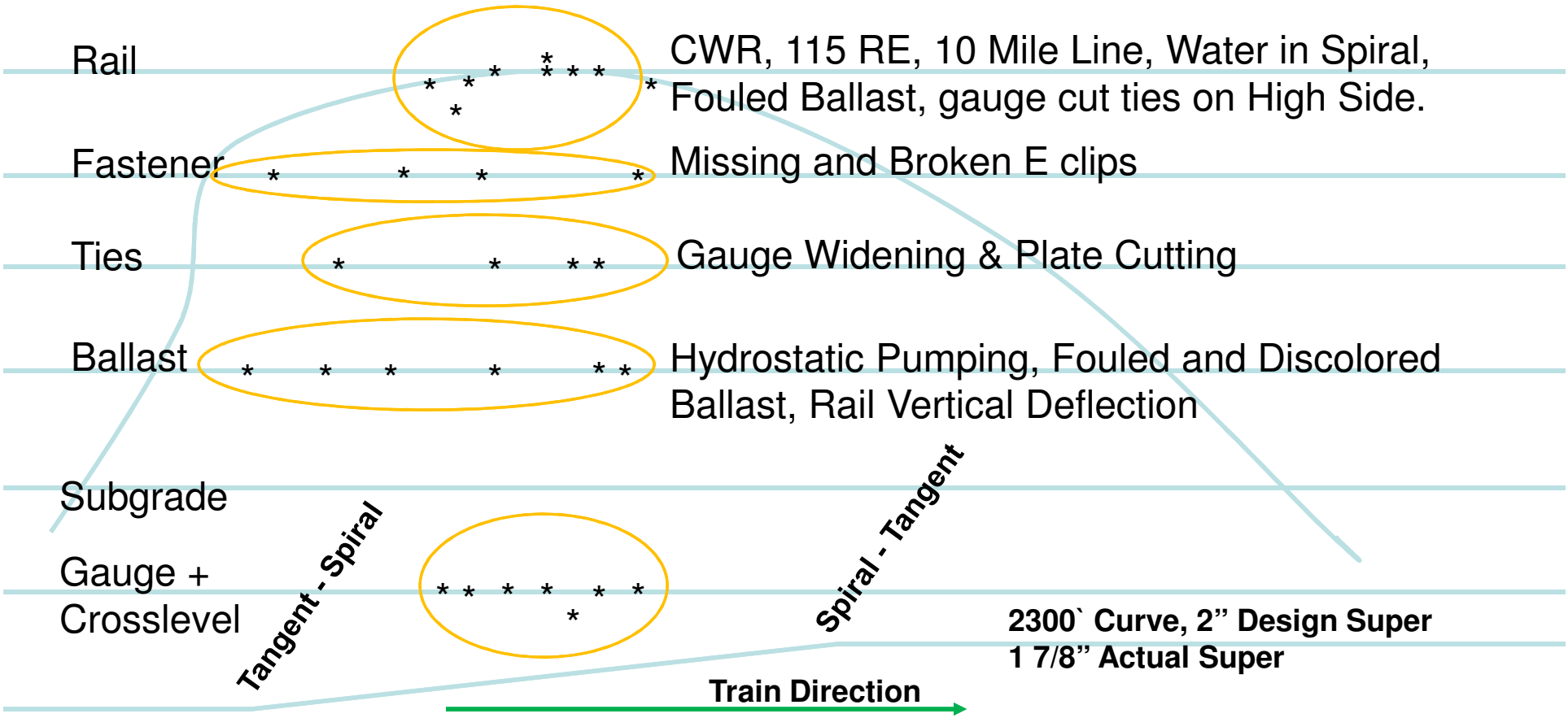
CWR, 115 RE Rail Renewed in 1998 with E Clips ~50 MGT line

	Parameter	Red	Yellow	Green	Delay (F*T)	Con	Freq*Con	Locations	Plugs	Adjust	Geometry
Defects	Broken Rail										
90	TD	2			180	3	6	210-213	Y	N	Spiral
	VSH	3			270	3	9	153-160	Y	N	Spiral
	Detail Fracture	2			180	3	6	210-211	Y	N	Spiral
	Rail Base Corrosion	1			90	3	3	10 & 189	Y	N	Tangent
	Pull Apart	2			180	3	6	211-212	Y	N	Spiral -CC
		10									
% Track Delays		0.08			900						
Criticality Index							30				
Conditions	Rail Wear/Profile										
	East			x							
	West			x							
	Ties @20 percent policy		x								
	Fasteners			x							
Geometry	Gauge	x			Difficulty holding gauge in spirals after heavy rains.						
(run over run)	X-Level	x			Cross level devations match rail cant defects.						
	Surface/Line		x								
Program Work	Rail Renewal			x							
	Grinding		x		Corrective						
	Ties		x		Cluster Failures						
	Fasteners		x		Spot Replacment						
	Ballast/Undercutting	x			Fouled/Pumping						
	Subsurface	x			Poor						
	Rail Adjusted	x			Never						

FMECA = Failure, Mode, Criticality and Effect, initially used by Military to prevent catastrophic failures of Jet Fighters

Linear Asset Management

Rail break data overlaid on engineering/condition data. Over 80% of all rail line breaks 2009-2012 found on 1 spiral:



Maintaining SOGR

Shift from reactive to proactive/preventive maintenance:

1. If you assess condition/benchmark
2. Develop plan and time frame
3. Backlog + Useful Life Remaining = Workload
4. Target SOGR by track, line and job type
5. Devise Production Plan (rail, ties, fasteners, undercutting, pad renewal, etc.)

Plan varies depending on funding/time frame. Ideally, make it 3-5 years to achieve SOGR.

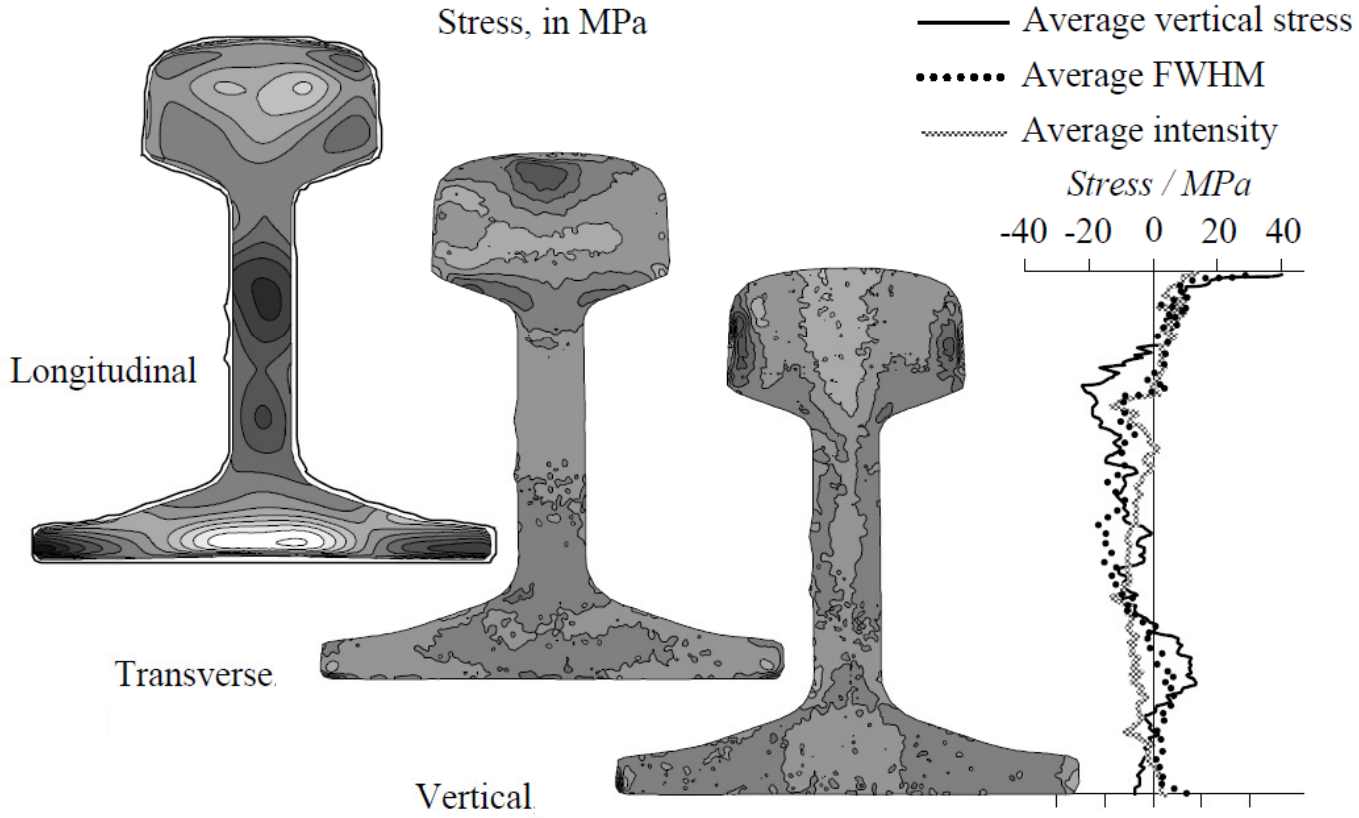
Keep Up with Training as Experience Base Retires

Automated track inspection proliferates but cannot replace the best track inspectors:

1. Rigorous training is required to augment the knowledge base now retiring in spikes.
2. CBT + Classroom + Field Training works best.
3. Labor force requirements to maintain new track systems evolving.
4. New diagnostics have more complex systems and subsystems to maintain.

Training is Critical

Ongoing SOGR training includes fundamentals of railroading: Rail stress at mill due to rail straightening. Challenge is to manage *in-situ* stress to negate the risk of break-out:



The Measurement of Residual Stress in Railway Rails by Diffraction and other Methods, J. Kelleher, et al, Manchester Materials Science Center, Journal of Neutron Research, 11-4-2003.

Lessons Learned

If you choose or have inherited systems to achieve SOGR:

1. Select low hanging fruit first.
2. Tie your SOGR initiatives to measurable:
   - Safety improvement: reduce service delay, derailments
   - Life cycle cost improvement.
3. Ensure business process is established and track production machine outputs compatible with EAM/LAM input requirements up front.
4. Don’t wait for delivery of new track equipment to pilot and test software integration.
5. Collecting and making sense of data outputs requires significant, ongoing, dedicated staff commitment.

Thanks for your time and interest!

May every day be a safe day on the railroad!

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