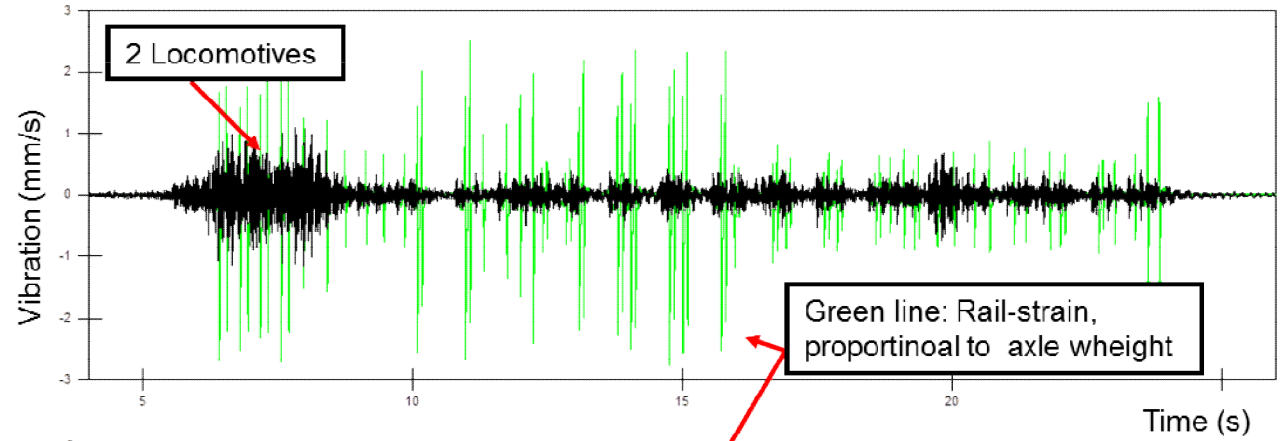
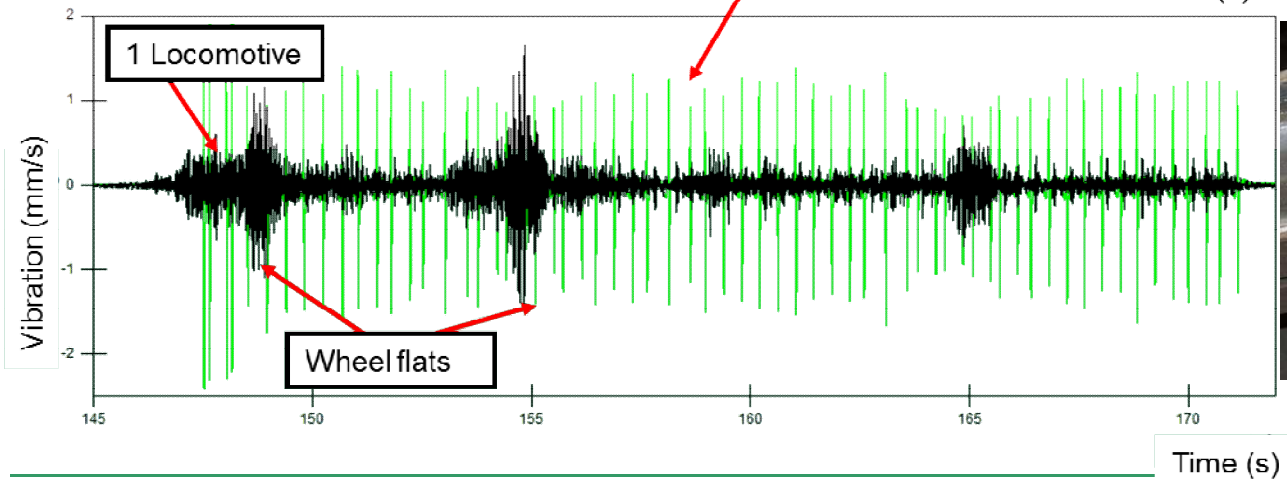
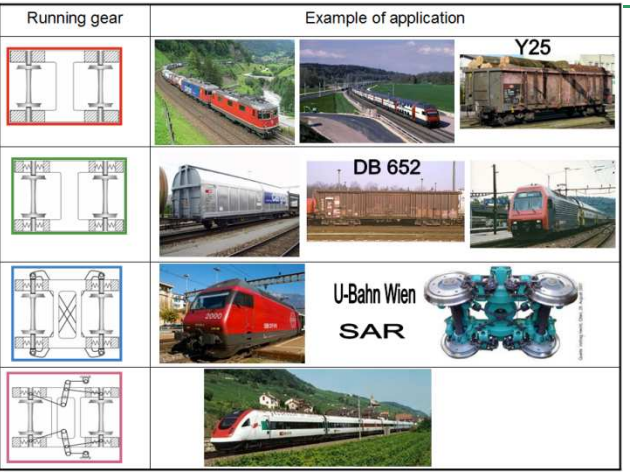
Reducing wheel OOR to mitigate vibrations



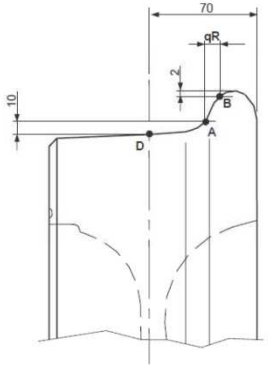


1. Introduction to complexity



Mechanisms

- Bogiedesign,
- Line characteristics,
- Creepage control
- Friction management



Parameter description	Units	Range
back-to-back	mm	1358 to 1364 mm
flange height	mm	28 to 37 mm
flange width	mm	23 to 30 mm
wheel diameter	mm	855 to 922 mm
tread rollover	mm	0 to 6 mm
false flange	mm	0 to 3 mm
wheel profile	N/A	N/A
steps in flange profile	mm	0 to 2 mm
flange profile radius	mm	2 to 15 mm
flange back excess material	mm	0 to 2 mm

Product

Material:

- Homogenity,
- Wear resistance,
- RCF resistance

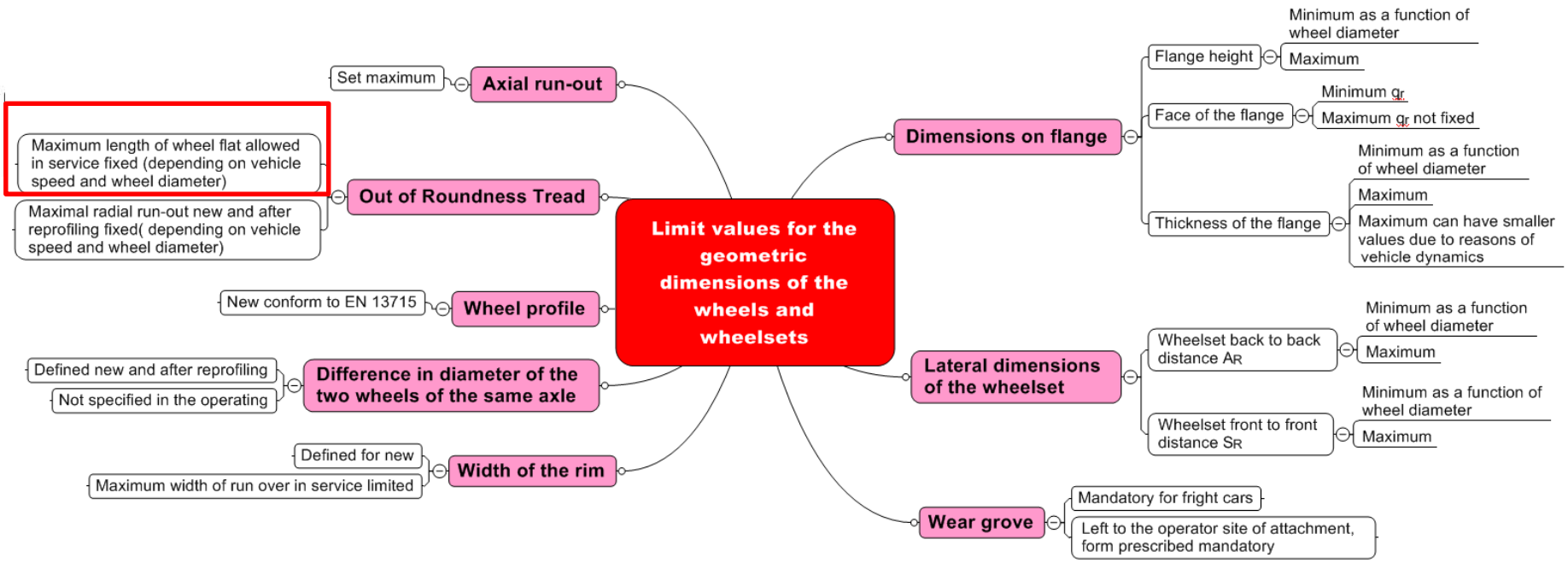
Maintenance

- Limit values,
- machining,
- validation criterias, control

1. EN15313-OOR maintenance: Only flats mandatory

Wheel diameter — dependent speed	Permitted Out-Of-Rondness (Δr)
$D > 840$ mm	
• $v_{max} \leq 60$ km/h	1,5
• 60 km/h $< v_{max} \leq 160$ km/h	1,0
• 160 km/h $< v_{max} \leq 200$ km/h	0,7
• $v_{max} > 200$ km/h	0,5
380 mm $< d \leq 840$ mm	
• $v_{max} \leq 200$ km/h	0,7
• $v_{max} > 200$ km/h	0,5
$d \leq 380$ mm	0,3

EN 15313
Organisation of Maintenance



2. Problems from international review

A) Wheel flats not longer than 60 mm (EN15313)

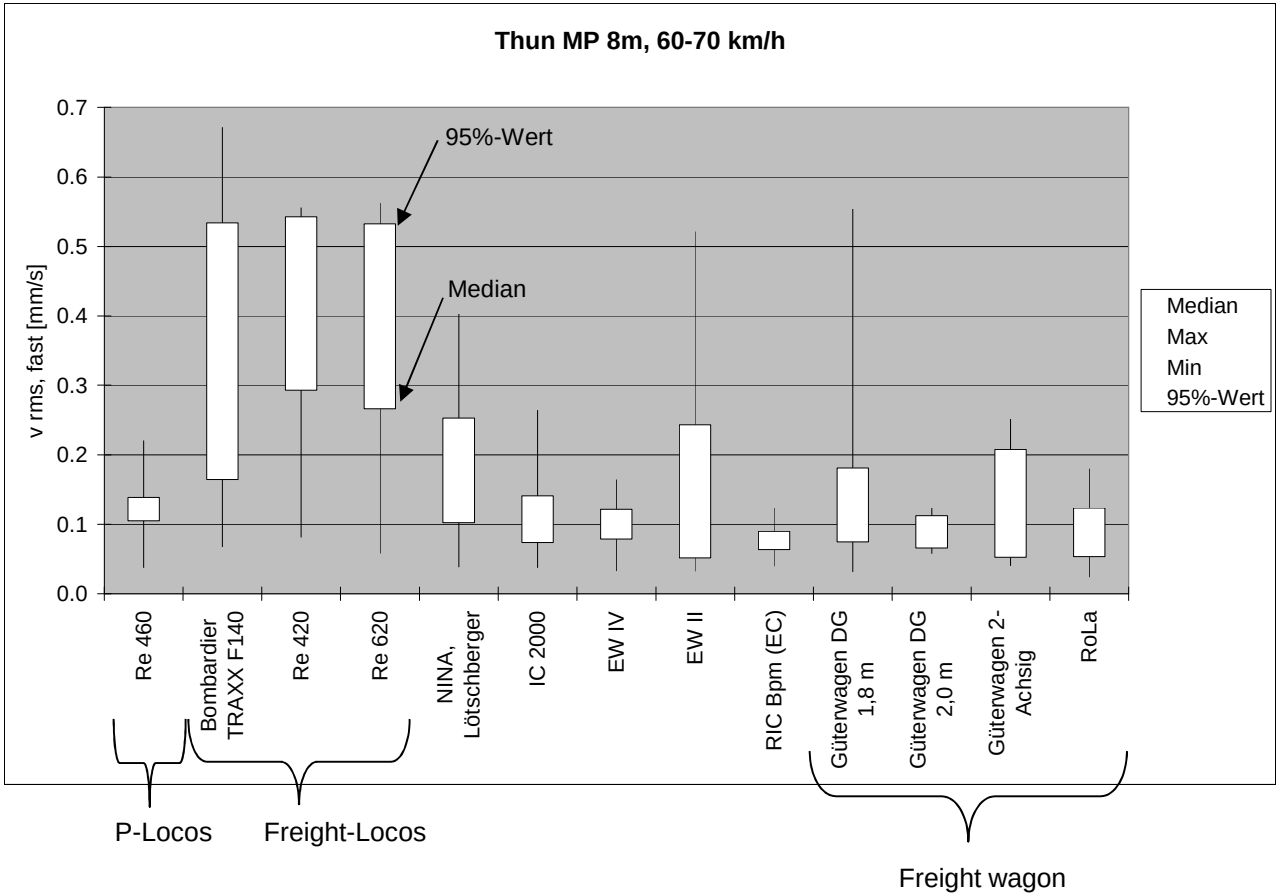
B) Reprofiling for passenger comfort to lower structure-borne noise in train

C) Change of maintenance plans for vibration purpose (disturbance problems in buildings from passenger trains and CARGO locos)

D) Lower reprofiling intervals for better LCC because of longer wheelset lifetime

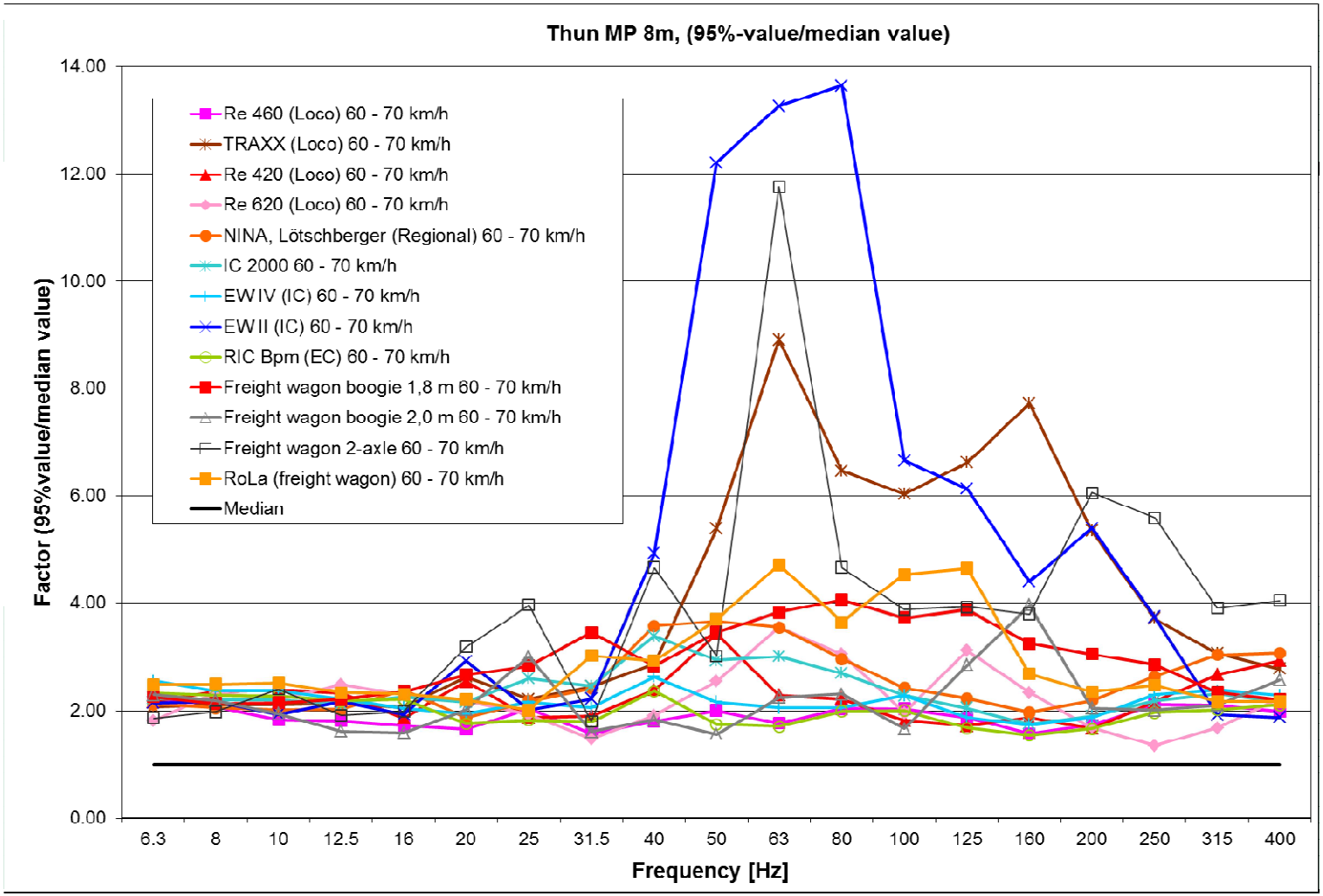
2. Problem: For certain trains big vibration scattering

Statistics v_{rms} [mm/s] in Thun, 8m distance



2. Vibration scattering

Improvements possible also for lower frequencies



3. Solutions: Depending on the problem!

B) Reprofiling in Workshop

- Enough wheel lathe capacity?
- All defects taken away?
- Maintenance plan according to train type?

C) Train type construction

- Passenger wagon
- Problematic passenger/freight wagon
- Problematic Locos
- Freight wagon

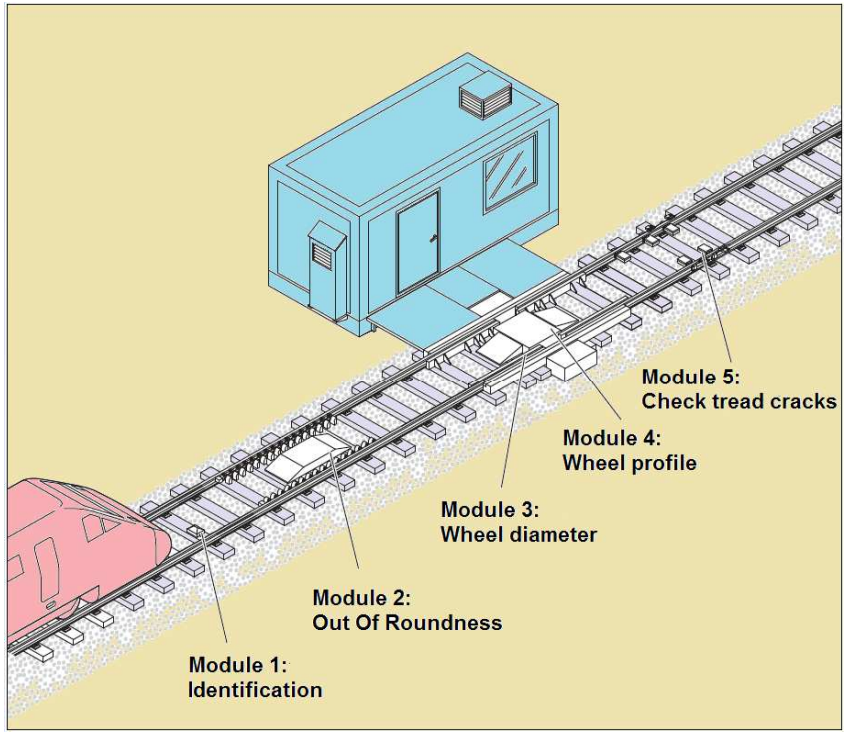
A) Detection of OOR

- Limit values?
- Which measurements?

3. Solutions:
A) Detection of out-of-roundness

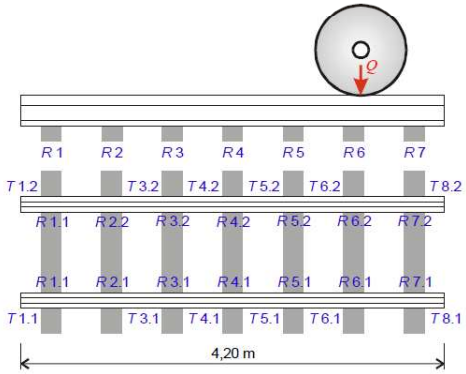
In Workshop

- Wheel lathe
- Automatic measurement equipment
- Manual OOR measurement equipement

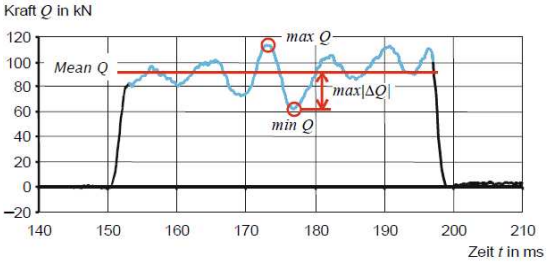


In Track

- Automatic measurement equipment



Time history of Q-Force



Characteristic values

- Maximum $max\ Q$ **113,73** kN
- Minimum $min\ Q$ **62,19** kN
- Mean $stat\ Q$ **91,87** kN
- Maximal difference to the mean value $max\ |\Delta Q|$ **29,68** kN

Dynamic coefficient (impact factor)

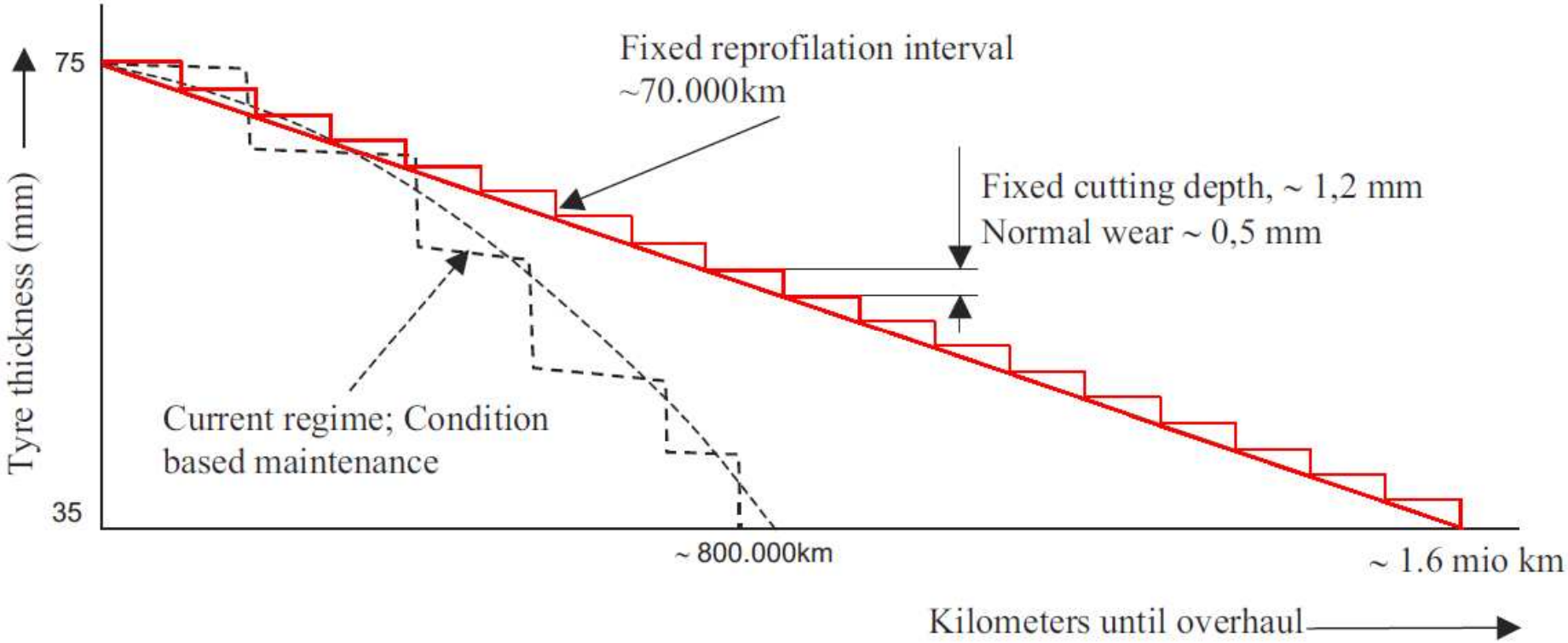
➔ Relation between static and dynamic force components related to the static wheel load →

$$\text{dynBw} = \frac{stat\ Q + max\ |\Delta Q|}{stat\ Q} = 1{,}32$$

3. Solutions:
B) Individual maintenance plans

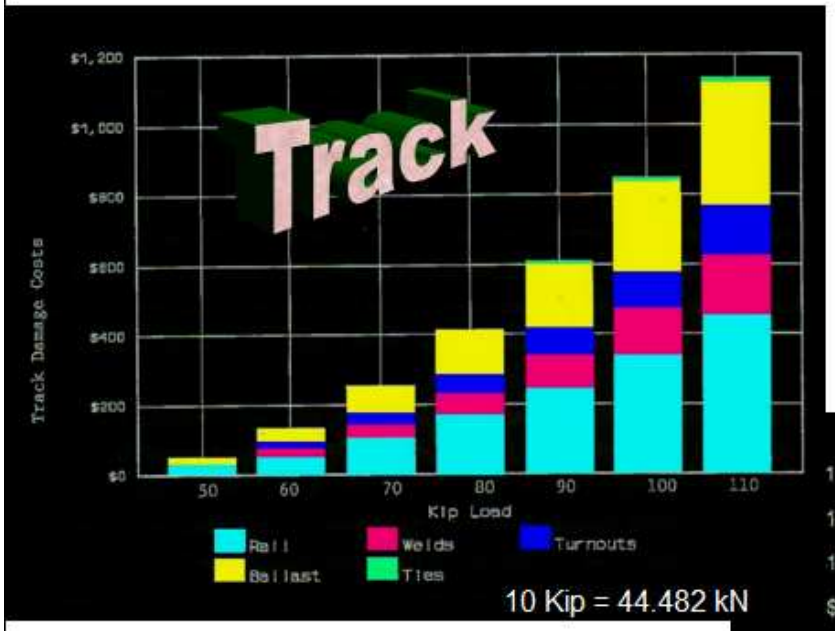
Maintenance plans according to

- LCC calculations, taking into account positive effects of wheel lifetime
- In addition: less boogie and other defects, less interior noise, less track damage



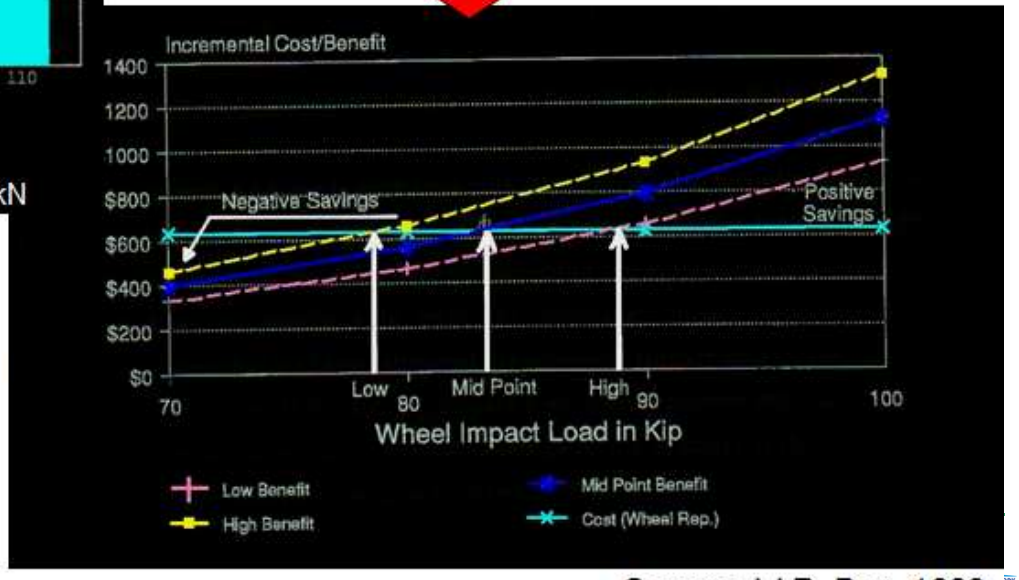
3. Solutions:
B) An example of economic impact

AAR's investigations versus Economics of high impact wheel loads



Economic Impact Load Threshold for Replacing High Impact Wheels

- **Vehicle component costs**
- **Track costs**
- **Fuel costs**



Investigations done by AAR, Research started in 1988

Source: AAR, Dec. 1993

3. Solutions:
C) Solutions outside maintenance (WP5)

If bigger problems occur:
Have a look also at technical solutions at the vehicle (WP5 results)

4. Conclusion

1. **Measurements to understand defects is crucial.**
2. **For LCC improvements an individual, per train type, study for maintenance optimisation is needed.**
3. **For Europe a relationship dynamic force – LCC Infrastructure is missing.**
4. **Keep an eye also on train-track mechanisms and train construction (such as bogie design, wheel material,…).**