

# INNOVATION

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# Welcome

In the past 12 months the UK rail industry has taken demonstrable steps forward in terms of addressing the key challenges facing us. Decarbonisation, digitalisation, collaboration and innovation are all familiar themes, but how we go about turning discussion into action and tangible outcomes is the most important part.

This time last year we were launching the UK Rail Research and Innovation Network (UKRRIN), a ground-breaking partnership between industry and academia. This year we are delighted to show the progress that UKRRIN has catalysed, with new industry members to UKRRIN committing investment into UK rail R&D and innovation activities. Once again, UKRRIN will have a strong presence at Rail Live and the four UKRRIN Centres of Excellence (Digital Systems; Infrastructure; Rolling Stock; Testing) will all be showcasing a range of current projects along with the capabilities that we can offer to work on innovation projects collaboratively with industry partners.

I am particularly pleased to be able to highlight the UKRRIN project between the University of Birmingham and Porterbrook that is providing one of the headlines at Rail Live this year - HydroFLEX, the UK's first full-sized hydrogen train.

This started following a conversation at Rail Live last year, leading to us signing a co-operation agreement at InnoTrans in Berlin last September, and nine months on from that point we have developed a demonstrator unit (799001) to showcase this technology.

This is only one of a number of innovation projects that UKRRIN has kick-started by initiating new partnerships between academia and industry. These collaborations are stimulating ideas and guiding them through the innovation process, using the

skills, knowledge and experience across these partnerships to generate new products, processes and solutions.

There are two key areas of concern for UKRRIN when it comes to supporting and boosting innovation.

Firstly, turning ideas into tangible solutions. Not all great ideas will end up delivering value as a commercially realisable solution for many different reasons, but a number of good ideas do get lost for reasons that could be prevented. Our focus here is on the innovation process, and working with innovators to develop practical, realistic solutions that answer a need. Great ideas do not always survive first impact with reality.

Secondly, reducing the barriers that stop those tangible solutions delivering value to the railway and its customers. Our focus here is on navigating the complexity of the sector and enabling market entry for innovative solutions. Great ideas can often survive that first impact with reality, but then fail to overcome the following impact with the market.

There is widespread commitment to the principle that we need to see more collaboration and innovation across the rail industry. It is also uncontroversial to suggest that digitalisation and decarbonisation are two of the major challenges facing the industry. The rapid success and development of UKRRIN has come as a response to these challenges, and the need to address them.

In this Innovation special issue, and at Rail Live, you will see a lot more about these challenges and examples of how they are being addressed. We hope you find this both informative and interesting, and we look forward to working with you to innovate the railway of the future.

**ALEX BURROWS**  
 Managing Director, BCRRE



## CONTENTS

**4 UKRRIN**  
 16 months since it was formed, UKRRIN is now a formidable force in rail research and product development.

**8 BCRRE**  
 CLIVE ROBERTS and ALEX BURROWS outline the progress being made at the Birmingham Centre for Rail Research and Education.

**10 RSSB**  
 New Chairman BARBARA MOORHOUSE on how RSSB is supporting members to meet the challenges of CP6 and industry reform.

**16 Porterbrook**  
 ANVESH PRASAD tells RAIL about Porterbrook's new platform for demonstrating new concepts in train technology.

**18 Talgo**  
 How the sheer power and capacity of cloud computing is opening up a new world of predictive maintenance.

**20 Cooling the Tube**  
 CALVIN BARROWS proposes an innovative solution to the age-old problem of overheating metro systems.

**22 Siemens Mobility**  
 PAUL BAINES tells RAIL how the award-winning Class 700 has already spawned new and improved versions.

### EDITORIAL

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# Revolutionising innovation in rail

**Only 16 months since it was formed, UKRRIN is now a formidable force in rail research and products and services**

The UK Rail and Research Innovation Network (UKRRIN) formed one of the star attractions at last year's Rail Live show, held at Quinton Rail Technology Centre at Long Marston in June 2018.

Despite being just four months old, the rail industry and university partnership brought a sizeable offering, including the UK's first hydrogen fuel cell locomotive.

More than 6,000 visitors had the opportunity to ride the 10¼ inch gauge train *Hydrogen Hero*, and to meet the team from the University of Birmingham's Centre for Railway Research and Education (BCRRE) that built it.

Rail Live 2019 (June 19-20) promises to be even bigger and better for UKRRIN, which says it will build on last year's presence to demonstrate how it is already delivering a step-change in research, development and innovation.

It will be exhibiting case studies and live demonstrations within the Innovation Zone at Rail Live to showcase the work of network members at UKRRIN's four Centres of

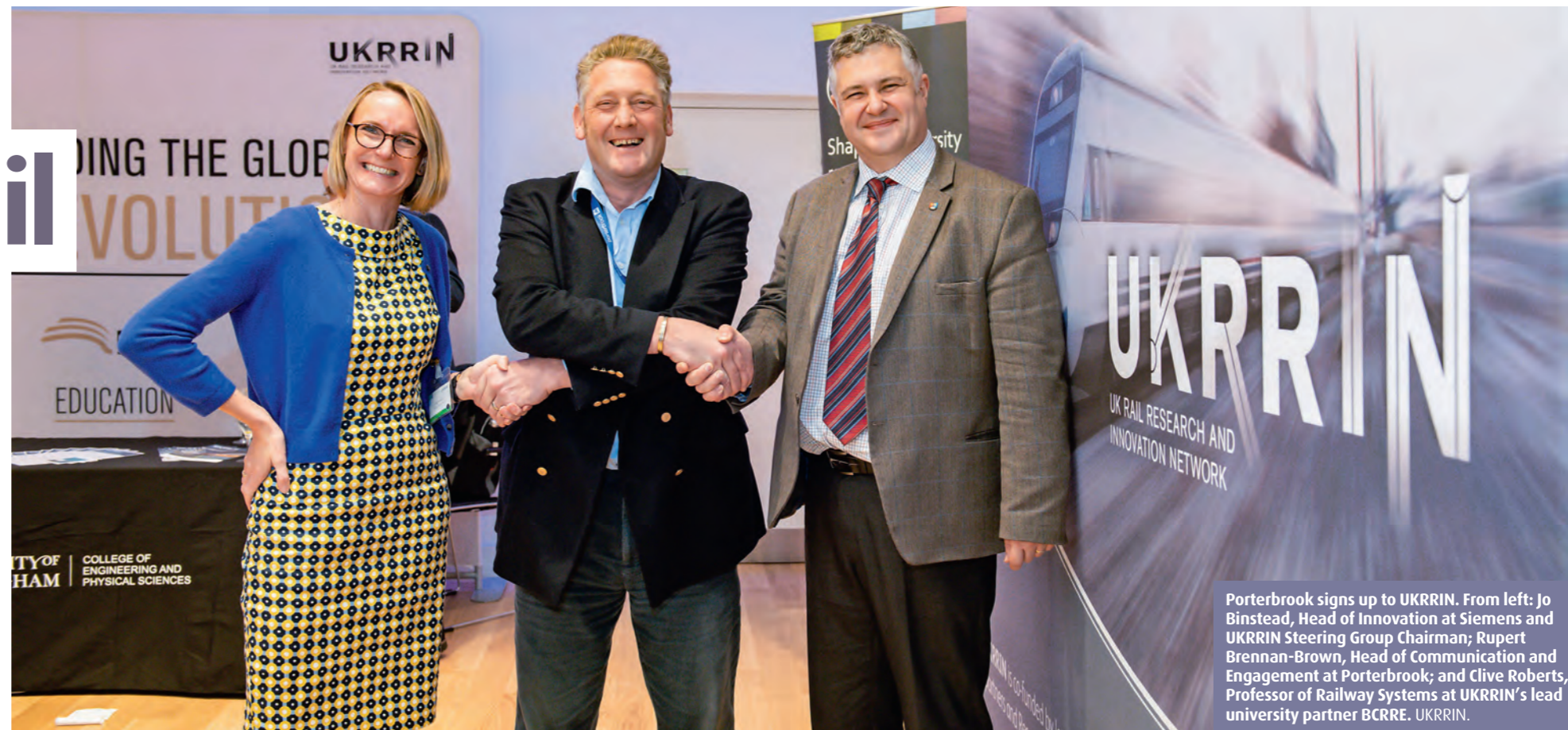
Excellence, and to introduce new members that have joined since UKRRIN's launch in February 2018.

Visitors will also have the opportunity to meet the centre leads and a wide range of UKRRIN members to better understand how the network fits together and to discuss whether membership would potentially suit their own organisations.

Clive Roberts, Professor of Railway Systems at UKRRIN's lead university partner BCRRE says: "UKRRIN was designed to provide powerful collaboration between individual companies and academia, because there was an issue that, although we design a lot of good stuff in this country, it takes a long time to get it out there on the rail network.

"We're now 16 months old, and we want to increase productivity even further by not just working with the larger companies that are already members of UKRRIN, but with SMEs so that it benefits companies of all sizes."

UKRRIN was founded in February 2018 to take forward and expand on the work of



Porterbrook signs up to UKRRIN. From left: Jo Binstead, Head of Innovation at Siemens and UKRRIN Steering Group Chairman; Rupert Brennan-Brown, Head of Communication and Engagement at Porterbrook; and Clive Roberts, Professor of Railway Systems at UKRRIN's lead university partner BCRRE. UKRRIN.

the Rail Research UK Association by linking 16 companies from the rail sector with eight leading UK universities.

Those eight universities have joined forces and combined their resources to form three Centres of Excellence in Digital Systems (BCRRE), Rolling Stock (University of Huddersfield, Newcastle University and Loughborough University) and Infrastructure (University of Southampton, University of Nottingham, Loughborough University, University of Sheffield and Heriot-Watt University).

A fourth Centre of Excellence has been created to focus on testing, which incorporates facilities at Network Rail's Rail Innovation & Development Centres at Melton Mowbray (Leicestershire) and High Marnham (Nottinghamshire), and those of other key partners Transport for London and the Quinton Rail Technology Centre.

UKRRIN's overarching mission is to adopt a more joined-up approach to enhance UK rail's research and development and innovation capabilities, as also enshrined in the Rail Supply Group's *Fast Track to Future* productivity and growth strategy (published in February 2016), the *Rail Technical Strategy* (RTS, published in 2012), and the *RTS Capability Delivery Plan* (developed in 2017).

The network will also form a key component in supporting the government's Rail Sector Deal and UK industrial strategy, as well as in delivering the Network Rail-led research and innovation programme in

**“ We’re rapidly growing in industry partners and people are knocking on our door rather than having to be persuaded. ”**

**Clive Roberts, Professor of Railway Systems, BCRRE**

Control Period 6 (Apr 2019-Mar 2024).

Given this integral role, it's of little surprise that UKRRIN has already successfully expanded from its original membership.

In November 2018 it was announced at UKRRIN's inaugural annual conference in London that rolling stock company Porterbrook has joined its ranks while, in April, both Furrer and Frey and Worldline were also welcomed to the network.

Jo Binstead, Head of Innovation at Siemens and UKRRIN Steering Group Chairman says: "I am very pleased with the progress that UKRRIN has made, and our focus this year is very much on how we engage further in order to continue to grow.

"This isn't a closed shop, but an active network in which you have to participate and the companies that are joining are really buying into that and bringing something to the party.

"I'm thrilled that UKRRIN is once again involved in Rail Live, where we can show just how much universities and industry are able to achieve by working together."

Professor Roberts adds: "We're rapidly

growing in industry partners and people are knocking on our door rather than having to be persuaded. They are mostly big companies but we also have the mechanisms in place to welcome SMEs through BCRRE's integration with the Rail Alliance (see pages 44-45) and the Rail Industry Association's membership of UKRRIN.

"It is a very good news story for the industry to be doing something so different, and the fact that the industry has come together over UKRRIN helps to make rail more investable to government, which is something we all rely on."

Pride of place at Rail Live will be exhibits and demonstrations from UKRRIN's Centres of Excellence, which are currently benefiting from more than £90m of investment in developing their research facilities, comprising £28.1m awarded by the Higher Education Funding Council for England and £64m from industry. All sites are due to be completed by 2020.

Leading the delegation from the CoE in Digital Systems will be Professor Roberts from BCRRE, who will be on hand to explain in more detail the work that is being

conducted in its four main research areas of future railway operations and control, data integration and cybersecurity, smart monitoring and autonomous systems, and introducing innovations (see pages 44-45).

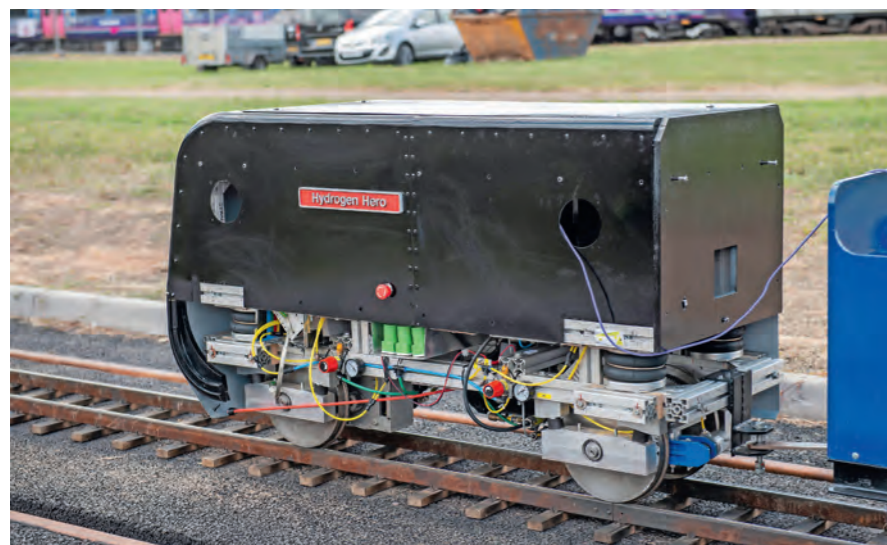
Projects recently completed include a knowledge transfer partnership between BCRRE and Abtus which resulted in the development of the ABT7000 'Max' Cyclic Top Measurement Device. 82 of the track inspection trolleys have now been sold to Network Rail as a result of this successful collaboration.

Meanwhile, BCRRE will also be providing on-track demonstrations of Britain's first full-sized hydrogen train.

The 'HydroFLEX' demonstrator has been converted from a Class 319 electric multiple unit, in a partnership with Porterbrook that was signed just nine months ago at the Innotrans trade fair in Berlin in September 2018.

No full-size hydrogen-powered train has yet run in the UK, but Alstom's 'Coradia iLint' entered service in Germany last year. Alstom and Eversholt Rail plan to have a Class 321 'Breeze' unit powered by hydrogen in UK traffic from 2021.

Having edged out Alstom in the race to produce a working prototype, BCRRE Senior Lecturer Dr Stuart Hillmansen says it is a prime example of how the UKRRIN tie-up between industry and academia is already helping to accelerate the rollout of new technologies.



A team of researchers from BCRRE exhibited the UK's only hydrogen-powered locomotive, *Hydrogen Hero*, at last year's Rail Live at Quinton Rail Technology Centre at Long Marston in June 2018. A standard gauge version will feature at this year's show at QRTC on June 19-20. JACK BOSKETT/RAIL.



► He says: "This would not have happened without BCRRE and the university being the glue to hold the project together. The team behind us is phenomenal, and I don't think anybody else could have got to this stage now on their own."

"We have a very close partnership with Porterbrook and hopefully this will set a good model for UKRRIN in future, by setting aggressive deadlines to get things done. The industry will be looking very carefully at this and we look forward to the next challenge [of building more] using the world-leading expertise we have developed."

BCRRE Director Alex Burrows adds: "It's great news that the HydroFLEX will be running. It's been a very effective partnership with Porterbrook which has had the same mindset as us to exploit our shared interest."

"We've both dreamed big and focused less on excuses, and to have made all this possible in less than a year tells a compelling story of what is possible through close collaboration."

The CERS, led by the University of Huddersfield will also be present to provide



**“ It’s amazing how quickly UKRRIN has taken off and how the industry has got behind us to make it the sole collaborative body representing academia and industry in rail. ”**

**Professor Simon Iwnicki, University of Huddersfield**

an update on its work to support the 'Four Cs' of the Rail Technical Strategy (cost, carbon, customer, capacity).

Successful projects include the construction of a prototype two-axle 'FORESEE' railway vehicle that is currently being tested at speeds of up to 200kph on the University of Huddersfield's full-size roller rig.

Part-funded by RSSB (formerly known as the Rail Safety and Standards Board), the aim was to produce a low-cost low-energy next generation vehicle to potentially replace the unpopular Class 142 and '144' 'Pacer' units that are currently being withdrawn across large parts of the UK.

The 'FORESEE' vehicle uses active suspension to steer the wheelsets and vertical suspension instead of bogies, and University of Huddersfield is now looking for an investor to take the demonstrator vehicle to the next stage of production.

A second project is the EU-funded Run2Rail programme to develop the next generation of running gear using novel materials and manufacturing methods. A prototype will soon be built using aluminium and carbon fibre for small components such as axle boxes.

The CoE will also soon have a suite of new facilities, with £10m being invested in a full-size motion platform to simulate service conditions and provide a high-fidelity reproduction of the environment experienced by passengers and crew on a wide range of rolling stock, from light rail vehicles to high-speed trains.

A new Hardware-in-the-Loop train braking test facility is also being built as are two new rigs for pantograph testing, including a test rig that can test the next generation of pantographs at speeds of up to 400kph (about 249mph).

This is due to be installed in February, and the university will be running a competition to choose a name.

University of Huddersfield Professor Simon Iwnicki says: "We've got a few projects bubbling away and we've taken a strategic approach with our other university partners to build our capabilities so that we have a completely rounded team."

"It's amazing how quickly UKRRIN has taken off and how the industry has got behind us to make it the sole collaborative body representing academia and industry in rail."

UKRRIN's CoE for Infrastructure will also be represented at Rail Live by its other partners - for example, Loughborough University and University of Sheffield.

Academics will be on hand to talk about the University's brand new National Infrastructure Laboratory, which opened in May to complete the Bolderwood Innovation Campus that has been built up over the last two decades.

This £46m facility contains a large structures testing lab, geotechnical lab, materials testing lab and a new geotechnical centrifuge that can induce 100G.

Professor William Powrie of the University of Southampton's engineering faculty

Northern 144010 calls at Gainsborough Central on March 10 2018 with the 1114 Cleethorpes-Sheffield local stopping service. These trains are notorious for their poor ride quality, and could one day be replaced by the 'FORESEE' vehicle currently being developed by UKRRIN university partner The University of Huddersfield. JOHN STRETTON.



explains: "This is a stunning new facility that will give us the capability to test 34 tonne beams, and to test track on full-scale ballast using state of the art measurement and loading instruments."

"We're also installing a geotechnical centrifuge which will, for example, enable us to test different models of pilings under cyclic (wind) loading and the effects of moisture movement and climate change on embankment soil. This way we can gather data in a couple of days for something that might take a century in the natural world by speeding it up by a factor of 100."

"A small-scale model in the lab won't do anything as good as that because stresses are too low in that environment, so to get around that we can simulate representative behaviour in the centrifuge, which will be the first in the UK to sit within an establishment that's engaged in a lot of railway research."

University of Southampton Rail Centre Coordinator Rod Anderson adds: "We will also have a high-fidelity measurement kit for the large structures testing lab so that data-rich imaging techniques can be integrated with advanced computational modelling. The combination of techniques into a single integrated system is unique, internationally, and will for the first time enable the assessment of interactions between material failure mechanisms and structural stiffness failures in a hitherto unattainable level of physical realism."

Representatives from the University of Southampton will be available to discuss a range of projects conducted with industry over the last 12 months, including its work for Network Rail to improve its understanding of various difficulties it encountered in creating foundations for overhead line equipment during the early stages of the Great Western electrification

programme.

Professor Powrie adds: "NR's high output piling system was getting down to only five metres depth, when the foundations needed to be 10m. This meant that NR had to drive two sections and weld them together, which is both time-consuming and drives up costs, so we were commissioned to see why this discrepancy had arisen."

"The problem was that the profile of the soil is hard to find, and it can cost you as much to get a soil stiffness profile as to install the piles. We ran tests at High Marnham and showed that NR needed to return to the old [pre-high output] methods which should make foundations more affordable in the future."

The University of Southampton has also produced a new guide for the industry on the effect of debris accumulation on river bridges.

Anderson explains: "It's well known that scour patterns and upstream water levels can affect structures, but how do we predict these effects? Our guide gives engineers an understanding they didn't have before."

"Scour is well understood, but what isn't well understood by asset managers is the effect of debris floating downstream. This guide is not an academic paper, but a guide for the practising engineer that is absolutely free online (or £6 for a physical copy)."

The future also looks bright for the university with a number of enquiries having been made by companies and organisations based in the UK, Africa and Europe to develop and test new types of infrastructure, such as sleeper types and larger bridge beams.

Last but not least, representatives from UKRRIN's CoE in Testing will also be attending Rail Live to discuss how these facilities can be accessed, and how it can work collaboratively with current and

prospective customers to deliver their testing requirements.

A vital element of UKRRIN is the Coordinating Hub which sits at its core, supporting the network and its members. The Hub (chaired by RSSB) offers services in the five core areas.

Nailah Fraser-Haynes (Senior Partnerships Manager, RSSB and Communications Lead, UKRRIN) says: "The UKRRIN Hub team brings RSSB, RIA, Unipart Rail and others together to support the network and maintain close contact with rail industry experts, activities and interests. Our focus for the coming period is very much on building understanding across the UK and globally of what UKRRIN has to offer, and why interested parties should engage with the network."

"Our second Annual Conference, taking place on November 21, will provide a number of opportunities to do so and for us to hear from industry and academics. We would like to understand how people would like to use network facilities, what they are struggling with in terms of getting research ideas and innovations out on to the railways, and what else they would like to know about UKRRIN and future plans for the network." ■

■ UKRRIN is very much open for business, and welcomes approaches to join from all interested organisations. To find out more, UKRRIN will be exhibiting at Rail Live (Quinton Rail Technology Centre) on June 19-20. Alternatively, visit [www.ukrrin.org.uk/about/](http://www.ukrrin.org.uk/about/). You can also contact UKRRIN's coordinating hub ([ukrrin@rssb.org.uk](mailto:ukrrin@rssb.org.uk)) or follow UKRRIN on Twitter @UKRRIN.



A new £46m National Infrastructure Laboratory (above) opened on the University of Southampton's Bolderwood Innovation Campus at the end of May. Rail testing facilities include a large structures testing lab (below) and a 150G-tonne centrifuge. ROD ANDERSON/GRIMSHAW.



# Innovation incubator

2018 was a big year for the Birmingham Centre for Railway Research and Education (BCRRE). Already the largest institution of its kind in Europe, it cemented its reputation as a global thought leader sitting at the very heart of the international research landscape within railways when, in February 2018, it officially became the lead university partner in the UK Rail Research and Innovation Network (UKRRIN).

Although one of eight universities that form the four Centres of Excellence within the newly established network (see pages 40-43), it was BCRRE that led the original bid for £28.1 million funding for UKRRIN from the UK Research Partnership Investment Fund.

This has since been boosted by a further £64m from UKRRIN's 16 industry supply chain founding members.

BCRRE hosts the UKRRIN Centre of Excellence in Digital Systems and £16.4m is subsequently being invested in a new 3,000m<sup>2</sup> building on the University of Birmingham campus where solutions will be developed in areas such as cybersecurity, data integration, smart monitoring and future train control.

This building is due to be opened next March and will feature new facilities that enable the entire UK rail network to be simulated, and where hardware-in-the-loop testing can take place for signalling, control and traction systems, and communications

## ALEX BURROWS and CLIVE ROBERTS outline the rapid progress being made at the Birmingham Centre for Railway Research and Education (BCRRE)

technologies.

Co-located with the University's new School of Engineering Centre, its meeting and seminar rooms, light and heavy laboratories, exhibition and catering spaces, workshops and offices will be open to all UKRRIN members, as well as other industry partners and project sponsors to facilitate greater collaboration.

Professor Clive Roberts, Centre Lead at BCRRE, says that in just the first year of UKRRIN, BCRRE has already been hard at work to accelerate innovations in partnership with industry.

This includes BCRRE's contribution to the Government's Rail Sector Deal to extend its plans for a Rail Industry Data Platform to include the wider industry.

Professor Roberts, Dr John Easton and Dr Lei Chen are currently combining their expertise to make the first full-release version available from spring 2020, which will enable multiple datasets to be shared so that problems can be viewed from several different angles, rather than in isolation.

Alongside the data platform, BCRRE is

leading the design of a cutting edge Digital Twin, a fully functional digital replica of the railway that is intended to drive innovation by allowing high-level analysis and the ability to see opportunities or problems before they occur in the real world.

Roberts says: "We've been beavering away in the last year on projects such as HydroFLEX (see panel), and we've got many more in the pipeline. We've done lots of work, for example, on how we fit into the National Digital Twin project and the Rail Sector Data Platform.

"The Digital Twin is a big step for us. Rolls-Royce already does it for its jet engines but focuses on components, whereas we are interested in the end-to-end journey. It will enable us to conduct tests in a system integration facility [rather than trackside] which removes the risks in the application of technology and the rest of the project.

"We don't do enough of that in the rail industry and by doing it first we have the potential to be world leaders, as well as deploying it on homegrown projects such as Digital Railway and HS2."

An artist's impression of the new 3,000m<sup>2</sup> building due to open at the University of Birmingham in March 2020 to house UKRRIN's Centre of Excellence in Digital Systems. BCRRE.



### HYDROFLEX

In September 2018 BCRRE entered into a Memorandum of Understanding with rolling stock company Porterbrook to create the UK's first standard gauge hydrogen-powered train.

Named the HydroFlex, BCRRE was asked to convert a Porterbrook-owned Class 319, owing to its unrivalled technical and research expertise in this type of traction.

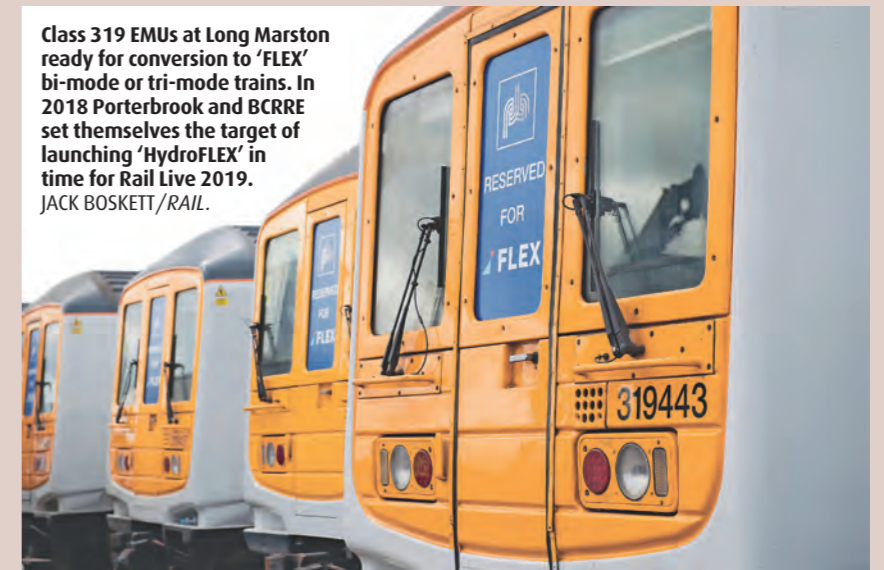
BCRRE earned many plaudits when it exhibited 10¼in-gauge locomotive *Hydrogen Hero* at last year's Rail Live event at the Quinton Rail Technical Centre, Long Marston in June 2018.

The full-size HydroFLEX demonstrator (which will also operate on 25kV overhead and 750V DC third-rail routes) is due to star at this year's show, which once again takes place at the QRTC on June 19-20.

Senior Lecturer in Railway Systems at BCRRE Dr Stuart Hillmansen says: "I have to pinch myself at how fast we've managed to do this, as it was only at the last Rail Live in June 2018 when this idea was conceived.

"The demonstrator will be available to

Class 319 EMUs at Long Marston ready for conversion to 'FLEX' bi-mode or tri-mode trains. In 2018 Porterbrook and BCRRE set themselves the target of launching 'HydroFLEX' in time for Rail Live 2019. JACK BOSKETT/RAIL.



run around the test track at low speeds, with the purpose being to showcase the main components including the hydrogen fuel cell, control system and storage. This is so we can demystify some of this technology and show it as a viable alternative to diesel power on non-

electrified lines.

"It was very pleasing from my point of view that we got so much interest in *Hydrogen Hero*. You can do a lot of papers and theoretical studies but there's nothing quite like getting something actually out there for people to see."



“By networking, SMEs can develop skills, understanding of the industry, knowledge of innovation, funding opportunities and, ultimately, greater access to facilities through BCRRE and UKRRIN.”

Alex Burrows, Director, BCRRE

Despite not even being at the halfway stage, 2019 looks like it will no less significant than 2018 with two recent announcements demonstrating the scale of BCRRE's ambitions to extend its national and international reach.

The first came in March when BCRRE announced its formal integration with the Rail Alliance supply chain membership organisation.

The union has provided RA members with access to BCRRE's substantial technical, testing and human resources in order to help develop products and bring solutions to market.

Meanwhile, access has also been given to programmes such as Rail Mentor and DIGI-RAIL, which provides long-term funding to SMEs based in the West Midlands to develop digital products and services.

BCRRE Director Alex Burrows explains: "RA has always existed to provide support to SMEs, so we've integrated with the specific aim to create a cluster, and a means to aggregate the power of individual parts of the community.

"By networking, SMEs can develop skills, understanding of the industry, knowledge

of innovation, funding opportunities and, ultimately, greater access to facilities through BCRRE and UKRRIN.

"UKRRIN is about leveraging interest around the larger players, so the next step is how to get SMEs through the door to share in the benefits, and you are now seeing the fruits of those labours in projects such as DIGI-RAIL."

He adds: "We (BCRRE) can also work as a 'virtual' Tier 2 contractor to contract with large organisations like Network Rail or HS2, and then provide that SME base. We will be bidding for work imminently in that sort of consortium manager role, and also for international opportunities through RA's membership of the European Cluster Initiative, and by joining forces with other clusters and organisations."

The second key announcement was made on May 8 when Burrows travelled to the SEE Mobility Fair in Belgrade, Serbia, to sign co-operation agreements with the University of Belgrade Faculty of Transport and Traffic Engineering (FTTE) and the Rail Cluster for South East Europe (RCSEE).

The agreements commit all partners to working together collaboratively on railway

research and innovation projects and to share best practice and transfer knowledge.

The RCSEE agreement, in particular, focuses on increasing opportunities for Rail Alliance and RCSEE members to grow and develop their businesses both in the UK and in Serbia.

Burrows adds: "These agreements really mark the start of an exciting period of collaboration between the Universities of Birmingham and Belgrade to increase railway research and education. We also hope that this will bring significant opportunities to our RA SME community in terms of exporting and growing their business opportunities.

"Serbia and the wider region is an emerging economy and its location within Europe with a developing rail network and supply chain make it an ideal region for us to develop our activity."

■ Visit BCRRE's exhibit at Rail Live (Quinton Rail Technology Centre) on June 19-20.

#### Further reading

RAIL 855: Fast track to the future  
RAIL 872: Focused on the future of rail

# Making an impact where it matters

Undaunted by the uncertainties posed to the sector by Brexit, a febrile political atmosphere and the potential outcomes of the Government's ongoing Rail Review, new RSSB Chairman **BARBARA MOORHOUSE** reflects on her first six months in the role, and tells **PAUL STEPHEN** about RSSB's innovative agenda for change over the next five years

**R**SSB has sat at the very heart of the rail sector's innovation landscape for more than 15 years. Established in 2003 in the aftermath of the fatal crash at Ladbroke Grove, it has been tasked with leading and facilitating industry-wide efforts to create a better performing, safer railway ever since.

Formally known as the Rail Safety and Standards Board, the not-for-profit company's remit includes managing and developing Railway Group Standards on behalf of the industry, leading the development of long-term safety strategy, and supporting cross-industry groups that address major areas of safety risk.

Since 2012, it has also facilitated the implementation of the Rail Technical Strategy (RTS), which calls on industry to find innovative technical solutions to address the multiple challenges it collectively faces over the next 30 years

RSSB provides technical support via its own research and development programme, which allocates funding to proposals made by industry. Meanwhile, RSSB also employs more than 270 specialist staff covering a range of technical disciplines, including operations, engineering, information technology and risk assessment.

Leading RSSB's day-to-day activities is its Chief Executive Mark Phillips, while governance, oversight, financial policy and strategic direction is provided by a board comprising representation from all areas of the rail industry. Board members are drawn from RSSB's executive team with three non-industry non-exec directors and its 130+ member companies, which include Network Rail, train and freight operating companies,

contractors, rolling stock companies and suppliers.

Chairing the board is former Department for Transport (DfT) Director General Barbara Moorhouse (see panel, page 50), who was appointed in January following the end of predecessor Anna Bradley's tenure in December 2018.

As well as inheriting RSSB's sizeable remit, the beginning of Moorhouse's term has been made all the more challenging by coinciding with a moment of considerable change for the entire rail industry.

Looming large is the government's root and branch Rail Review (led by Keith Williams), which was already well under way by the time of Moorhouse's arrival, and which is expected to make recommendations this autumn on the future structure of the rail industry and the way passenger services are delivered.

Although it is impossible to predict its final outcome, the review has been billed to deliver the biggest shake-up of the industry since privatisation in the mid-1990s, with any reforms likely therefore to affect all RSSB members, and perhaps even the ongoing role of the organisation itself.

Then there is further uncertainty over whether the current government will still be in power to implement any subsequent reforms, as political disagreement over Brexit, the minority status of the Conservative government, and the current leadership race to succeed Theresa May as party leader and Prime Minister all threaten to precipitate the need for a snap General Election well ahead of the next one scheduled in 2022.

In that event, the future composition and

structure of the rail industry would be a key battleground between the two major parties, with bringing all passenger operations back into public ownership high on Labour's agenda.

Against this noisy and chaotic backdrop Moorhouse has an additional variable to content with, albeit one that she can exercise more influence over. That is because RSSB is in the midst of its own transformation to create a new settlement between itself and members that will help to clarify its core functions and turn RSSB into a more proactive organisation, increasingly responsive to its members' wants and needs.

By becoming a more customer-focused business, and creating more commercial opportunities, it is hoped that RSSB can

enhance its core offering to members while also reducing its financial dependence on membership levies and central funding from the DfT.

To achieve this, the CEO had already done much to strengthen its senior team, including the appointment of former Deputy Chief Inspector for Railways Johnny Schute OBE as its first ever Chief Operating Officer in May 2018 (RAIL 858).

RSSB has also published a five-year Strategic Business Plan for Control Period 6 (April 2019-March 2024) following close

consultation with its members, that sets out objectives in six strategic business areas that cover the full scope of RSSB's products and services.

Considering the sheer scale of external and internal factors that accompany her chairmanship, it begs the obvious question of what exactly attracted Moorhouse to the position in the first place?

"Firstly, I like the rail sector," she tells RAIL. "I've touched on it various times when I was a civil servant at the DfT, and I've always found it interesting given how

Govia Thameslink Railway 700129 (centre) forms the 0652 Littlehampton-Bedford on January 14 as it approaches London Bridge, where it will transition from conventional to in-cab signalling before travelling through the Thameslink core. Supporting the continued rollout of Network Rail's Digital Railway programme is a key objective in RSSB's Strategic Business Plan. ROB FRANCE.



“ The core objective is to make sure that as the industry changes, both in terms of structure and the technology being deployed, safety and performance doesn't get lost. ”

Barbara Moorhouse, *Chairman, RSSB*

► complicated it is, and the need for changes from a public policy perspective.

"I also like the organisation of RSSB, which has a lot of technical expertise, and a well-motivated group of people trying to do right by the sector. This is a relatively small organisation, but it has its fair share of people who genuinely want the railways to be better for all passengers, as well as managing a core of safety work.

"Most of my previous positions have been in change agent roles, so even though I now sit as a Non-Executive Chairman, I like roles that have a degree of change in the organisation and reshaping."

Putting politics, Brexit and Westminster infighting to one-side, Moorhouse is keen to re-emphasise RSSB's commitment to achieving its founding principles of improved safety and performance.

With most of the factors governing future outcomes beyond her control, she says the functions and outputs of RSSB are simply too important to put in abeyance, and so a 'business as usual' attitude has rightly been adopted.

She admits that it's not always easy to cut through the background noise, but as a non-political organisation, it is of paramount importance that RSSB plays a leading role in supporting members adapt to any reforms, regardless of their nature or palatability.

She adds: "I've worked in the health and water industries that were highly politicised, and although there are genuine political choices to be made, when everything you do is subject to political point scoring, it becomes unbelievably destructive. It's not for me to make political points, but the railways are clearly subject to that - and it doesn't help morale or recruitment, which is unhelpful to us as a society, economy, consumers, voters and service users.

"The key thing for me is that the Review comes up with a good set of answers to some very difficult questions, and I hope that there will be non-politicised implementation. We need good answers deployed over time that have cross-party support.

"There is no reason to pause anything [at RSSB] because most of the work we do needs to carry on even if there is a different [industry] shape in future. How people want us to deploy that in future is entirely a matter for other people to decide, but we will continue doing what we do successfully and making a well-respected contribution.

"The core objective is to make sure that as the industry changes, both in terms



**Hanson 59104 passes through Redhill on April 10 working the 0923 Ardingly-Acton Yard empty bogie hoppers. RSSB seeks to become more responsive to all its rail industry members throughout Control Period 6. ALEX DASI-SUTTON.**

of structure and the technology being deployed, safety and performance doesn't get lost. Nobody intends for that to happen, but it's easy when there are lots of things happening and when there is a perception that our safety record is good. As things change we can't be complacent and we need

to make sure we stay with the programme and make sure that's maintained."

Although familiar with the rail sector, Moorhouse has shrewdly spent most of her first six months at RSSB in listening mode. But with that phase now over, her full attentions must now turn to overseeing the implementation of RSSB's Strategic Business Plan, and the wholesale cultural change that will be needed as the organisation adjusts to its new-found commercial appetite.

Moorhouse is candid about the difficult balance that will need to be struck between the need to grow alternative revenue streams and become more profit orientated, while continuing to be a not-for-profit company with a fundamental mission around safety

and quality.

She adds: "It's about using our technical expertise to best effect in the sector. That sounds terribly tedious, but in reality most big public services need to run a damn sight more efficiently - and if more people paid attention to core values and running things well then it would take this country a long way forward.

"Changing culture is one of the hardest things to do in an organisation, and so you have to take your hat off to people running a large organisation like Network Rail, which is trying to enact big changes and puts ours into the shade completely.

"We've got a lot of technical experts with good knowledge in profound subjects,

which RSSB has been good at using, but not necessarily good at selling, so we now need to put them together in the right synthesis to take our skills to market in an appropriate way that's complementary to our core purpose.

"The example we always use is that if we're developing safety standards, supporting training so people know how to use those standards is a natural extension of our role. There is a natural direction for those extensions and we just need to pick those directions and stick with them.

"It's about taking those skills to market where it's entirely helpful and appropriate and adding constructively to what we've always been here to do, rather than changing

the focus of the organisation completely."

The Strategic Business Plan also demonstrates how RSSB intends to stay at the vanguard of research and development, and Moorhouse identifies Digital Railway and decarbonisation as two of the areas in particular where RSSB can demonstrate its flair for collaborative problem solving.

But away from these headline priorities she also points to how the plan sets out ways in which RSSB will tackle a range of less well-publicised challenges, in crucial but perhaps less fashionable areas, such as safety, health and wellbeing.

She says: "The idea that train systems can be more digital is a whole different way of running the railway and there's huge

**“ The key thing for me is that the Review comes up with a good set of answers to some very difficult questions, and I hope that there will be non-politicised implementation. ”**

**Barbara Moorhouse, Chairman, RSSB**

**Eurostar 170218 races through Dagenham with a service from St Pancras International to Paris Gare du Nord on February 17 2018. RSSB has pledged to support its members, responding to various uncertainties, including the nature of the UK's future trading relationship with the European Union. PAUL SHANNON.**

► scope for efficiency and improvement, but we must keep an eye on the risk. With decarbonisation and the environment it typically involves people making difficult choices, and rail in that sense is an easy win. But we've got to maintain a consistency of approach and support and funding for these things if we're going to innovate and make an impact.

"Improved performance and customer service is going to be delivered by incremental operational changes and not by flashy headlines, and so I'm also very focused on our bread and butter and how we can use our skills to contribute to great change in the sector. What makes us very different from other parts of the sector is our reputation for being naturally collaborative, and if there's an issue we'll work on it.

"There is that culture of the whole industry working together and coming together in a much more proactive and coherent way to fix the basics."

Despite the obvious pride that Moorhouse has in her role, and her strong desire to see the Strategic Business Plan fully implemented, she has adopted an extremely pragmatic and surprisingly non-partisan view on how RSSB should emerge in the post-Rail Review landscape.

Instead of stubbornly defending the status quo, she appears more concerned that the valuable role and functions of RSSB are protected, rather than the actual organisation itself.

This view is informed by her experience as a senior civil servant where she witnessed the unedifying spectacle of raw self-interest coming to the fore during similar government-sponsored reviews into aspects of the health and water industries.

RSSB has made a submission to Keith Williams' Rail Review team, in which Moorhouse says any self-defence is set aside in favour of achieving the most optimal solutions to problems faced by industry and

### BARBARA MOORHOUSE

Moorhouse's executive career encompasses board appointments in international IT companies, Director General positions at the Ministry of Justice and Department for Transport and as Chief Operating Officer for Westminster City Council. She was appointed the new Chairman of the RSSB board, taking effect from January 1, and is a Non-Executive Director at Balfour Beatty, Microgen and Agility Trains. She is also a Trustee of Guy's and St Thomas' charity.



**“ RSSB has a lot of technical expertise, and a well-motivated group of people trying to do right by the sector.”**

**Barbara Moorhouse, Chairman, RSSB**

passengers.

"In the submission we've already made we talked a lot about the importance of bringing people together because it really matters that contractors, TOCs, suppliers and infrastructure managers are able to work together. But I sit as a former civil servant, so I know how deeply unattractive it is when personal self-interest is made a higher priority than the public good.

"It would be a perfectly reasonable thing for me to say that I think RSSB has some good skills and it would be a great pity for them to be lost, but I think what really matters is that Williams comes up with a new set of structures that are as fit for purpose as they possibly can be.

"I would like to feel that we don't shuffle the deckchairs too much structurally without thinking through all the operational underpinnings. The only partial thing I'd say at this point is that we think a lot of our work needs to carry on somehow, somewhere, and the culture and mentality embodied by RSSB needs to be writ large.

"I have no desire to promote RSSB's interests, and if my role disappears and it's in a good cause then that's absolutely fine. But I do want to promote what I think is

distinctive and helpful to the rail sector, so I would be sorry if those things that RSSB does so well are lost completely."

It would be easy for someone in Moorhouse's shoes to view the Rail Review as an existential exercise that threatens the immediate future of RSSB and its members, so it is refreshing to see this particular industry leader entering into the full spirit of the Review, and placing the interests of the wider industry ahead of her own.

With so much hunger among those that operate and use Britain's railways to overhaul many of its basic elements, perhaps we could all learn some lessons from Moorhouse's example.

She concludes: "I joined RSSB because I think it is doing a damned good job and I would be sorry to see those initiatives lost but, as I said, if you've been in the civil service you will have listened to all the lawyers and lobbyists turn up and say how critically important it is that their particular interest is given vast sums of public money.

"I will defend what we do - but would I defend our organisational structure in any circumstances? No. I like working in rail and I'm lucky to be contributing to it, but that won't be in terms of defending our turf at all costs, but in terms of making sure that the things we do well are given appropriate consideration in whatever comes next." ■

### Rail Live

For more information, RSSB will be exhibiting at Rail Live from June 19-20 at Quinton Rail Technology Centre, Long Marston, Warwickshire.

### Further reading

**RAIL 858, Shaping RSSB's mission.**  
**RAIL 855, Funding the future.**

# How can we answer the big questions facing Britain's railways?

Together with our members, RSSB has been looking ahead at what's needed to help our railways thrive in the face of change. Our CP6 Business Plan sets out how we'll use in-depth analysis and innovation to work towards a better, safer railway.

Find out how we're  
**THINKING FORWARDS**  
[www.rssb.co.uk/thinkingforwards](http://www.rssb.co.uk/thinkingforwards)



# All aboard the Innovation Hub

## ANVESH PRASAD tells RAIL about Porterbrook's platform for demonstrating new concepts in train technology

One year after its first ever supplier conference, Porterbrook has created its Innovation Hub, using a redundant electric multiple unit to create a platform where suppliers can demonstrate their products.

Using an off-lease Class 319, the company describes the Innovation Hub as a "missing link" in escalating concepts to viable products.

Porterbrook's Head of Procurement Anvesh Prasad tells RAIL that the market had called for such a platform to demonstrate innovative ideas.

In June last year, the rolling stock leasing company's conference was attended by more than 200 people, representing more than 100 companies.

At the event, many of them highlighted the need to showcase products and technology aboard a real train.

Between October 1 2018 and March 31 this year, the rolling stock company sourced a donor EMU and invited interested suppliers to offer products to display on it. It created a unique livery and worked with the industry and various stakeholders, including government departments, to turn it into an attractive venue for potential customers.

Porterbrook plans for the Innovation Hub to focus on four key areas: environmentally friendly manufacturing processes; improved

passenger facilities; new uses of data and connectivity; and system monitoring.

Porterbrook believes that the idea is particularly appealing to small and medium-sized enterprises seeking to make their debuts in the rail industry.

These companies often want to showcase their wares to the market but have been unable to do so in a real-life environment. So by creating that using an actual EMU, Porterbrook believes the market will be better able to respond to the sector.

Prasad tells RAIL: "You have to remember that SMEs are likely to want to show conceptual products rather than what's already on the market, and they may not yet have the approvals."

Porterbrook is due to launch the train at Rail Live on June 19/20 at Long Marston, and it's planned that the EMU will stay there. The event was the first time that many UK-based businesses had the opportunity to showcase their products in a real train environment - and for free.

The four-car unit is split into four zones (although it remains formed as a single unit). On board are around 30 products from some 25 suppliers, showcasing a range of products including flooring, graphics, seats and signage. The entire train will be full of new products.

Prasad says this allows Porterbrook to mix



The Innovation Hub uses a four-car Class 319 that has been significantly repurposed for the event. PORTERBROOK.

Innovation Hub. Echoing the 'missing link' theme, he says: "To date, a critical stepping stone between laboratory-based testing and live rail operation has been missing, and as an engineering innovation developer we welcome Porterbrook's investment in bridging this gap."

He said the EMU will provide a "unique and highly valuable" facility in which to test and demonstrate the company's product, which enables carriages to be used both for passenger and freight use.

Companies working with Porterbrook on the Innovation Hub include: 3M, 42 Technology, AB Turnkey Solutions, Altro, Aqueous Guard, AS-FE, Aura Graphics, Axminster Carpets, Birley Manufacturing, BlockDox, Blocksil, Camira Fabrics, Chrysalis Rail, Derby Engineering Unit, DG8 design and engineering, Digital Railway, ELeather, EAO, ESG Rail, Flitetrak, Harrington Generators International, I.M. Kelly R & A, Infodev EDI, Inspiring Solutions Group, KeTech Systems, Marl International, Milwaukee Composites Incorporated, Motorail, On Train, Petards, Powelextrics, Quinton Rail Technology Centre, Revitaglaze, Train FX, Transcal Engineering, TRB Lightweight Structures, Ultra Fog, Unipart Rail and UR Group.

Another key benefit of the project has been the creation of networking opportunities between the suppliers, and several have worked together on the Innovation Hub. Porterbrook believes that by bringing suppliers together there will be the creation of not only long-lasting relationships between the suppliers, but also between the suppliers and the rolling stock company.

Porterbrook CEO Mary Grant sums up the project: "We hope it will pave the way for brilliant new ideas and technologies to be implemented on the railways. Innovation is the lifeblood of the rail industry, but while there is no shortage of new ideas, we are very aware of the challenges our suppliers face in demonstrating and testing new products.

"As an industry steeped in heritage, it's essential that we keep our fingers on the pulse of new technology and customer needs, and this is something that we at Porterbrook put at the core of what we do." ■

**“ We are all being encouraged to look at innovations that will benefit passengers - what's not to like about this? ”**

**Anvesh Prasad, Head of Procurement, Porterbrook**

Innovation Hub initiative is the catalyst that will allow URGroup to further develop and demonstrate its innovations. It will also receive valuable feedback from experts in many areas of the industry."

He describes the train as the ideal platform for demonstrating digital train solutions and to showcase how real value can be delivered.

Dr Zane van Romunde, Transport Sector Lead at 42 Technology Limited, said his company would be able to demonstrate its Adaptable Carriage technology on the

and Department for Business, Energy and Industrial Strategy (BEIS).

This means that Porterbrook can help drive forward ambitious plans from the Rail Supply Group to help grow the UK's rail export market. Prasad doesn't rule out international customers, but says the focus is very much on the UK supply chain.

"It's going to help the smaller suppliers engage with the train operating companies on innovation. At Porterbrook we are looking at what's in the marketplace, so this is good for both us and the supply chain.

"We are all being encouraged to look at innovations that will benefit passengers - what's not to like about this?"

The Innovation Hub also supports the Government's rail supply chain objectives and will also help drive forward the Rail Supply Group's ambitious plans to grow UK rail exports.

Feedback has been positive. URG Sales Director Gary Lock says: "Porterbrook's

and match what is required, show a flexible configuration, and enables customers to get a better understanding of the product they are investigating. By doing this it's also possible to showcase innovative ideas in real-time.

It's planned that the Innovation Hub will be an annual showcase for businesses to demonstrate their products and Porterbrook is keen for the train to be used by suppliers all year round for customer visits and demonstrations.

Prasad says that the idea has proved so popular that he had to turn interested parties away, but they are keen to be involved in the next one, planned for next year. That works for the industry, he says, because the supply chain works to the end of each year, and so that will allow the next Innovation Hub to be created.

Basing the train as a static showcase at Long Marston also allows Porterbrook to carry out more on-board activities, as the approvals process is not as stringent as if it was on the main line.

Feedback from the supply chain has been positive, according to Prasad, who reveals the Innovation Hub unit was announced to the sector last autumn at RVE 2018.

Crucially for the project, it has support from key government departments - Department for Transport (DfT), Department for International Trade (DIT)



Each vehicle in the four-car train will feature different interiors and products, while the exterior will feature a specially designed livery. PORTERBROOK.



The motor vehicles of the Class 319 highlight the innovative work the Porterbrook is carrying out to repurpose its fleet for the future, including hydrogen power. PORTERBROOK.



# Cloud Nine maintenance

Spanish manufacturer Talgo has had a strong focus on innovation since its inception, in 1942. For example, one of its revolutionary designs obviates the need for bogies and axles, and is in use across the world.

The company has ambitions to build trains in the UK, and to do this it's breaking new ground, this time in a major collaboration that uses Google's Cloud Platform.

The company's Chief Maintenance Engineer Jose Antonio Marcos explains: "We chose Google for its unlimited scalability, great connectivity, massive storage, data streaming and its machine learning solutions."

A *bon mot* at Talgo is "When is a high-speed train not a high-speed train? When it's sat on a depot undergoing repairs." The thrust of this new partnership is to ensure the trains are in traffic far more than they are sat on depots.

Currently, the company is finishing an order for 36 very high-speed trains for Saudi Arabia, with 80 similar trains on order for Spanish state operator Renfe, and up to 100 trains for Deutsche Bahn.

Talgo is also shortlisted to supply 54 classic-compatible trains for High Speed 2 in the UK, and all of these fleets, as well as those already in service, will potentially have one thing in common - they will communicate with the company's

## The sheer power and capacity of cloud computing is opening up a new world of predictive maintenance for Talgo, writes RICHARD CLINNICK

headquarters, in Las Matas near Madrid, in a system designed to improve reliability.

Says Marcos: "Cloud technologies are essential for any predictive maintenance model on this scale. Companies that do not use cloud technology simply cannot meet the challenges of attaining high reliability and availability alongside low maintenance costs."

"If you use cloud technology, you are in. If you don't, you are out."

But how does it work?

Using sensor data from the trains, Talgo maintenance teams can analyse data gathered by the train to predict problems. The trains can then be recovered to a depot where preventative maintenance can be carried out, thus ensuring continued reliability. An example of this is how one of the neural networks being developed will be able to predict rolling bearing failures one to two weeks before they occur. That is achieved by predicting the temperature of the bearing based on data from the sensors.

The new technology enables the company

to enhance the volume of data it collects by a massive margin. Previously, Talgo would collect about 1Mb of data per day from each train, while trains would send an event alarm in case of a problem.

That data has increased considerably.

Talgo now captures 2,000 times that amount, with 2Gb received daily from each vehicle. On a train, 2,000 sensors capture a piece of data every second. This enables Talgo staff to monitor how the train is performing while it's on the move. Some of the data streamed includes voltage, acceleration and hydraulics, and even a video of the driver's view.

Supplementing that data, the train also sends a batch of information every four minutes, which can include any reports triggered by anomalous data that might require the attention of maintenance teams.

However, this technology also allows the same staff to predict maintenance needs as the data is fed into high-precision modelling machines that can predict any problems that



An artist's impression of a future Talgo Very High Speed Train for the UK market. TALGO.

could arise. This means Talgo can plan to remove any train from traffic anywhere in the world, and not affect the performance criteria laid down by the operator in that particular country.

Each train sends the 2,000 events per second via a VPN (Virtual Private Network) for central analysis. It also connects to the Cloud Datastore.

Marcos explains: "Once the data is in the Cloud Datastore, we conduct real-time monitoring using an application (OpenSistemas) we developed."

"Both our maintenance engineering department in Saudi Arabia and our corporate headquarters in Spain can use that to monitor the data in real time, and from Cloud Datastore we can easily add extra

**“ Companies that do not use cloud technology simply cannot meet the challenges of attaining high reliability and availability alongside low maintenance costs. ”**

**Jose Antonio Marcos, Chief Maintenance Engineer, Talgo**

functionality, like tracking train locations using Google Maps."

A key benefit for Marcos' team using cloud technology is the cost savings. While it was clear that the on-premises infrastructure required to meet the demands of customers was financially prohibitive, the cloud infrastructure was not.

Historical data can be stored for future analysis. Gone are the days of stores of paper notes - Talgo's solution also allows trains to upload their entire daily data capture of 2Gb to a Cloud Storage Bucket. Once in the store it can be used by Talgo's analysts to model the performance of the trains and identify any potential issues.

Ninety of the new trains will carry event alarms monitoring equipment. This is a reaction to recent contracts that have had a much higher expectation when it comes to maintenance.

Marcos explains: "The new contracts we have with operators are very, very demanding. In terms of reliability, we may have to guarantee more than 30,000 kilometres between basic inspection stops, and more than 1.5 million kilometres between failures."

Marcos explains there is now even more pressure to enhance reliability, and that external factors must also be taken into consideration. He says: "We also have to ensure 99% availability of the fleet, whether it is travelling through a Saudi Arabian

sandstorm or a UK winter. Talgo can provide that level of service, but the only thing that makes it possible is the use of cloud technology."

Once Talgo has the data, its maintenance teams can compare the variables to keep track of the train's condition. But even that is not enough for the company. It wants to create machine learning models that can assist in the predictive maintenance using condition-based monitoring.

Marcos explains: "We are experimenting with sending data using Cloud IoT (Internet of Things) Core and Cloud IoT Edge and ingesting it with the same Cloud Pub/Sub, Dataflow, BigQuery architecture that we already use."

He says that is being used to load libraries into onboard equipment, which subsequently enables Talgo to control every sensor on board. It can also change onboard patterns and rules, filter the information trains transmit and send messages directly to sensors in the train.

"We can easily send results from our Google Cloud Platform machine learning model to mobile devices using App Engine," says Marcos.

"Predictions, recommendations and evaluations of the condition of trains can be sent directly to engineers anywhere, and we can automatically generate reports using Google Data Studio so maintenance can be more effective," he adds. ■



Upper left: A vehicle from Talgo's 'Haramain' train for Saudi Arabia. TALGO.

Below left and above: Talgo's 'AVRIL ES' for Spanish operator Renfe, under construction at Las Matas, Madrid. TALGO.



# Cooling the Tube

Retired Chartered Engineer **CALVIN BARROWS** proposes simple but innovative solutions to the age-old problem of overheating metro networks

**W**orldwide there are a significant number of Metro networks that are grappling with overheating problems and the following findings will make all the difference. For London Underground, which originally advertised "IT IS COOLER BELOW" until the 1920s, this has been a 120-year problem and their Cooling the Tube Project has contributed little improvement since its inception in 2005.

Even in the temperate climate of the United Kingdom, from autumn 2017 to autumn 2018 there was a 40°C seasonal ambient temperature variation. In fact, a surface peak of 40°C+ was recorded last summer on the London Underground Central Line! However, the train and tunnel systems create broadly the same heat year round. In the summer, the seasonal effects add to this year-round heat. In the winter the seasonal effects are subtractive - so much so that to keep the passengers warm in winter saloon heaters are needed to generate additional heat.

There are essentially three types of network: underground only, predominately overground, and combined over/underground. They all behave differently.

For Metro networks that run only underground, such as Glasgow, overheating is not a problem - hold that thought.

For trains which run predominately overground, air conditioning (AC) expels the excess heat to free air, a technically sound but costly solution, both financially and environmentally.

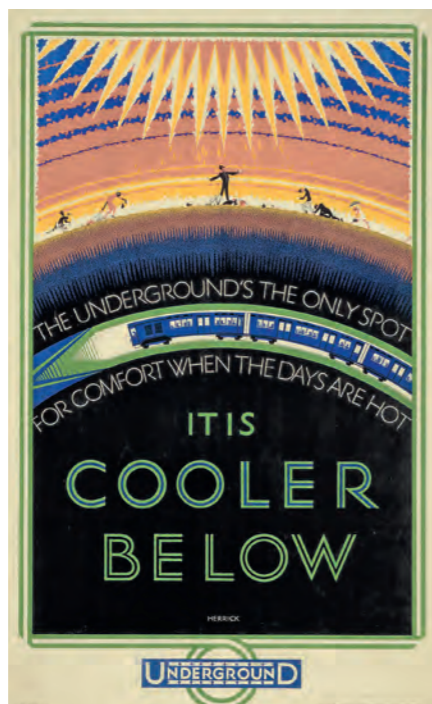
However, in the summer, combined over/underground Metro networks overheat throughout. Saloon heat is not the only problem - it's also the tunnel heat! However, AC in the trains alone is not an effective solution.

The current response to metros overheating underground is either to do nothing and subject the passengers to risk and discomfort or to install massive cooling plants in the tunnel network, which addresses the symptoms but not the root cause. Conventional wisdom, dictating the

installation of these cooling plants - with their expensive capital and running costs and adverse environmental impact - is imprudent.

## Why does AC on the train not work for combined over/underground Metro Networks?

First, because the elevated ambient air is pushed and dragged into the tunnel by each train movement and secondly, the sun's irradiation heats the entire train both internally and, more importantly, externally! Even the undercarriage is affected when the sun's rays strike the large mass of the wheels. Additionally, the rails and ballast are being irradiated and this heat is conducted, convected and radiated back to



This 1926 poster dates from a time when London Underground was promoted as a cool sanctuary that offered respite from the hot summer sun. LONDON TRANSPORT MUSEUM/TRANSPORT FOR LONDON.



the undercarriage and the underside of the carriage itself, not to mention that with every metre travelled this effect is compounded. All this absorbed heat is emitted from the carriages, effectively making each train entering the tunnel into a series of giant 'storage radiators'. Hence, AC in the train will not address all these heat sources, seemingly only the saloon temperature. However, the total effect of all these heat sources in the tunnel will overwhelm any attempt at cooling the saloon using AC.

The combined effect of the ambient air and direct/indirect solar irradiation is massive when compared to the train and tunnel system's operational heat sources and causes the tunnels to overheat in the summer. The rise in tunnel heat is progressive with each train entering the tunnel throughout the day. Furthermore, attempting to cool by tunnel ventilation requires several air changes to achieve any benefit, so this is neither an effective nor feasible solution.

More research and monitoring should be undertaken to quantify the relative impacts of each heat source.

## How can we be sure we're on the right track?

First, as mentioned earlier, because underground-only trains do not overheat! Secondly, because temperature monitoring has demonstrated considerably greater rises in saloon temperature when on the surface compared with the underground. Finally, because the sun causes rails to buckle, Tarmac roads to melt and metal seats and children's slides to become hot enough to cause burns - so how can trains be immune from this phenomenon?

## What is the answer?

We need to reduce the heat of the trains

“ With absorbed heat being carried into the tunnels and overheating them, even a short 'stalled train event' underground could seriously compromise passenger safety. ”

before they enter the tunnel and address the problem in an environmentally friendly and effective way. Consequently, this will reduce the need for additional tunnel cooling systems.

## Why do anything?

Obviously, improving comfort is a primary reason. But safety is also a reason. With considerable absorbed heat being carried into the tunnels and overheating them, even a short 'stalled train event' underground could seriously compromise passenger safety. These are the operational imperatives. However, we should not forget costs and the environment.

On that basis, we can and should address the cause and mitigate the problem, preventing the symptoms in the first place. This calls for a two-pronged approach: by introducing radiant and thermal barriers to the trains and by avoiding stabling trains in the sun during off-peak periods. These changes should be recognised as key requirements and should be incorporated at the design stage. However, these key requirements can also be implemented during routine repair, replacements and refurbishments.

It should be noted that while the above changes are not an operational imperative for predominantly overground trains, the environmental benefits to these trains should not be dismissed!

## What are these barriers?

First, there is solar reflective paint which should be applied to all the metalwork exposed to the sun's rays - on the carriage and the undercarriage/wheels. Reflecting the sun's rays away reduces both the heat absorbed by the train's metalwork and that conducted inwards to the saloon. This would reduce both the internal and external train temperatures. The Australian Navy has applied this type of paint to its warships, and it has reduced surface temperatures by 15-20 C; the power load on the cooling systems has also been reduced.

Secondly, there is solar control glass. Standard glass allows 84% of the sun's radiation to pass into the saloon and only reflects 16%, whereas solar control (Low E) glass allows only 4% of the sun's radiation through the glass into the saloon but reflects a massive 96%. Moreover, by reflecting the radiation, less heat is absorbed by the glass itself, reducing its external temperature.

Thirdly, there is the undercarriage. Combined foiled/insulation products can reflect the radiation from the track and insulate against heat convected from the overheated bogies.

Finally, where trains are out of service during off-peak times, they should not be stabled in the open but shaded by a structure that does not in itself suffer from overheating by solar gain. There are two feasible options: fire-resistant fabric canopies or finned walls

A Piccadilly Line service for Heathrow arrives at Manor House on June 11 2018. Among the measures called for by Calvin Barrows to reduce temperatures on the London Underground system is the coating of such trains in high-performance solar-reflective paint. ANTONY GUPPY.

and roofs that operate like Venetian blinds with the openings facing north or east.

In conclusion, the Glasgow Subway demonstrates that all the heat sources from train and tunnel systems do not produce enough energy on an underground-only network to cause overheating!

Given that the principal cause of overheating of any train travelling overground in summer is quite simply the effect of the sun's irradiation, obviously, all such trains would benefit environmentally from the suggested radiant and thermal barriers.

However, it is abundantly clear that the long-standing issue of underground tunnels overheating is also a direct consequence of this solar irradiation of the trains, so incorporating such radiant and thermal barriers on trains in combined over/underground systems is an easy decision, benefitting the travelling public from a safety and comfort perspective and, notably, providing significant cost and environmental benefits.

Finally, stabling of all trains travelling overground should be suitably shaded. This shading would also be advantageous to trains that only travel underground when in service but may be stabled overground during off-peak periods. However, such appropriate stabling would then obviate the need for underground-only trains to have radiant and thermal barriers. ■

## ABOUT THE AUTHOR

Calvin Barrows is a chartered engineer, latterly retired.

During his earlier career, his work was focused on forensic engineering, to establish the mechanisms of structural and mechanical failures. Then, continuing as an engineering manager within the rail industry, he used his extensive, theoretical and practical knowledge of all construction disciplines, together with a holistic approach to creative problem-solving.

Outside his professional career, he brought the same skills and focused, hands-on approach to his architecturally unique, self-build home and outbuildings in rural Essex, incorporating many innovative amenities to make it both user and environmentally-friendly.

Together with his wife Sylvia, he also runs a small but successful property development and rental business, still making time to travel, visit the gym and go walking in the country.

# Evolution of the smart train

## Siemens Mobility's Rolling Stock Sales Director PAUL BAINES tells RAIL how the award-winning Class 700 has spawned new and improved versions

**T**rains from Siemens Mobility's Desiro City range have become a familiar fixture on the UK rail network ever since the first Class 700 entered passenger service with Govia Thameslink Railway in June 2016.

Making that maiden journey was 12-car 700108, which was procured in 2013 as part of a 115-train order for the government-sponsored Thameslink programme.

It remains one of the largest ever train orders in UK history (worth some £1.5 billion), and required Siemens Mobility to build a total of 1,140 vehicles at its factory in Krefeld, Germany, between 2013 and 2018.

Despite the significant logistical challenges posed by such a large undertaking, in partnership with GTR, all 115 trains were delivered and commissioned on time before the end of June 2018.

The fleet will create capacity for an additional 50,000 passengers to travel into central London each day, once GTR has fully introduced its high-frequency timetable of up to 24 trains per hour at peak times.

The Desiro City platform was offered by Siemens Mobility following a research and development programme, during which more than 50 million euros (£43.8m) was spent by the company to create a bespoke solution for the Thameslink programme.

Siemens Mobility's engineers needed to fulfil a demanding specification that required not only increased capacity (in order to serve some of Britain's most intensively used commuter routes) but also improved safety, security, comfort and cost and energy efficiency.

The '700s' also had to be fully digitally enabled to integrate with new infrastructure, becoming the first main line trains in the world to operate using both ATO (Automatic Train Operation) and ETCS (European Train Control System) in-cab signalling technology.

The train's intelligent software design also offered other benefits, including increased reliability and performance through data-driven technology.

The installation of thousands of data points in each vehicle means that diagnostic data could be streamed from each train to Siemens Mobility's service centre, enabling preventative action to be taken while the train is still in service, and a new regime of predictive maintenance to operate at Thameslink's two depots at Hornsey and Three Bridges.

Diagnostic data has also enabled Siemens Mobility's technicians to increasingly operate in a paperless environment at the depots, where they are equipped with handheld devices, rather than the toolkits of old.

This facility allows them to view relevant technical drawings through the company's Train Care portal, and refer back to a 3D Vehicle Maintenance Instruction portal to quickly diagnose, report and remedy faults.

To help manage and understand the 'big data' produced by Desiro City and other Siemens Mobility train platforms, the company offers operators access to its Railigent cloud-based mobile application suite.

Powered by Siemens Mobility's cloud-based Internet of Things operating system MindSphere, Railigent can integrate with various applications and automated measurements which are then analysed and interpreted through a simplified dashboard.

Siemens Mobility Rolling Stock Sales Director Paul Baines explains: "Maintenance regimes used to be very manual, but the regime [on Thameslink] now reflects modern automation and more than 30% of maintenance actions are currently being generated by the train. Our technicians work in paperless depots using tablets all because we, as engineers, spotted the digital trend early on."

"The market for new trains has shifted completely from ten years ago. Back then manufacturers were offering manual regimes with a few digital enhancements. Now customers want to know why they can't have everything digital."

With more than 20 million miles of service



Govia Thameslink Railway 700126 calls at Stevenage on April 12 with a service from Peterborough to Horsham. The fleet's successful introduction and its digital sophistication were recognised last September when the Class 700 was named Train of the Year at RAIL's National Rail Awards. PAUL BIGLAND.

accrued since the first '700' entered service, the fleet has already achieved an MTIN figure (miles between a technical incidence causing a service delay) of nearly 20,000, but Siemens Mobility's ambition is to strive towards achieving zero faults.

To achieve this, faults and items for improvement are logged and then stored in a database if they have occurred before. They then enter a 'performance pipeline' in which remedial action is taken either through software or hardware modification.

This will not only further improve the already impressive reliability of the '700' fleet, but has already enabled Siemens Mobility to introduce even higher performance variants from its Desiro City range in the last couple of years.

This includes the 30 five-car Class 707s that were ordered in September 2014 to operate services out of London Waterloo, and the 25 six-car Class 717s ordered to replace 40-year-old Class 313s on Great Northern services from Moorgate.

The first '707s' entered service with South Western Railway in August 2017 and, according to Baines, have become one of the most reliable trains in SWR's fleet.

Meanwhile, Great Northern has now taken delivery of its final '717', with six sets in traffic at the time this issue of RAIL went to press.

Not enough performance data has yet been gathered on the '717' fleet to draw meaningful comparisons with the '700s', but Baines points to the MTIN figure currently being achieved by the '707s' as firm evidence that newer variants of the Desiro City are registering improved performance rates.

He says this is due to lessons being learned from fault-finding and a robust testing process on the '700s' as software and hardware has had time to fully bed in.

Also, just like a smartphone, the software on Desiro City trains is continually updated during its lifetime, meaning that newer variants including the '707' and '717' can come pre-equipped with more recent and improved versions.

He adds: "We are the only manufacturer to have successfully introduced more than 150 post-privatisation second-generation trains in the UK. It's a German way of doing things, to take an idea and then make it even better. Fleet introductions rarely run as smoothly as you'd like, but when we've had issues with software, for example, the scale

and reach of our global business has been able to quickly respond and deal with it.

"The Class 707s MTIN was 80,000 before Christmas and typically it's between 50,000-60,000 which, for a fleet that's still under warranty, is extremely high. They are due to go off-lease [from South Western Railway] at the end of the year, but this might suggest that there will be no shortage of takers."

"It's a different operational concept but it's the second series in the Desiro City fleet to

**“ It's the second series in the Desiro City fleet to outperform the reliability curve, which goes to show the process of repeated learning is working. ”**

**Paul Baines, Rolling Stock Sales Director, Siemens Mobility**

outperform the reliability curve, which goes to show the process of repeated learning is working. A train can only be as good as it's built, which is a testament to its quality and this cycle of learning."

In terms of the future, Baines says that research and development is being undertaken to design Siemens Mobility's next range of Desiro City trains that builds on the successful '700', '707' and '717' variants, and will include an inter-city and regional variant to enhance the product range.

This might include the possibility of bi-mode trains that incorporate hydrogen or battery technology to offer a more environmentally friendly alternative to diesel traction away from the electrified part of the network.

The company is currently engaging with a number of potential customers with a view to building a proof-of-concept prototype.

Siemens Mobility has a hybrid battery EMU in operation on one of its CityJet trains in Austria, and is at an advanced stage its hydrogen fuel system operating on a test bench in Germany. The intention is that both of these products will be available for the UK market in due course. ■

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