The UK Rail research and Innovation Network

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• Since the development of Railway Research UK in 2003 which brought together 8 founding universities, British universities have significantly increased research and education capabilities

• The formation of RRUK-Association broadened the breadth and participation to over 50 research institutes working in railway related areas

• This has brought about an increased national research and innovation capability in rail that is internationally recognised
Railway Supply Group Strategy

• The Railway Supply Group Strategy, which was launched in February 2016 has the objective of transforming the supply industry making the UK a global leader in rail.

• By 2025, the rail supply industry aims to:
  – More than double export volumes and values
  – Attract the very best UK talent to create a sustainable skills base and to develop new technologies
  – Harness the energy, drive and innovation of SMEs to meet the needs of the global railway market
  – Be a global leader in High Speed Rail
  – Have an entrepreneurial supply chain that innovates to meet customer needs

The RSG clearly recognise that investment in research and innovation capabilities will be essential to the delivery of these goals and aim to develop Centres of Excellence in key areas to support the industry
Higher Education Funding Council for England (HEFCE)

- HEFCE run an annual capital funding competition to industry/academic partnerships
- In April 2016 the University of Birmingham led an EOI application to HEFCE’s Research Partnership Investment Fund (RPIF) together with a number of partner universities
- The HEFCE RPIF funding is available on the basis of £2 private investment leveraging £1 of government capital funding
- The EOI sought funding for a network of Railway Centres of Excellence:
  - Digital System Innovation Centre
  - Rolling Stock Innovation Centre
  - Infrastructure Innovation Centre
- The EOI was successful - work begun on a full bid in June 2016
University Selection

- RSG formed a steering group which comprised members of RSG and TLG to select the universities to lead and collaborate in each of the Centres.
- In August 2016 the following universities were selected to develop each of the Centres:
  - **Digital**: University of Birmingham
  - **Rolling Stock**: University of Huddersfield with University of Newcastle and Loughborough University
  - **Infrastructure**: University of Southampton with University of Sheffield, Loughborough University, Heriot Watt University and Nottingham University
Private Industry Support

- ALSTOM
- SIEMENS
- BOMBARDIER
- SMRT
- IBM
- northern
- RSSB
- UNIPART
- BRITISH STEEL
- Rail Industry Association
- THALES
- HITACHI
- Inspire the Next
- AECOM
- ATKINS
- PANDROL
- AGGREGATE
- Progress Rail
  A Caterpillar Company
Public Sector Support

• Strong support from Network Rail and HS2
  – Network Rail have pledged their Railway Innovation Network Centres to provide a fourth Centre of Excellence within UKRRIN

• Support also from:
  – Technical Leadership Group (TLG)
  – Rail Delivery Group (RDG)
  – Rail Supply Group (RSG)
  – Rail Alliance
  – Department for Transport
  – Test Facilities Steering Group
  – Met Office
  – Greater Birmingham and Solihull Local Enterprise Partnership
  – Leeds City Local Enterprise Partnership
Benefits to Industry

• The network will provide the railway supply chain with:
  – Access to the facilities and expertise of the network where at minimal risk and reduced cost they can ....
    • develop, prove, prototype, trial and scale up the next generation of products and processes or services allowing them to ...
    • Improve their competitive offer to clients;
    • Facilities and partnerships which will help secure research funding such as Shift2Rail

• Suppliers will be able use the networks resources to:
  – Access new knowledge from research and develop it into products or services;
  – Develop their staff through access to world class higher education
  – Undertake confidential projects with appropriate IP protection or collaborate in neutral space with key partners
  – Demonstrate the effectiveness of process improvements and new service propositions in a low risk environment
  – Have opportunity to influence the research agenda and access public funding to support strategic but longer term R&D
  – Get advice on technology transfer and accessing the facilities and expertise from the wider research and innovation community including, for example, the Catapult Network
Benefits to Clients

• The network will provide clients with:
  – A more innovative, productive and better value UK supply chain
  – A facility to encourage the development of the next generation of technology and services and to undertake client led research, development and innovation
  – A source of advice on the ‘art of the possible’
  – The ability to de-risk the procurement of complex new technology through techniques such as pre-commercial procurement and collaborative R,D&I
  – A location to house representative examples of client owned systems to allow suppliers to demonstrate compatibility and innovations in a benign environment
  – The opportunity to encourage supplier research, development and innovation to address specific challenges
  – Access to Universities to shape and use world class higher education
Digital Systems Innovation Centre
Digital System Innovation Centre

- Providing thought leadership and research and innovation capability in the future of digital systems capabilities, integration and education
- The ‘go to’ facility for the integration and verification of digital technologies
- Focus on:
  - Railway Control and Operations
  - Data Integration and Cybersecurity
  - Condition Monitoring and Sensing
  - Technology Introduction
Railway Control and Operations

- System-in-the-loop simulator development to support integration, verification and validation (ability to simulate the entirety of the British – and other – networks – e.g. Singapore)
- Operations optimization through improvements and benchmarking of traffic management and automation approaches
- Simulation and testing for validation
- Development of the next generation(s) of control systems
- Future railway communication system
Data Integration and Cybersecurity

- Controlled access to national and international data
- British and international data library and librarian
- Data modelling and architecture
- Integration of operations and customer facing systems
- Cybersecurity testing (and verification facility)
- Development ‘sandpits’
- Connection to other data sources (e.g. Transport System Catapult)
Condition Monitoring and Sensing

- Next generations of smart condition monitoring, linked up with other systems
- Ability to carry out early trials
- Data processing toolboxes
- Independent verification of capability
- Specific asset test rigs
- Modular equipment (energy harvesting, ad hoc networking
- Electronics development laboratory
- Railway specific sensing and data acquisition library (lasers, strain gauges, etc.)
- Automated inspection and robotic systems
Technology Introduction

- Focus on how technology can be correctly specified
- Business case development
- Integration, verification and validation of systems
- Strategies for no onsite testing
- Rapid deployment of technology
- Support of standards
- Processes for technology introduction and justification of replacement of existing processes
- Support to develop new business models
Rolling Stock Innovation Centre
The work will be carried out under two themes:

**Overview of the Reduced Whole Life Cost theme:**
To improve the competitiveness of the railway system the Rolling Stock Centre will explore a wide range of innovative technologies applied to the design, manufacture, operation and maintenance of railway vehicles. A key aim is to develop new components and vehicles that are designed for low maintenance, high reliability and have integrated monitoring and smart maintenance as part of the vehicle design.

**Overview of the Future Low Energy Vehicle theme:**
Although railways are inherently energy efficient this advantage is in danger of being eroded by rapid technological developments in other modes. The Rolling Stock Centre will facilitate research into a wide range of energy optimisation techniques and will provide a test bed for innovations aimed at reducing carbon emissions and improving sustainability.
Equipment will be developed in four facilities:

- Traction and Braking facility
- Pantograph interaction Dynamics and Aerodynamics facility
- Structural integrity and crashworthiness facility
- Flexible Hardware in the Loop facility
The Traction and Braking facility

As a result of RGF funding the University of Huddersfield has a full-scale bogie rolling contact, adhesion and braking test rig. The rig allows testing at 25t axle load and 200km/h under controlled adhesion conditions in traction or braking. The team at Huddersfield is also developing mathematical models of train braking systems to improve braking performance in low adhesion conditions.

Newcastle is using funding from FutureRailway/InnovateUK (Predictable and Optimised Braking Competition) to develop a novel braking concept based on linear motors.

Further infrastructure will be added to develop the facility to allow ‘Hardware in the Loop’ evaluation of train braking systems and the capability to test drivetrain and gearbox sub-systems to improve performance and reliability under the unique and demanding GB operating conditions.
The Pantograph Interaction Dynamics and Aerodynamics Testing facility

**Pantograph Interaction Dynamics**
- RSSB identified a lack of GB expertise in pantograph testing and R&D
- The Rolling Stock Centre will provide a full-scale pantograph dynamic test rig within a climatic wind tunnel
- Development of software Including OVERHEAD pantograph dynamics software package

**Typical application areas:**
- Develop methods to minimise pantograph-wire interaction forces and reduce wear
- Assess the capabilities of existing pantograph / overhead line systems
- Investigate the compatibility of untested overhead line and pantograph combinations

**Aerodynamic and Structural Interaction Facility**
A large scale climatic wind tunnel will allow evaluation of aerodynamics forces and environmental impacts for Rolling Stock related components including pantographs, full cab sections and associated critical components
Developments in materials and manufacturing techniques have the potential to deliver significant weight reductions and improvements in performance and life cycle costs. However, in order to move towards virtual certification of composite Rolling Stock cabs, bodyshells and structural components, there are certain practical tests that need to be performed in order to provide confidence in the composite or hybrid (joined metal/composite structures) alternatives. Appropriate inspection techniques need to be developed and proved.

The Rolling Stock Innovation Centre will include equipment able to test structures at the component level under both static and dynamic multi-axial loads, to simulate service conditions. An impact test facility will be set up at Newcastle and a dynamic, multi-axis structural integrity facility will be set up at Huddersfield. Accelerated testing will be possible as well as the assessment of interactions between components under realistic conditions.
The Flexible Hardware in the Loop facility

We will establish a hardware-in-the-loop laboratory for rail, which will be unique in Europe. It will be linked in real-time via high-speed internet to the Huddersfield and Newcastle facilities.

The testing set up will therefore be flexible, allowing it to be reconfigured to meet the emerging needs of new industrial R&D concepts and emerging research projects.

The facility will be focused around a ‘full system’ simulation model, using multi-body dynamic simulation packages linked to passive and active elements from the physical demonstrators in any of the facilities.

The Loughborough Vision

- A specialist facility for developing new concepts for rolling stock and infrastructure
- Enables validation and testing prior to track testing
- Low-risk and cost-effective development and testing of game-changing concepts
- Reduced development time
- Reduced number of prototypes
Infrastructure Innovation Centre

UKRRIN
UK RAIL RESEARCH AND INNOVATION NETWORK

UNIVERSITY OF Southampton
The University of Nottingham
Loughborough University
Increased capability for the National Infrastructure Laboratory, which is under construction at Southampton

New facilities to include:

- Laboratory equipment (hydraulic test rigs, centrifuge enhancements, soil element tests)
- Equipment for and construction of field tests
- Measuring equipment (thermal and optical imaging)
- Two new twin disc machines
- Flexible multi-axis rig for testing components
- Grinding research rig
- Portable equipment for rail surface analysis
- Increase capacity of hydraulic fatigue test machines for rail bending
- Digital image correlation system
Infrastructure Innovation Centre

• Track systems
  – Ballasted track
  – Slab track
  – Structures
  – Power supply infrastructure

• Noise and vibration
  – Ground vibration and ground-borne noise
  – Noise from railway structures
  – Rolling noise from trains
  – Field measurements
  – Numerical modelling
  – Laboratory testing
  – Human factors: response to noise and vibration
Infrastructure Innovation Centre

• Metallurgy & interacting surfaces
  – Bearings and lubrication
  – Friction management
  – Rail-wheel interface
  – Rail materials
  – New materials including composites

• Asset management
  – Risk and reliability
  – Economic & environmental performance modelling
  – Asset monitoring including RCM
  – Inspection and field measurements
  – Data fusing and analysis
  – Optimising maintenance strategies
  – Whole system, whole life cost prediction
  – Climate change prediction and adaptation
Summary and next steps
Current Position

• Full bid submitted on 16th December 2016
• £64M of private co-investment has now been committed
• £28M of capital funding was requested from HEFCE to fund:
  – Digital Systems Innovation Centre - £16.4M
  – Rolling Stock Innovation Centre - £10M
  – Infrastructure Innovation Centre - £1.7M
• The anticipated competition outcome announcement date is mid May 2017
Conclusions

• Over the last year significant work has been undertaken to bring the UK rail industry together to support the development of the UK Rail Research and Innovation Network

• UKRRIN will bring about a step change in railway research and innovation supporting both Department for Transport and Department for Business, Energy and Industrial Strategy Objectives

• We will understand whether we have been successful during May 2017

• If successful, we will be able to mobilise during Summer 2017, with facilities coming on line over the following 30 months

• Please visit: www.ukrrin.org.uk for further information and updates