Institute of

Railway Research

Railway research to support sustainable mobility

CENTRIC and Tram-Train Best Practice Guide

Prof. Paul Allen
David Crosbee

14th May 2026

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The Queen's Anniversary Prizes
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2019

centric. centre for transport in cities

'a research and education ecosystem to support the successful delivery of transformative urban transportation systems'

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Institute for Transport Studies

University of HUDDERSFIELD
Institute of Railway Research

West Yorkshire Combined Authority | Tracy Brabin Mayor of West Yorkshire

centric.

Client-side, independent expert advice

De-risk & enhance business case

Support design, build & operation

Deliver knowledge transfer, education & training

Promote innovation, maximise legacy value and asset life

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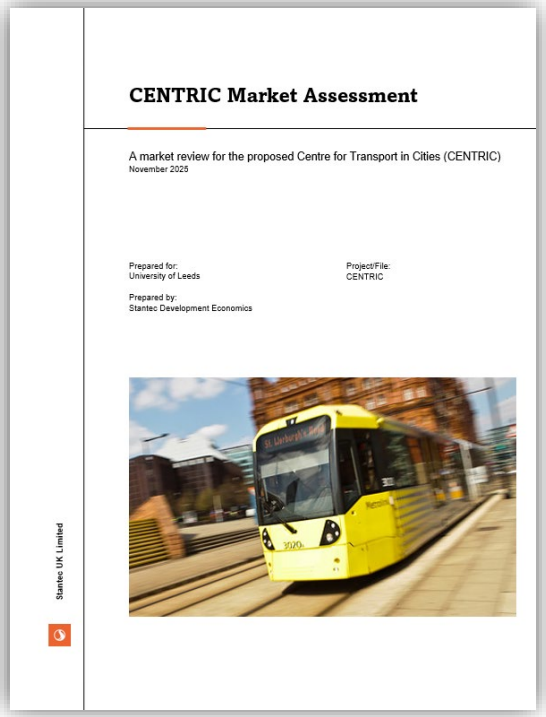
Key messages from an independently commissioned market assessment report...

- *"**centric's** positioning as a knowledge custodian and strategic advisor offers a unique opportunity to support the UK's transport sector in delivering sustainable, inclusive, and future-ready urban mobility solutions"…*
- *"there is a unique and timely opportunity to capitalise on devolution and transport funding streams to launch **centric**. The centric offer is already gaining traction yet has significant untapped potential including the opportunity to support delivery of the West Yorkshire Mass Transit scheme which is a once-in-a-lifetime investment in public transport within the sub-region".*



West Yorkshire's world-class transport research institutes

University of HUDDERSFIELD

Institute of Railway Research

- *'A world-leading centre in the field of railway engineering and technology; applying advanced simulation, automation and testing for a safer and more efficient railway'.*
- 40 academics and research students
- £15m invested in world-class test facilities
- Hosts UKRRIN Centre of Excellence in Rolling Stock
- Queen's Anniversary Prize for Innovation

UNIVERSITY OF LEEDS
Institute for Transport Studies

- *'A leading transport research institute worldwide…Our research mission is to support the development of intelligent mobility systems that are connected, inclusive, productive and resilient'.*
- 160 academics and research students
- £20m in current research contracts
- Hosts Virtuocity city simulation facility
- Queen's Anniversary Prize for Higher & Further Education

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Economics & appraisal

- Demand & revenue forecasting
- Cost modelling & incentives
- User benefits
- Pricing & ticketing
- Wider Economic Impacts
- New mode/station appraisal
- Regulatory reform

Virtuocity

- City simulation & co-design
- Car, truck and pedestrian simulators
- Distributed simulation
- Connected and shared mobility
- Automation

Environmental impacts

- Urban air quality
- Emission sensing & modelling
- Evaluation of CAZ

Digital futures

- Leeds Institute for Data Analytics (LIDA)
- New forms of digital data
- Analysing large and complex datasets
- Geocomputation

Society & policy

- Policy & governance
- Accessibility & affordability
- Social inclusion
- Ex post evaluation
- Active travel

Energy & decarbonisation

- Sustainable, low carbon and secure sources of energy
- Centre for Reduction in Energy Demand Solutions (CREDS)
- UK Energy Research Centre (UKERC)
- Place-based decarbonisation strategies (DecarboN8)

Modelling

- Traffic assignment (SATURN)
- Microscopic traffic and rail simulation (DRACULA & TRACKULA)
- Strategic land use-transport interaction (MARS)
- Choice modelling (Apollo)
- Evaluation of traffic emissions and air quality (COMIS)
- Propensity to Cycle
- Scheduling & optimisation

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Design assurance

- Track alignment review wrt to passenger comfort, maintainability and safety
- OLE scheme review and optimisation
- Identification of opportunities for asset standardisation
- Accessibility and level access
- Evaluation of potential vehicle architectures

Rail vehicle high-fidelity motion simulator

Rolling stock and infrastructure system procurement

- Vehicle performance specification, tender development and evaluation
- Rail, S&C and trackform specification development
- OLE and discontinuous electrification optioneering
- Evaluation of tractive power options

Asset management

- Strategies to reduce operational costs and maximise asset life
- Rail life extension strategies
- Wheelset maintenance optimisation
- Vehicle and Infrastructure monitoring
- Planning and specifications for renewals and upgrades

Innovation and digital concepts

- Lineside energy storage for capture of regenerative braking energy
- Novel trackforms
- Driver advisory systems for reduced energy usage
- Data analytics and Intelligent condition monitoring
- AI-based traffic management and traffic prioritisation
- Pedestrian and obstacle detection
- Overspeed and overrun protection

Incident prevention and investigation

- Safety assurance of ‘As-Built’ infrastructure
- Wheel-rail wear, defects and failures
- Pantograph/OLE, wear, defects and failures
- Passenger ride comfort investigations
- Derailment prevention and investigation

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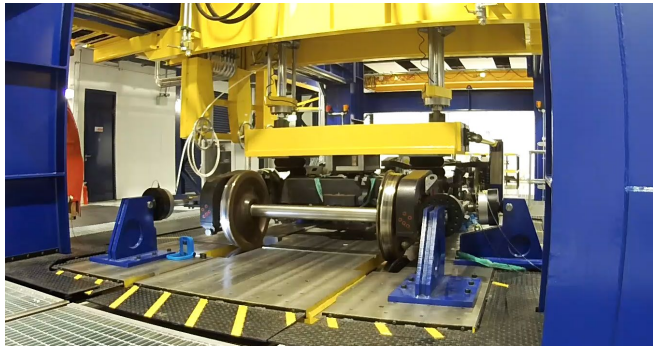
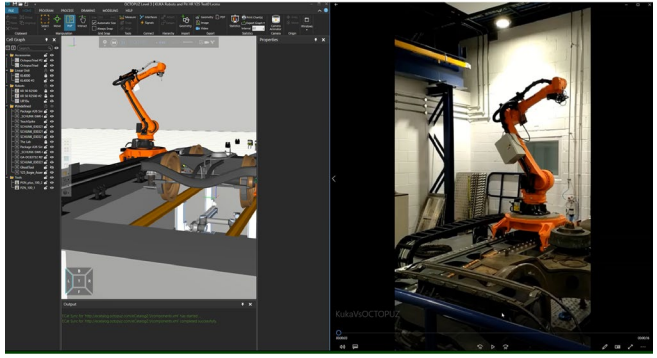
Pantograph Dynamics

Bogie Dynamics, Traction and Braking





Vehicle Motion Simulator

Robotics for Vehicle Maintenance

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Models of engagement:

- Consultancy (*Commercial rates*)
- Collaborative bidding and working under MoU
- Longer term Framework Research
- Strategic Partnerships
- Masters courses, CPD and Doctoral programme provision
- KTP Schemes

Key contacts:

- Richard Batley, University of Leeds (r.p.batley@its.leeds.ac.uk)
- Paul Allen, University of Huddersfield (p.d.allen@hud.ac.uk)

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Tram-Train Best Practice Guide

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- **Tram-Train schemes are being developed:**
  - South Yorkshire Supertram pilot
  - South Wales Metro
  - Manchester Pathfinder
- **No standard solution for GB Tram-Trains**
- **Replication of feasibility studies**
- **The Tram-Train Best Practice Guide aims to address the technical and economic barriers and promote the future use of the technology**
  - Collate learning and best practice from across the world
  - Provide local authorities with clear guidance to help decision making
  - Reduce the technical and financial uncertainty that such schemes present
  - Aid in the promotion of a transport policy that supports light-rail and Tram-Train.
- **Consortium made up of academia, industry and local authority**

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Network Rail

LIGHT RAIL Safety and Standards Board

RAIL SAFETY AND STANDARDS BOARD

West Yorkshire Combined Authority | Tracy Brabin Mayor of West Yorkshire

Tram-Train Best Practice Guide

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Rolling Stock & Infrastructure

- Standards & Deviations
- Energy & Multi-Mode
- Wheel-Rail Interface
- Vehicle-Track Interface & Track Design
- Vehicle-Vehicle Interface & Recovery
- Audibility & Visibility
- Crashworthiness & Vehicle Structure
- Gauging
- Platform Heights and Level Access
- Traction Braking & Adhesion
- Control, Command & Signalling
- Operational Procedures & Timetabling

Economics & Policy

- Economic & Social Business Case
- Transport Policy Agenda

Wheel-Rail Interface

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- **South Yorkshire Tram-Train Pilot Scheme entered passenger service in 2018**
  - Bespoke Hybrid Wheel Profile
- **Network Rail proposed a research project to revisit the SY wheel-rail interface to see if it is appropriate and optimal for use throughout Great Britain**
  - RSSB Project - 'Optimising Tram-Train Wheel Profile and Wheel-Rail Interface (COF-HTT-01)' (https://www.rssb.co.uk/research-catalogue/CatalogueItem/cof-htt-01)
- **Examines interface in more detail:**
  - Compatibility assessment of SY Hybrid Wheel Profile for all GB modern light-rail systems
  - Considers both rolling stock & infrastructure solutions
  - Guidance document and decision tool

Wheel-Rail Interface

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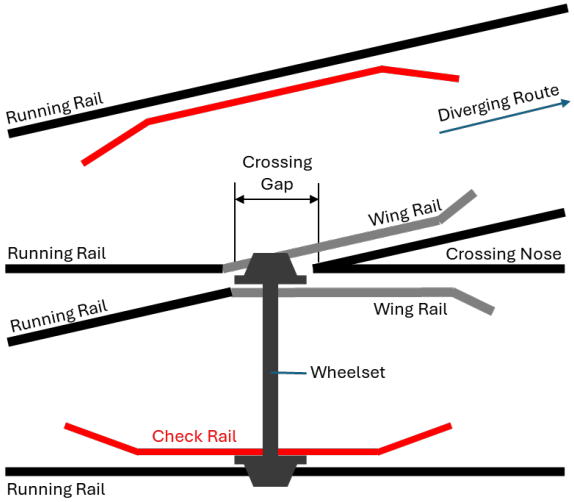
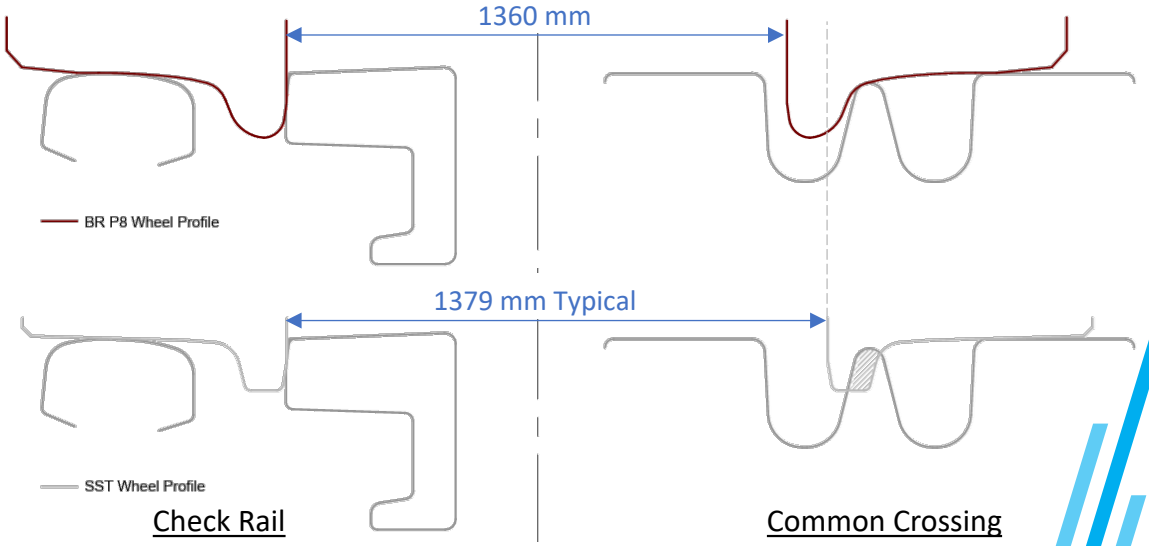
- **Why not use a light-rail vehicle on the heavy-rail system?**
  - Back-to-back dimension of light-rail wheelset is wider than heavy rail wheelset
  - Back-to-back dimension is critical for safe interaction at crossings
  - Check rail guides opposite wheel through crossing





Wheel-Rail Interface

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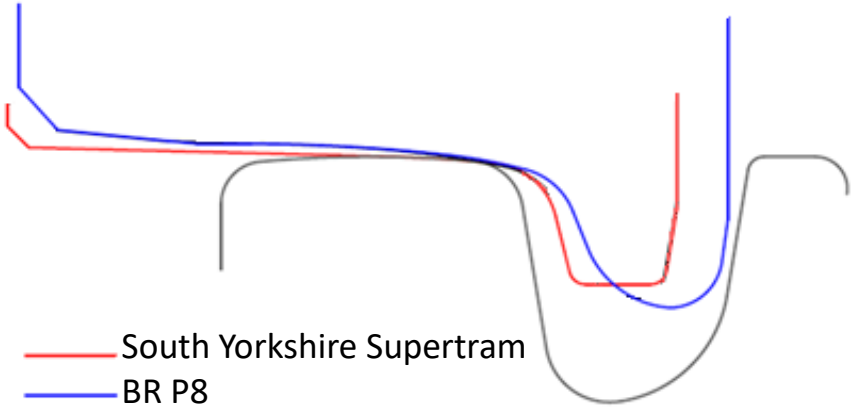
- **Why not use a heavy-rail profile on the light-rail system?**
  - Wheel flange too wide to pass through light-rail S&C and other special trackwork safely
  - Typical grooved rail profiles do not have a flangeway wide enough
  - Keeper contact will dominate and provide lateral guidance rather than wheelset conicity
  - Keeper wear will dictate and seriously reduce rail life
  - Profile not designed for flange tip running



Wheel-Rail Interface Solution 1 - Hybrid Wheel Profile

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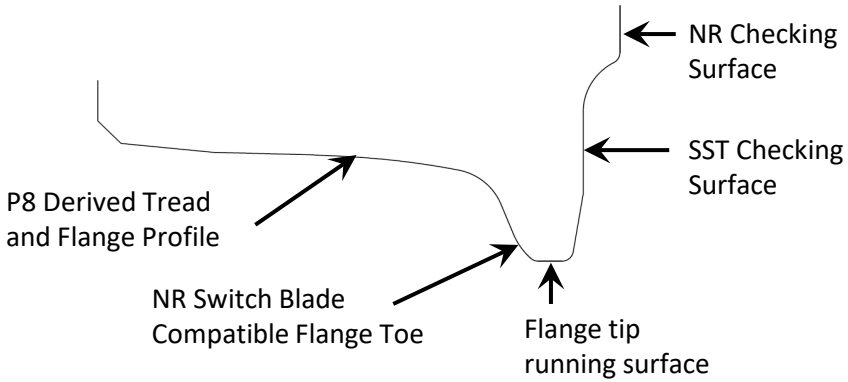
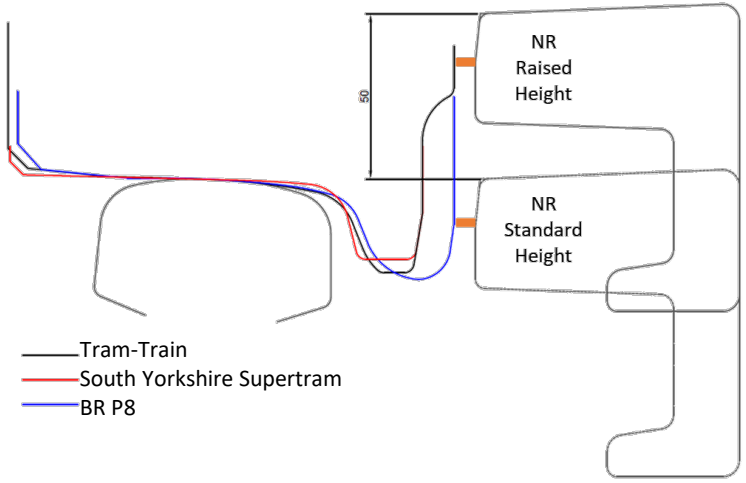
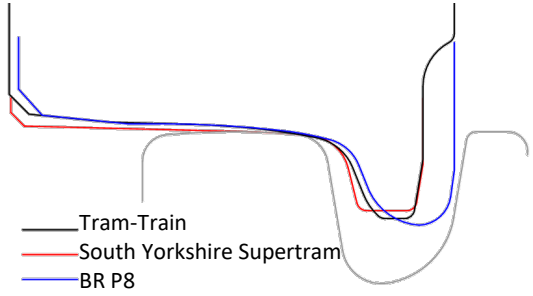
- **Solution used for South Yorkshire Supertram**







- Runs in grooved rail and interacts with light-rail S&C
- Requires raised check rails on heavy-rail S&C
- Cost associated with raising check rails
- Clearance issues with limited number of rolling stock and track maintenance machines
- Potential clearance issues when recovering vehicles using wheel skates

Wheel-Rail Interface

Solution 2 - Heavy-Rail Wheel Profile

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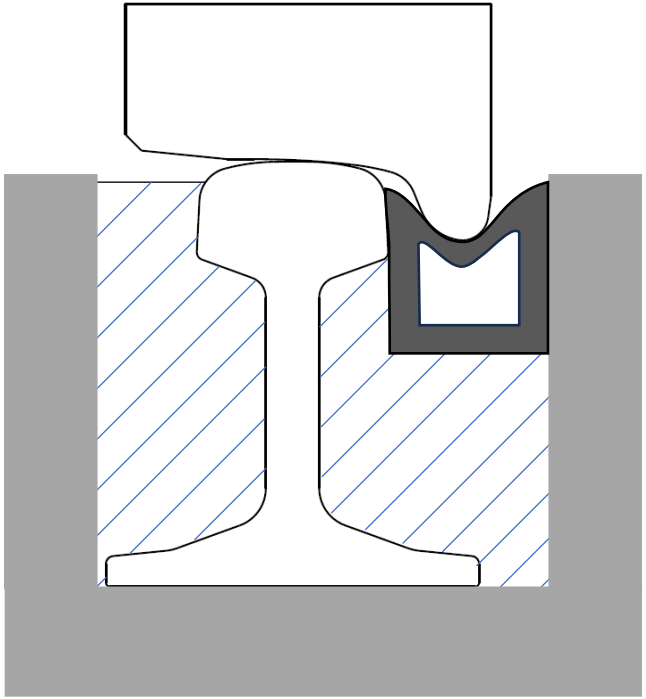
- **Solution used for South Wales Metro**
- **No changes required to heavy-rail infrastructure**
- **Requires embedded trackform to have a wider flangeways for wheel-rail interaction**
  - **Grooved rail profile with wide groove OR**
  - **Bespoke trackform using vignole rail**
- **Increased tripping and trapping risk to pedestrians, cyclists and pushchair and wheelchair users**
  - **Mitigate with flangeway fillers**
  - **Design the public realm to discourage people from following the tracks**
    - Defined safe walking routes off the track
    - Crossings that are perpendicular to tracks
    - Clever use of street furniture to guide people



Wheel-Rail Interface

Solution 3: Light-Rail Wheel Profile

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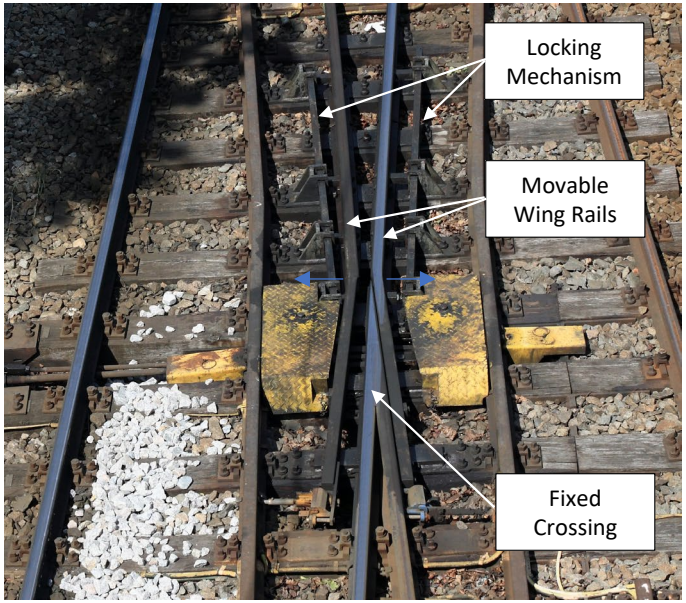
- **No changes required to light-rail infrastructure**
- **Heavy-rail switches & crossings need addressing**
- **Moveable crossings that do not rely on check rails for guidance**
  - Swing nose crossings
  - Swing wing crossings

Image by J.Dyduch & J.Paś (DOI: 10.24136/tren.2023.012) is licenced under CC BY-NC-ND 3.0

Badner Bahn, Vienna



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Wheel-Rail Interface

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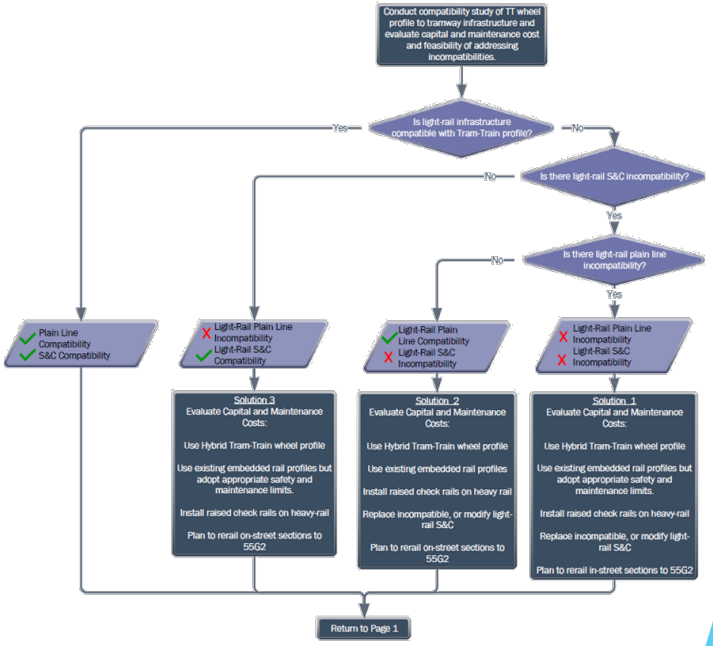
- **Which solution to use depends on a number of considerations:**
  - The extent of any incompatibilities with the hybrid wheel profile and the light-rail system
  - New or existing light and heavy rail
  - Proportion of light-rail to heavy-rail infrastructure
  - Number and type of S&C units on the on the route
  - Future aspirations for the network
- **Guidance on choosing the appropriate solution is provided in the project reports**
  - Guidance document
  - Flow diagrams/Decision trees
  - Calculation spreadsheet



RSSB Project - 'Optimising Tram-Train Wheel Profile and Wheel-Rail Interface (COF-HTT-01)' (https://www.rssb.co.uk/research-catalogue/CatalogueItem/cof-htt-01)

Platform Heights & Level Access

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- **Low or High platform?**
  - Light-Rail systems usually have low level platforms of 280 to 390 mm
  - Heavy-Rail platform nominal height of 915 mm
- **South Yorkshire pilot opted for low floor vehicles**
  - Compatible with existing South Yorkshire Supertram platforms
  - Required low-level platforms to be built on heavy-rail track
  - Only two heavy-rail stations on the route (now three with Magna)
- **South Wales Metro opted for high floor vehicles**
  - Large number of existing heavy-rail stations (Core Valley Lines)
  - Cardiff CrossRail is new infrastructure and can be built to match
- **Choice of platform height depends on:**
  - Number and height of existing platforms
  - Planned stop locations
  - Future expansion plans

Image by Hammersfan - Own work, CC BY-SA 4.0, https://commons.wikimedia.org/w/index.php?curid=85815580

Image courtesy of Transport for Wales https://news.tfw.wales/resources/stadler-citylink

Platform Heights & Level Access

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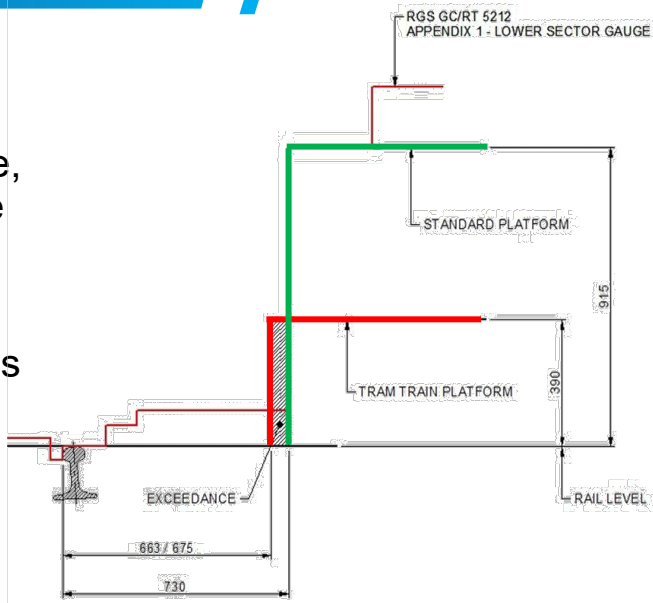
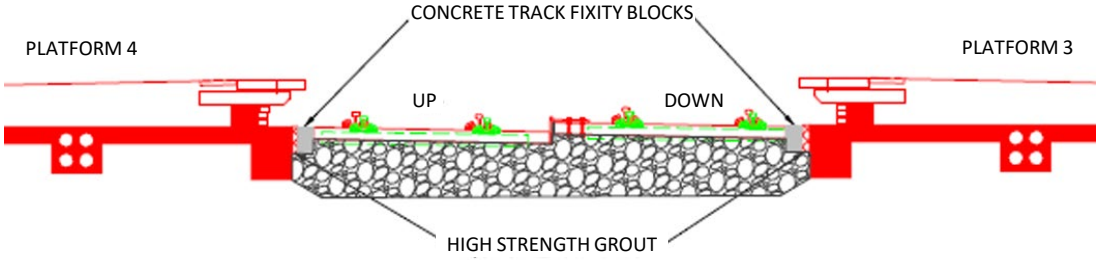
- **South Yorkshire Tram-Train low level platforms presented a gauging challenge on Network Rail**
  - To minimise the horizontal gap between vehicle and platform edge, the platform had to infringe the Lower Sector Infrastructure Gauge
  - The position of the track relative to the platform needed to be tightly controlled to maintain gauge clearances to vehicles.
  - This required a special track design that was tied into the platforms
  - Gap fillers also needed to be added to the platform edge
- **The use of retractable steps on the vehicle would have rectified this issue**





Figures courtesy of Network Rail, "Report 112449 Sheffield Tram Train Project Low Platforms – Stepping and Gauge Feb 2017 Part 2 - Rotherham" available on the South Yorkshire Tram-Train Learning Hub - https://tramtrainlearning.co.uk/

Timetabling

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- **“The problem with Tram-Train is that it isn’t possible to fit a service into the existing timetable…”**
- **Experience in South Yorkshire and Tyne & Wear demonstrates it is possible**
- **The official line is that <u>all operators have an equal right to access</u> Network Rail**
  - Network Code Part D- ‘Timetable Change’[1] outlines the bid process and criteria used in Network Rail’s decision on timetable allocations
- **The advice for future schemes is to**
  - Start preparing the timetable bid early
  - Develop a robust case for the proposed service
  - Engage with other operators on the route to ensure your timetable bids are aligned

[1] NR Network Code - (https://www.networkrail.co.uk/industry-and-commercial/information-for-operators/network-code/

Publication

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- Research for the other Best Practice Guide sections is well advanced
- Final publication expected this winter
- The final document will be available online and will be hosted by one (or more) of the industry partners

LIGHT RAIL Safety and Standards Board

NetworkRail

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Contact Us

If you would like to know more about our areas of expertise or wish to discuss research opportunities with the Institute of Railway Research then please contact us on the details below:

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