INNOVATION

SEE INSIDE FOR:
- Portebrook’s Innovation Hub
- Evolving Siemens Mobility’s Smart Train
- Talgo’s new world of predictive maintenance
- UKRRIN’s expanding partnership
- Europe’s largest railway research centre
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

Siemens Mobility
Paul Baines tells RAIL how the award-winning Class 700 has already spawned new and improved versions.

Cooling the Tube
Calvin Barrows proposes an innovative solution to the age-old problem of overheating metro systems.

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

BCRRE
Clive Roberts and Alex Burrows outline the progress being made at the Birmingham Centre for Rail Research and Education.

RSSB
New Chairman Barbara Moorhouse on how RSSB is supporting members to meet the challenges of CP6 and industry reform.

Porterbrook
Anvesh Prasad tells RAIL about Porterbrook’s new platform for demonstrating new concepts in train technology.

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

A NEW ISSUE
Every month, RAIL offers an informative, insightful and interesting mix of features, analysis and comment from an editorial team with unrivalled experience in the rail industry.

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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

T he 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, Long Marston in June 2018.

Despite being just four and a half 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, ‘Hero’, at last year’s Rail Live at Quinton Rail Technology Centre at Long Marston in June 2018.

A team of researchers from BCRRE exhibited the UK’s only hydrogen-powered locomotive, the standard gauge version will feature at this year’s show at QRTC on June 19-20.

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The ‘HydroFLEX’ demonstrator has been converted from a Class 319 electric multiple unit, 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.”

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.

“Their support will be crucial to UKRRIN’s continued growth and development.

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

Professor Roberts adds: “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, BCRR

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Pride of place at Rail Live will be exhibits and demonstrations from UKRRIN’s Centres of Excellence, which are currently benefiting from more than £60m of investment in developing their research facilities, comprising £28.1m awarded by the Higher Education Funding Council for England and £31.4m from industry.

All sites are due to be completed by 2024.

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 BCRR and Alstom which resulted in the development of the ABB7100 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, BCRR 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 Freighttrain trade fair in Berlin in September 2018.

No full-size hydrogen-powered train has yet run in the UK, but Alstom’s ‘Coradia Lint’ entered service in Germany last year. Alstom and British 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, BCRR’s 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.
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

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 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 experience by passengers and crew on a wide range of rolling stock for 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 an air rig that can test the next generation of pantographs at speeds of up to 400mph (about 240km/h).

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 buzzing away and we’ve taken a strategic approach with our other university partners. It is absolutely clear 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 attending 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 Innovation 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 lab and a new geotechnical centrifuge that can induce 10G.

Professor William Powrie of the University of Huddersfield’s engineering faculty explains: “This is a stunning new facility that will give us the capability to test 34 tonne beams, and to test track on a 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 loading to study their 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 at 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 lab 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 Fowie 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 deeper types and larger load-bearing 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 new 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 18-21. Alternatively, visit www.ukrrin.org.uk/about. You can also contact UKRRIN’s coordinating hub (ukrrin@rssb.org.uk) or follow UKRRIN on Twitter @UKRRIN.

Further reading
RAIL 837 - University Challenge
RAIL 835 - Innovation Central
RAIL 867 - The Innovation Game

Northern 144010 calls at Gainsborough Central on March 10 2019 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 SHSTON.
Innovation incubator

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

An artist’s impression of the new 3,000m² building due to open at the University of Birmingham in March 2020 to house UKRRIN’s Centre of Excellence in Digital Systems, BCRRE.

Despite not being at the halfway stage, 2019 looks like it will be no less significant than 2018 with two recent announcements highlighting 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 IRIS Rail, which provides long-term funding to SMEs based in the West Midlands to develop digital products and services.

BCRRE Director Alex Burrows explains: "We have always sought to provide support to SMEs, so we’ve integrated with the specific aims of creating a cluster, and providing the scale 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."

The agreements commit all partners to share best practice and transfer knowledge.

The RCSEE agreement, in particular, focuses on increasing opportunities for Rail Alliance and RA SME 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.”

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"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 activities.”

"We have BCRRE’s exhibit at Rail Live (Quinton Rail Technology Centre) on June 19-20.”

Further reading

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Alex Burrows, Director, BCRRE
Making an impact where it matters

Paul Stephen and Barbara Moorhouse reflect on their first six months in the role, and RSSB Chairman Barbara Moorhouse talks about RSSB’s innovative agenda for change over the next five years.

RSSB 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 programmes, which allocate 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 underway 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...”

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.

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
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 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 tasks that will need to be tackled. 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 large organisations 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 those 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 potential...”
Innovation
Big interview

**Barbara Moorhouse, Chairman, RSSB**

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

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.

**“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.”**

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 CPS Business Plan sets out how we will use in-depth analysis and innovation to work towards a better, safer railway.

**Further reading**

**RAIL 855, Shaping RSSB’s mission.**
**RAIL 855, Funding the future.**
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 339, 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 leasing company sourced a donor EMU and invited interested suppliers to display on it. It created a unique lively 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 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 2019 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 50 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 and match what is required, show a flexible configuration, and enable customers to get a better understanding of the product they are investigating. By doing this, it is 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 approval 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 (DTF), Department for International Trade (DIT) 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

...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

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.
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 few years 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 110 trains for Deutsche Bahn.

Talgo is also contracted to supply 54 classic-compatible trains for High Speed trains in the UK, and all of these fleets, as well as those already in service, will communicate with the company’s 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 150b 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 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 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 ex-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. Given are the days of storing 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.
Worldwide there are significant numbers 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 2015.

Even in the temperate climate of the United Kingdom, from autumn 2017 to autumn 2018 there was a 40°C seasonal ambient temperature variation, that is, 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 the train passengers warm in winter saloon heaters are needed to generate additional heat.

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

For Metro networks that run predominantly underground, such as Glasgow, overheating is not a problem - hold that thought. For trains which run predominantly overground, air conditioning (AC) copes 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 metro overheating underground is either to do nothing, and suffer the passengers 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 underground carriage is affected through the large mass of the walls. Additionally, the rails and ballast are being irradiated and this heat is conducted, convected and radiated back to 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, solely 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; thus 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 seams and children’s slides to become hot enough to burn the skin. How can trains be immune from this phenomenon?

**What is the answer?**

We need to reduce the heat of the trains 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 trains metalwork and that conducted into the saloon. This would reduce both the internal and external temperature. 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 44% of the sun’s radiation to pass into the saloon and only reflects 16%, whereas solar control (Low E) glass allows only 25% of the sun’s radiation to pass through the glass 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 bogie.

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 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 underground in summer is 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 radiant and thermal barriers on trains in combined over/underground systems is an easy, effective and beneficial to the travelling public from a safety and comfort perspective and, notably, providing significant cost and environmental benefits.

Finally, stabling of all trains travelling underground should be suitably shaded. This shading would also be advantageous to trains that only travel underground when in service. To reduce this effect, effectively, all trains should be stabled underground during off-peak periods. However, such approach to 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 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

Train services from Siemens Mobility’s Desiro City range have become a familiar fixture on the UK rail network over 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 113-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 1,340 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 113 trains were delivered and commissioned on time by 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 102 four-car units capable 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 fulfill a demanding specification required not only increased capacity (in order to serve some of Britain’s most intensively served railways) but also improved safety, security, comfort and energy efficiency.

The “700’s” 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 ATC (Automatic Train Control) and ETCS (European Train Control System) 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 Horsham 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 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 ever 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 Waterlo and the 25 six-car Class 717s ordered to replace 40-year-old Class 313s on Great Northern services from Moorgate. The first “700” 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 fifth ‘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 ‘705s’ 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 ‘705s’ 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 707 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 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 “705, “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 London, and is also involved in 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.

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
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