

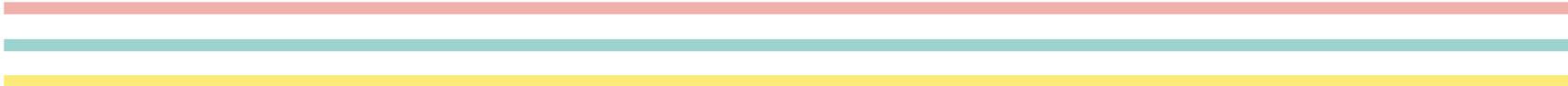
New and Future Rolling Stock

Giles Pettit – Rolling
Stock Lead, Arup



Contents

- 1. Damage at The Wheel / Rail Interface**
- 2. Network Rai's incentivisation of better suspension performance**
- 3. Technologies adopted on the current generation of rolling stock**
- 4. Future technologies to look out for**
- 5. The shock of the new**
- 6. Be careful what you wish for...**



Damage at the Wheel / Rail Interface

Damage	Main Cause(s)
Rolling Contact Fatigue	Primary yaw stiffness
Vertical fractures	P_2 force (speed & unsprung mass)
Gauge side wear / track spreading	Flange contact, long / stiff wheelbase
Top wear	Poor curving ability
General wear & tear	Gross tonnage



Network Rail's Work to Improve Rolling Stock performance

Train Infrastructure Interface Specifications (TIIS)

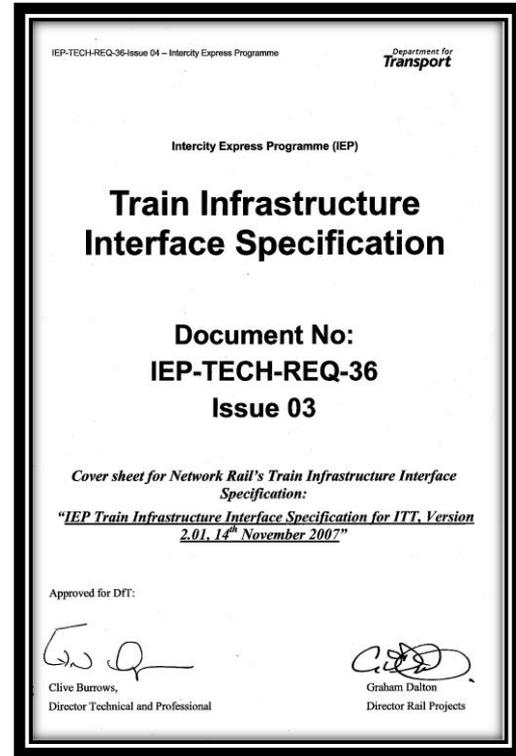
Key document used in conjunction with train requirements to manage all interfaces

Wheel / Rail Interface focus on limiting T-gamma values

In conjunction with GM/TT0088, has been used on all major rolling stock procurements over the past 12 years, including:

- IEP
- Thameslink
- CrossRail

TIIS requirements have been refined and incorporated into the Train Technical Specification for HS2



Technologies responding to track-damage incentives

ARUP

Inside-frame bogies

- Reduces overall and unsprung mass
 - B5000-series pioneered in the UK by Bombardier
 - Used on Voyager / Meridian designs
 - Limited used on Turbostar
 - Now utilised across the Aventura platform (“FlexxEco” brand)
-
- Siemens compact SF5000 design on the City Train platform
 - Hitachi inside-frame trailer bogies used on IEP
 - CAF inside-frame bogies used on Mark 5 and Civity platforms
 - Stadler inside-frame used on the Class 777 Merseyrail Stock



Image by Mediarail.be



Image by Ivor the Driver

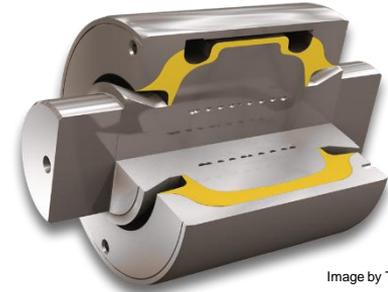
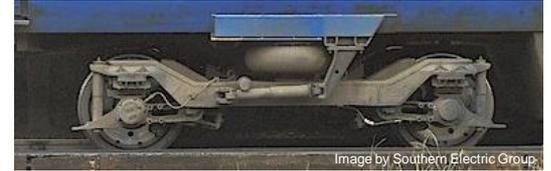
Technologies responding to track-damage incentives

ARUP

'Hall' bushes

- Rolling contact fatigue depends on the level of 'creep energy' at the contact patch (measured as 'T-gamma')
- Creep is highly dependent on Primary Yaw Stiffness (PYS) in bogies with radial-arm suspension
- PYS values in turn are controlled by the stiffness of the radial arm bush
- Lower PYS = more track friendly
- **But** lower PYS also = reduced stability / critical speed

- Hall bushes have hydraulic cavities which ease low frequency movements and stiffen in response to high frequencies
- Trialled in Mk 4 and Desiro designs
- Now becoming regularly specified as new, as well as considered for retro-fit on mid-life fleets



Technologies of the future

Materials

- Bogie frame evolution:
 - cast iron \Rightarrow welded sheet \Rightarrow cast steel \Rightarrow cast SGI
- Composites being explored for primary structures:
 - Good on mass
 - Costs still high
 - Maintainability?
- Lightweighting of other mass-attracting elements



Image by Plastics Today



Image by Multimatic

Mechatronics

- Variable primary springs
- Variable rate dampers
- Actuators in place of dampers, bushes, etc.

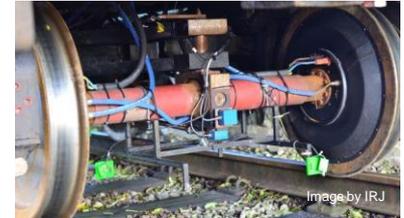


Image by IRJ

Steering, wheel de-coupling

- Some passive steering mechanisms in use, active ones may be introduced
- Independently powered / rotating wheels as a 10-year development?

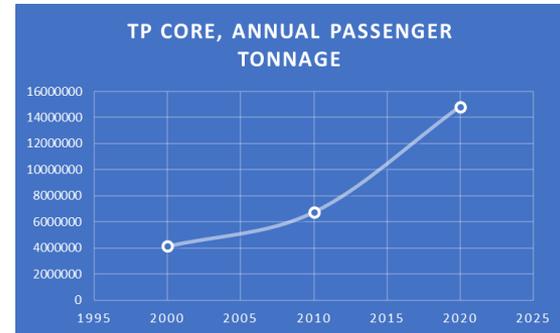
The shock of the new

On the one hand...

- We all like to see new trains!
- New fleet introductions should remove / reduce wear drivers

On the other...

- Gross tonnage increase:
 - More trains
 - More axles
 - Longer vehicles
 - More passengers
 - Greater TE
 - Higher line speeds
- Are there some hidden wear mechanisms we don't know about yet?
- Where will the tonnage increase end?



Looking further ahead

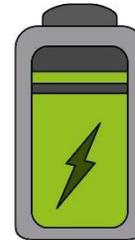
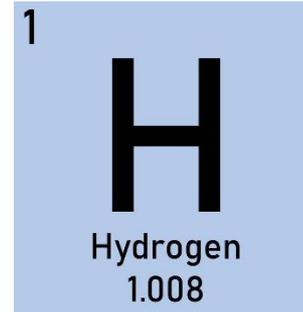
De-carbonisation implications

- Trains of the future will be powered by:
 - Electrified infrastructure
 - Battery hy-brids
 - Fuel-cell hybrids
- Full electrification might stretch beyond 2050, therefore...
- UK fleet mix will be all three depending on the network capabilities
 - Batteries good for short off-wire hops (circa 60 miles)
 - Fuel-cells good for longer off-wire journeys, but not at speed or with a lot of mass
- Mass increases inevitable with the non-electrified option, Whole Life Cost implications?

Williams, etc. How will procurement be managed / specified?

Maglev, Hyperloop

- A whole 'nother conversation



“It will be alright in the end,
and if it’s not alright, it’s not the end!”

Mark Kermode

Thanks for listening

