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Innovation

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- Europe's largest railway research centre
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- Digital expertise from Taylor Woodrow
- Creating a safer railway

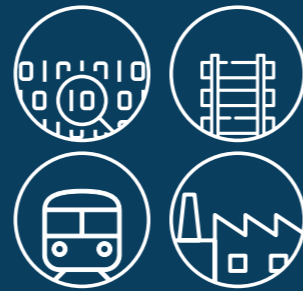
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Innovation

IN PARTNERSHIP WITH RAIL



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Welcome

Innovation is being talked about more than ever but it is worth reminding ourselves of what it actually is. To innovate is to translate an idea or concept into a new application, which could be a product, service or solution. And the innovation must also create value by answering a need or requirement.

But to offer a balanced view of innovation we must also recognise the critical and equal importance of research and development. That power of knowledge and mastery of technology is an underlying source of ideas and concepts which have the potential to become innovations.

With both of these definitions in mind, we can investigate the importance of R&D and innovation to the rail industry and truly understand the scale of the UK's advantage as a global leader in rail R&D and innovation.

Earlier this year the UK Rail Research and Innovation Network was launched, bringing together the UK's rail R&D powerhouses and innovators to create a world-class network of Centres of Excellence. The UKRRIN story is only just beginning, but its impact is already being felt. An increasing number of significant global players in the rail industry are engaging with UKRRIN, recognising the commercial opportunities to be realised from investing in R&D and innovation support as a part of UKRRIN.

Investing in innovation brings a wealth of benefits to a business, including improved productivity, efficiency and profitability, as well as increased business value and market share. Products can be made more reliable and efficient and their life cycles extended; better services can be provided to customers, and solutions can be enhanced that deliver increased value and performance.

The rail industry is well aware that we all have a part to play in driving improvements to how we work and what we deliver. Innovation is central to that. But it can be even more - the UK is truly a global leader in rail R&D, and could also be so for innovation. With the launch of an organisation such as UKRRIN, we have the opportunity to deliver the step change that unlocks the full potential of the railway. It has the backing of the Government and strong support from key players such as Network Rail, HS2, Transport for London and the Rail Delivery Group.

In this 16-page supplement, *RAIL* considers the important contribution that UKRRIN wants to make in supporting innovation and R&D in UK rail, focusing in particular on the network's lead university partner The Birmingham Centre for Railway Research and Education.

RSSB explains how it continues to support the development of the railway and help industry to respond to the changing needs and expectations of passengers and other users. Forming a major part in this is RSSB's Research and Innovation programme, plus its facilitation of the Rail Technical Strategy.

Finally, Taylor Woodrow showcases an innovative solution that reflects the growing digitisation of the industry, and how the company is committed to improving the way we build infrastructure for several decades to come. ■



ALEX BURROWS
Managing Director,
Birmingham Centre for
Railway Research and
Education

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Innovation Central

The UK has a proud history of rail innovation. Beginning with the opening of a passenger railway between Manchester and Liverpool in 1830, the torch for that early pioneering spirit was subsequently carried by a pantheon of great Victorian and Edwardian engineers, including the likes of Brunel and Stephenson.

More recently, development activities were carried out by British Rail's Research Division in Derby, which provided pioneering research and development for British Railways.

Providing consultancy services to railways across the world, it became famous in particular for its theoretical and practical advancements in train tilting technology and Solid State Interlocking (SSI) signalling systems, which would go on to be adopted (or emulated) by manufacturers and railway operators across the globe.

Since the privatisation of the railways in the 1990s, that innovation hasn't gone away with much of the space vacated by BR filled by a resurgence in university-based research.

UKRRIN was launched in Parliament on February 20 by Rail Minister Jo Johnson (centre). Representing the Centres of Excellence are (L-R) Professor Simon Iwnicki (University of Huddersfield), Jo Binstead (Siemens and UKRRIN Steering Group Chairman), Professor Clive Roberts (University of Birmingham) and Professor William Powrie (University of Southampton). UKRRIN.

PAUL STEPHEN reports on how the ground-breaking new UKRRIN partnership between industry and universities will provide a step-change in rail research and development, while also increasing the UK's international standing as a world leader in rail

Attempts to thread together the work of these institutions began in 2003 following the creation of Rail Research UK (RRUK), which comprised specific research groups from a limited number of universities.

That partnership was then expanded in 2010 when RRUK became the Rail Research UK Association (RRUKA) and opened up to all universities, with its central functions funded by RSSB (Rail Standards and Safety Board).

Its purpose was simple: to provide a bridge between the rail supply chain, infrastructure managers, train operators, manufacturers and others (all of whom could fund research and bring its outputs to market) and those within academia who conduct research.

RRUKA also had a useful role as a forum for knowledge transfer and in 'mapping'

expertise by collating information about ongoing and planned research projects to ensure that they were not needlessly duplicated.

Having been established as a successful model to bring innovations to market more quickly, this type of close collaboration has now been taken a step further by the UK Rail Research & Innovation Network (UKRRIN), which was launched in Westminster on February 20.

Building on the work of RRUKA, UKRRIN links 16 companies from the rail sector with eight leading UK universities.

Those universities have joined forces and combined their resources to form three Centres of Excellence in Digital Systems (University of Birmingham), Rolling Stock (University of Huddersfield,



OLE foundation testing takes place at Network Rail's Rail Innovation & Development Centre (RIDC) at Tuxford, Nottinghamshire. It forms part of UKRRIN's Centre of Excellence in Testing alongside NR's RIDC at Melton Mowbray, Leicestershire, Transport for London's test facilities at Acton and Stratford and the Quinton Rail Technology Centre at Long Marston, Warwickshire. UNIVERSITY OF SOUTHAMPTON.

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 in Testing, which incorporates testing facilities at NR's Rail Innovation & Development Centres (RIDC) at Melton Mowbray (Leicestershire) and Tuxford (Nottinghamshire), and those of other key partners Transport for London and the Quinton Rail Technology Centre.

UKRRIN's Steering Group is chaired by Siemens' Head of Innovation Jo Binstead, who says that the network will deliver mutual benefits to members by enabling the UK rail sector to stay at the cutting edge of emerging technologies, to boost its

productivity and export strength, and bring increased value to its customers.

It will also make the rail industry a more attractive place for the next generation of talent to base their careers, which will in turn help address the sectoral problems posed by an ageing workforce and lack of diversity.

In turn, university researchers and students will have improved access to industry experts and real-life projects, helping to expand their skills sets and boost their employability.

Meanwhile, the four Centres of Excellence will benefit from more than £90 million 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.

These outputs make UKRRIN closely aligned with the Government's Industrial Strategy to position the UK as a leading player in a number of global markets, including rail, and the Rail Supply Group's Fast Track to the Future strategy to support productivity and growth in the UK rail supply chain.

Binstead explains: "There's a bigger picture at play here from an industry perspective, as UKRRIN is not all about gaining commercial advantage for individual members. We are united in wanting the UK to be a leader in certain technologies, and to be the place where people come for academic research and to bring products to market."

"There's a bit of patriotic pride at play, but essentially it's about creating jobs, delivering flagship projects like HS2, and talent acquisition and retention. We have



“ We are united in wanting the UK to be a leader in certain technologies, and to be the place where people come for academic research and to bring products to market. ”

Jo Binstead, Head of Innovation, Siemens, and UKRRIN Steering Group Chairman



► to create a talent pipeline which is what UKRRIN will do, and if we don't do that then we will never address diversity, or close the gender pay gap."

Binstead points to the Centre of Excellence in Digital Systems at the University of Birmingham as an example of where supply chain competitiveness can be put aside in order to address an industry-wide capability gap, and where shared investment will mean that all can benefit.

She adds: "Everybody talks about digital signalling, but not data analytics. When we create extra capacity and run more services, how are we then going to increase the train fleet by a third or replace track more frequently? Wherever you sit in the supply chain, what we're missing is asset management and data analytics to predict failures and maintenance requirements."

According to Binstead, membership of UKRRIN is not expected to be static, and it will be open to new suppliers and universities in order to increase the breadth of both its research facilities and expertise.

UKRRIN's structure also allows for research to be undertaken at different levels of collaboration and knowledge sharing, with industry partners able to

“ We will have succeeded when the UK becomes known as the place to do business in rail. ”

Jo Binstead, Head of Innovation, Siemens, and UKRRIN Steering Group Chairman

secure complete client confidentiality and associated protection of Intellectual Property rights, to encourage them to make optimal use of the Centres of Excellence without fear of losing ground to competitors.

"Confidentiality can be ring-fenced if needs be, and each Centre of Excellence will have a number of IT layers to completely separate different companies and their projects. Siemens has already engaged in defining projects to pursue within UKRRIN, and we've already met with some of the universities at our R&D centre in Chippenham to scope out what we will be doing, and whether the use of software and

other things are to be kept confidential. "At our monthly meetings of the Steering Group, we talk about where UKRRIN is going rather than individual projects because at the end of the day we are in competition. We talk about the financial commitments we've made to develop the Centres of Excellence and how to grow the network, because the whole point is that it is not a closed shop."

Richard French, Engineering Manager R&D at Bombardier, is also on the Steering Group and agrees with Binstead that the ability to partake in fully collaborative or confidentiality-protected R&D is one of the key drivers for joining the network.

He says: "You can look at projects in two ways, as either commercial or collaborative. The latter might include things like legislation and approvals for emerging technology which all suppliers have in common, and tackling them would be good for everybody."

"We all share many of the same problems, so one of the big things for us joining UKRRIN was in training and developing young talent in a supported and coordinated way. UKRRIN also enables competitive work in a very secure environment so it caters for

Introducing UKRRIN's Centres of Excellence



Rolling Stock: Professor Simon Iwnicki, University of Huddersfield

"UKRRIN is definitely not just about rhetoric, but will provide a step change in innovation by giving us the drive to expand our capabilities. All three universities in the CERS (Huddersfield, Newcastle and Loughborough) have considerable expertise so it made sense to bring those skills together."

"We are receiving £10m from UKRRIN to support our theoretical work, which we are investing in four new testing facilities in traction and braking, alternative energy, pantographs and a full-size motion platform."

"This will allow us to test how comfortable seats are and other aspects of the passenger environment, through to body structure and the use of composites, future traction, full-scale test rigs for bogies, drivetrain, pantographs, interiors and driving cabs, together with world-class simulation facilities for analysing train systems and the interfaces with the rail network."



Digital Systems: Professor Clive Roberts, Director of Birmingham Centre for Railway Research and Education

"As lead partner and home to the Centre of Excellence in Digital Systems, we are especially excited about UKRRIN. Our new 3,000m² building will open in spring 2020 and offer an on-campus environment for people to work together and with our researchers to deliver a step change in rail transport."

"The CEDS has four key themes: future railway operations and control, data integration and cyber security, smart monitoring and autonomous systems, and introducing innovation. We will have dedicated labs, servers, computers and working areas where industry will work in confidential, secure areas. The centre will have space and facilities for a host of research and development work, as well as meeting and development spaces."



Infrastructure: Professor William Powrie, University of Southampton

"You might think that track is, in principle, the same as in Stephenson's time, but what we expect in the 21st century is hugely different. What is right for 90mph running is not right for 125mph, or even 250mph on HS2. Over the last 15 years

we have been developing our large-scale laboratory apparatus and instrumentation, but UKRRIN will give us the opportunity to gear up for innovation in NR's next control period, and continue to develop our understanding of infrastructure."

"We like to take a fundamental approach to solving practical problems but we've also had awards for being entrepreneurial, so being the lead for the Centre of Excellence in Infrastructure, alongside our partners in Nottingham, Sheffield, Edinburgh and Loughborough, we can build on that reputation to support industry and innovation even more."



Testing: Amanda Mackie, RIDC Programme Manager at Network Rail

"As the lead partner of the Centre of Excellence in Testing, we are delighted to be part of UKRRIN and are looking forward to working with our partners and the rail industry to turn the exciting opportunities offered by UKRRIN into reality."

"The CET incorporates access to existing at-scale test facilities. We will link with the other three CETs to provide a one stop shop for testing and trialling, and we will support the 'Four C's' of the Rail Technical Strategy – cost, capacity, carbon emissions and customer satisfaction."



Home to UKRRIN's Centre of Excellence in Digital Systems, a new 3,000m² building will open at the University of Birmingham in spring 2020 to complement its existing labs, computers, simulators and workspaces. BCRRE.

both, which is a big attraction."

At the heart of UKRRIN is its co-ordinating hub, which is administered by RSSB and the Railway Industry Association as part of those organisations' existing remit to support innovation and growth in the supply chain.

Luisa Moisisio, R&D Programme Director at RSSB says: "We were desperately keen to be a founding member of the UKRRIN adventure. We see it as the next fundamental step in innovation. The great appeal of it is to have universities fully backed by industry with an injection of cash into their facilities, and a mass of researchers ready to pick up exciting work."

David Clarke, Technical Director at the Railway Industry Association adds: "In this industry, we haven't had an open-to-all research facility since privatisation, which makes UKRRIN very special for this sector, although not very special in the context of other sectors like aerospace and automobiles."

"They've been very successful in the networks they've built, and so we're hoping for similar growth from the ambitious scale of the footprint we've put in place."

Clarke says that membership of UKRRIN will be particularly beneficial to small and medium enterprises (SMEs) and will help unlock even greater levels of innovation by giving them access to resources on a larger scale than before.

He adds: "In the past, it simply wasn't conceivable for an SME to turn up at RIDC Melton Mowbray for instance, and Network

Rail has no mechanism to deal with that. Most innovation comes from SMEs, so harnessing that is really important and this will provide a springboard for them to commit to R&D with less risk and greater confidence."

Measuring UKRRIN's success will be through a combination of key performance indicators (KPIs) that are listed in the network's terms of reference around growth in membership and numbers of live projects, but also through more qualitative measures, including the strength of its innovative research.

Both Binstead and French believe that people will ultimately choose to vote with their feet as UKRRIN hopefully encourages multinational suppliers to redirect R&D resources from other countries to the UK, or increase those already invested in these shores.

"We will have succeeded when the UK becomes known as the place to do business in rail," says Binstead. "UKRRIN will be worn as a badge of honour, either when universities are bidding for research funding or companies are tendering and putting in their bids, and people from around the world will want to work with UK universities and not consultants."

French adds: "Success will come when we get momentum in the UK as the place to go for R&D."

We are an international company focused on lots of different markets but if UKRRIN develops world-class facilities and capabilities, then it might become attractive

to other parts of Bombardier from abroad, and other companies like us." ■

■ UKRRIN is now very much open for business, and welcomes approaches to join from all interested organisations. To find out more about working with its Centres of Excellence, contact the co-ordinating hub (ukrrin@rssb.org.uk) as a first port of call. You can also follow UKRRIN on Twitter @UKRRIN or visit the new UKRRIN website at www.ukrrin.org.uk

UKRRIN at Rail Live

UKRRIN will be a key part of the Innovation area at Rail Live, which takes place at Quinton Rail Technical Centre, Long Marston on June 20-21.

Visitors will have the opportunity to meet leading staff from the Centres of Excellence, and to network with members and other individuals to learn more about UKRRIN.

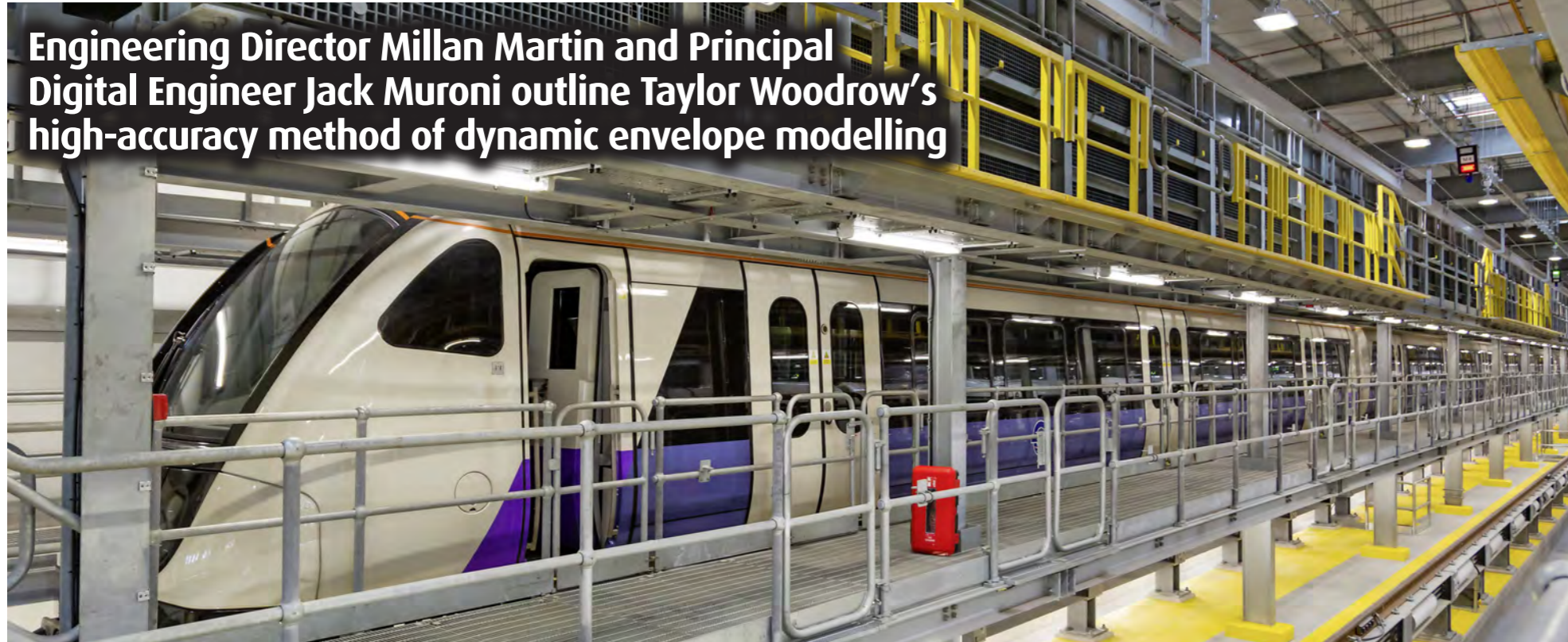
Its exhibition area is located at the heart of Rail Live's Innovation Showcase and surrounded by an exhibition focused on the Rail Capability Plan, in order to physically reflect the reality of UKRRIN's pivotal status in delivering the industry's vision.

There will be case studies of real projects to showcase successful collaborations to date, and the potential impact that more research and innovation could have on the rail industry.



New Model Railway

Engineering Director Millan Martin and Principal Digital Engineer Jack Muroi outline Taylor Woodrow's high-accuracy method of dynamic envelope modelling



When it comes to building new railway infrastructure, getting the basic measurements right is absolutely essential before it can be safely pressed into regular service.

Whether it be new track, bridges, depots or even retaining walls, making assumptions or relying too heavily on data produced at an earlier stage of the design and construction phase can invite the risk of significant gauging or structural issues occurring later.

Making such mistakes or failing to spot them is not just unnecessary, but can be expensive and time-consuming to rectify, which is why leading civil engineering firm Taylor Woodrow has overhauled traditional modelling and measurement techniques to more precisely capture and validate this crucial information.

The company's Digital Engineering team has taken a technique employed in other sectors of the construction industry and successfully pioneered the use of established 3D modelling software and applied them in the rail sector. This is of particular relevance to the complex interfaces between a train and the infrastructure through which it moves.

These newly applied methods have been clearly demonstrated at the Old Oak Common depot, where Taylor Woodrow

has designed and built a new £142 million maintenance facility for Bombardier including an Operations, Maintenance and Control building, containing nine maintenance roads, a jacking road, and 33 stabling sidings to accommodate half of the Elizabeth line's fleet of Class 345 Aventras.

The trains are currently being delivered to the site by manufacturer Bombardier. The facility will become fully operational before the line's central section beneath London opens in December.

But before any trains could be accommodated, Taylor Woodrow was required to provide firm assurance that they would not collide with any maintenance gantries.

In order to verify the measurements of the steelwork, the company asked its Digital Engineering team to devise a more accurate method than using the classic manual

techniques traditionally associated with such tasks, including building a plywood model replica, and using a tape measure and check sheets.

The new and improved solution for quality assurance was to use a Leica ScanStation P40 by Leica Geosystems scanner to build an accurate 3D model of the gantries and surrounding elements to produce a 'point cloud', the raw data from which was then processed using Leica Cyclone REGISTER 360 software to tie the data in with a local coordinate system.

A 3D model could then be created to compare the new measurements with original 3D models created at the design stage, that had been made using Bentley MicroStation 3D computer-aided design (CAD) software.

To check for potential clashes, a 3D model of a Class 345 train was also provided to

Taylor Woodrow in Catia CAD format to import into the new 3D model.

A software program called Verity, produced by Clearedge3D Ltd (a subsidiary of Topcon), was then employed to compare the existing model, based on manually captured data, with the Leica-scanned point cloud model. All the information was imported into infrastructure modelling software Bentley MicroStation to produce the drawings that would verify that the new trains wouldn't foul any infrastructure.

Taylor Woodrow Engineering Director Millan Martin explains: "We have taken software that's already available and applied it to the complex environment of rail. I have seen similar techniques used to construct

TfL Rail's new depot at Old Oak Common began operations in May ahead of the launch of London's new Elizabeth line in December. Taylor Woodrow pioneered new 3D modelling techniques to validate measurements for its maintenance gantries, so that Class 345s could be safely accommodated. TFL.

buildings and civil structures, but this was the first time they'd been used in modelling the difficult geometries of rail."

Principal Digital Engineer Jack Muroi adds: "The traditional method for gantry measurement would be to take measurements by hand every five or ten metres. It is a painstakingly slow process and it would be very difficult to measure every single beam because there is lots of steelwork in the way.

"It is very important to get this right because if someone has made a mistake and the original model is inaccurate then it causes embarrassment and can be very costly to fix. Having a model built on digitally scanned data is a far more accurate and reliable way of finding discrepancies."

Two further examples of the digital engineering team applying the same innovative solutions to validate new pieces of rail infrastructure are at Filton Bank, where a two-track section of line is currently being doubled to four in order to increase capacity between Bristol Temple Meads and Bristol Parkway, and at Whitechapel, where a new interchange station is being constructed for Elizabeth line, London Underground and London Overground services that will open in December.

At Filton Bank, the partial deviation of a new retaining wall had been detected due to unequal settlement of backfill. Having carried out remote monitoring of the wall to better understand the behaviour of the earth movement, it was determined that the wall was stable but that a new, more up-to-date 3D model would be required to design the best fit and alignment for coping stones along the top.

Taylor Woodrow again used its digital expertise to create a 3D model using a Leica ScanStation P40 by Leica Geosystems and a digital camera to produce point cloud data.

This data was then processed using Leica Cyclone REGISTER 360 software, in which the Leica ScanStation P40 scan data and photogrammetry (taking measurements

from photographs) data was merged and tied into a local co-ordinate system. It was then exported to MicroStation to create a final 3D model of the wall, while PointCab Data Module software was also used to highlight disparities between the design and as-built data sets for the wall.

Meanwhile, at Whitechapel, discrepancies had been found between the point cloud and Bentley MicroStation models used by the manufacturer of cladding for a new bridge and raised station concourse being constructed above the London Overground, Elizabeth line and London Underground platforms.

It was deemed necessary by engineers to remodel the bridge where information was found to be missing, and then use point cloud data and data gathered using traditional topographical methods to make a comparison between the design and as-built data sets.

Muroi says: "This process is quite new to rail and it takes people time to develop the right expertise. You need to understand how to use this software and the large amounts of data it generates which is a big challenge, but successfully completing these three complicated projects enables us to go to clients with confidence that we can give the right answers."

Taylor Woodrow is now planning to deploy this suite of digital solutions more widely, and is steadily building a portfolio of projects where its benefits can be clearly compared with traditional methods.

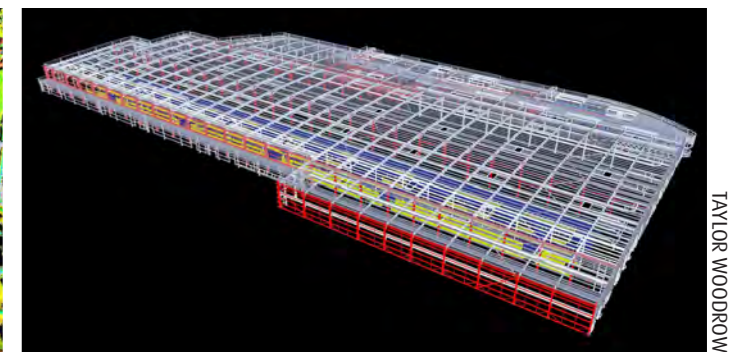
Although unfamiliar to the rail sector, Martin believes it is only a matter of time before it becomes the standard way to model and validate infrastructure after construction: "There is a cultural issue here, because I think some clients are still unsure of the software, but as soon as they see how valuable it is they will want it for their projects too."

Network Rail was very impressed that we could identify the issue of the wall at Filton Bank, for example, and so these things are now being appreciated by clients and really starting to make a difference.

"We now have three good examples, but this is a change of culture so we have to work with the client, and we are telling them to go virtual because we believe this is the best way to work." ■

“ Having a model built on digitally scanned data is a far more accurate and reliable way of finding discrepancies. ”

Jack Muroi, Principal Digital Engineer, Taylor Woodrow



TAYLOR WOODROW

Fast track to the future

Professor CLIVE ROBERTS and Dr STUART HILLMANSEN introduce UKRRIN's lead University partner, the Birmingham Centre for Railway Research and Education

The Birmingham Centre for Railway Research and Education (BCRRE) is the largest institution of its kind in Europe. With more than 145 researchers, academics and support staff plus an annual roll call in excess of 400 undergraduate and postgraduate students, its size and capabilities place it at the very heart of the international research landscape within railways.

But scale isn't everything, and it is through the strength of its multidisciplinary research and problem-solving ingenuity that it has cemented its reputation as a global thought leader.

Renowned for its expertise in power systems, energy use, future fuels and digital technologies in particular, it has continually demonstrated considerable prowess in

translating conceptual ideas into tangible improvements on the railway since its creation in the 1970s.

RAIL readers will have seen an example of this in July 2017, when a team of students from BCRRE scored highly in the annual IMechE Railway Challenge, an event held at the Stapleford Miniature Railway near Melton Mowbray, and which brings together small teams of engineering students from universities and industry to build small locomotives (RAIL 831).

The BCRRE team narrowly missed out on the top spot by entering the UK's first and only operational hydrogen fuel cell-powered locomotive.

The 10¼-inch gauge locomotive had been in development since 2012, when researchers realised that there was a need to demonstrate



new autonomous propulsion systems in railway traction as a more environmentally friendly alternative to diesel.

It has taken six years since then for industry to catch up, with Alstom confirming on May 14 that it would bring a full-sized hydrogen-powered train to the UK market by converting Class 321 electric multiple units owned by Eversholt Rail (RAIL 853).

Meanwhile, in digital systems, BCRRE has formed a strategic partnership with Network Rail in data integration as the track authority prepares to roll out its Digital Railway programme across the network from the start of the next Control Period (CP6: April 2019-March 2024).

BCRRE is also supporting NR to make investment decisions in Traffic Management Systems and is developing future models for European Train Control System (ETCS) in-cab signalling.

Dr Stuart Hillmansen, a senior lecturer in Electrical Energy Systems, says: "We identified digital systems as an area for development more than ten years ago, and have been growing our capabilities ever since. Our work with hydrogen is also something we've been doing for a long time, so it's good to see it being considered now as a possible alternative to diesel trains."

"I think this just goes to show how good we are, here in Birmingham, at anticipating the future challenges the railway will face, and in setting the agenda."

The level of innovation achieved at BCRRE has also enabled its international portfolio to expand as it continues to form research

BCRRE's TRAIN (Transient Railways Aerodynamics INvestigation) Rig is used for a wide variety of aerodynamic investigations, and consists of a 150-metre track along which model vehicles can be propelled at speeds of up to 75m/s. BCRRE.

collaborations and forge close links with manufacturers and operators from a diverse range of countries, including France, Germany, the USA and China.

It has created an international MSc programme in Railway Systems Engineering for students from across the world, and for which BCRRE has sponsored students from Ireland, Norway, Turkey, the USA, Australia, China, and Malaysia.

Students from Singapore have also been taught postgraduate modules since September 2016, when BCRRE signed a wide-ranging collaboration agreement with the city state's largest multi-modal land transport provider SMRT.

Under the agreement, BCRRE additionally provides strategic, technical and managerial education to graduates and employees at the SMRT Institute while, in May 2017, it took a step further by inviting 20 SMRT engineers to take part in four research projects being undertaken at BCRRE that focus on condition monitoring of different assets, and the effect of dynamic loads on power systems.

Hillmansen adds: "We are proud of our international links, such as those we enjoy with SMRT (Singapore), SNCF (France), Federal Railroad Authority (USA) and Central Japan Railways, and taking forward research previously developed in the laboratory."

"As a group, we've always done a lot of research with real-life applications that the industry can use as there's no point doing theoretical studies for trains on the move that has no practical use."

In February 2018, BCRRE's preeminence in rail research was further secured when it officially became the lead university partner of the UK Rail Research and Innovation Network (UKRRIN), which brings together

UK universities with the wider rail industry (see pages 2-5 of this supplement).

The newly established network will enable industry to access purpose-built facilities and research skills at four Centres of Excellence created within the universities that cover rolling stock, infrastructure, digital systems and testing. There is also a coordination hub run by RSSB and the Railway Industry Association (RIA).

In return, the universities are given access to industry experts, and students are provided with more opportunities to work on real world projects while helping bring ideas from conceptualisation to commercialisation much faster than before.

Although it's just one of eight universities that form the four Centres of Excellence within UKRRIN, it was BCRRE that led the original bid for £28.1 million funding for the network from the UK Research Partnership Investment Fund.

That funding has since been boosted by £64m from UKRRIN's 16 industry supply chain partners, including Siemens and Bombardier, and non-financial support from Network Rail, Transport for London and HS2 Ltd.

BCRRE hosts the Centre of Excellence in Digital Systems and £16.4m is subsequently being invested in a new 3,000 sq m building

A team of researchers from BCRRE entered the IMechE Railway Challenge in June 2017 with the UK's only hydrogen-powered locomotive. Visitors to Rail Live will be able to see it in action at Quinton Rail Technology Centre at Long Marston on June 20-21. BCRRE.

on the University of Birmingham campus, where solutions will be developed in areas such as cybersecurity, data integration and smart monitoring, future train control and introducing innovations onto the railway.

Construction began on March 1 on the Centre of Excellence Digital Systems, which will feature new facilities to enable the entire UK rail network to be simulated, and where hardware-in-the-loop (HIL) testing can take place for signalling, control and traction systems, and communications technologies.

Professor Clive Roberts, Centre Lead at BCRRE, is in no doubt that UKRRIN will help accelerate the passage of new products from the drawing board to market, and help make the UK a global leader in rail innovation.

He says: "We took the initiative to help bring together this university partnership with industry by making the bid for funding because historically it's always taken quite a lot of time to get new ideas on to the railway."

"There are lots of Digital Railway technologies that we already have the knowledge to build and put to good use, but we just need to get them out there. It's an area which we've worked on for more than 30 years and we could become world leaders in railway technology, but we must grow our capability."

Dr Hillmansen adds: "The really great thing about UKRRIN is that it will provide a pathway for the implementation of good ideas by applying them to industry. The industry has traditionally been quite conservative in this respect, and the hydrogen train is a prime example of something that has taken a long time."

"UKRRIN can help make that happen much faster. If we were taking hydrogen from year zero again, I don't think it would have taken ten years to get a viable product to market. This way we bring the right testing framework and the right people together to accelerate the introduction of new technologies under the UKRRIN umbrella."

■ If you want to find out more, BCRRE will be exhibiting at both Rail Live (Quinton Rail Technology Centre, June 20-21) and at InnoTrans (Berlin, September 18-21).

“ There are lots of Digital Railway technologies that we already have the knowledge to build and put to good use, but we just need to get them out there. ”

Professor Clive Roberts, Centre Lead, BCRRE



“ If we were taking hydrogen from year zero again, I don't think it would have taken ten years to get a viable product to market. ”

Dr Stuart Hillmansen, Senior Lecturer in Electrical Energy Systems, University of Birmingham



Funding the future

When the Rail Technical Strategy (RTS) was first published in December 2012, it was accompanied by a bold call to action.

By outlining a vision for the future railway over the next 30 years, it tasked industry and the supply chain with finding the innovative technical solutions needed to address the core challenges that they collectively face.

These challenges are to increase capacity and improve the customer experience, while at the same time reducing both costs and carbon emissions so that the railway's continued business base can be secured for its current and future customers.

To deliver the aims of the RTS, a Capability Delivery Plan (CDP) was subsequently drawn up to focus industry-wide efforts, expertise and investment, and to provide a framework for research and development

RSSB's NEIL WEBSTER tells PAUL STEPHEN why the RSSB's Innovation Programme isn't just blue sky thinking

activities to closely align with

In order to do this, the CDP identifies 12 key capabilities that are needed to achieve the RTS vision, for example creating more space on trains, obtaining more value from data, running trains closer together and lowering the cost of railway solutions.

Leading the CDP's delivery is the Technical Strategy Leadership Group (TSLG) which is facilitated by RSSB, and comprises the Rail Delivery Group, Network Rail, government and the rail supply chain.

The CDP is also supported by a suite of resources, tools and funding opportunities aimed at encouraging stakeholders to engage with the strategy, and help stimulate

the development and deployment of new technologies.

A significant amount of this support is provided by the RSSB's Innovation Programme, which is delivered by RSSB in collaboration with Network Rail and the Department for Transport.

Overseen by RSSB Innovation Programme Director Neil Webster and a team of ten members of staff along with more than 300 technical experts from the rail sector and non-rail industries, the programme allocates funding to innovative technology proposals made by industry entering a range of competitions.

The focus of each competition varies widely from vehicle-based innovation and technical improvement through to remote condition-monitoring and heritage and community rail.

Webster's directorate currently supports 240 live projects as a result of these competitions. Each of them represents a high-risk project for a commercial organisation to bear the full cost of development on its own, but which has been offset by RSSB because of the significant potential benefit they have been

judged to offer UK rail.

Webster explains: "The Innovation Programme covers everything from rolling stock through to infrastructure, and the projects we are involved in are proof that the rail industry is facing right now.

"This isn't just high-level theoretical work and blue sky thinking, but ultimately demonstrates how we can practically work with industry to reduce costs, increase profitability and improve service to rail customers."

Webster reveals that one such live project has the potential to save the industry up to £1.8 billion across the next 40 years, earning it financial support from RSSB under its Railway Operator Challenge in 2014.

Vortex Exhaust Technology systems had already proved successful in saving fuel and lowering diesel emissions in road vehicles and marine vessels by improving the efficiency of their engines and was deemed a prime candidate for the rail sector.

RSSB's innovation team, therefore, partnered with the company and Northern Rail (now Arriva Northern) to test the product on a Class 156 diesel multiple unit over a six-month period. The results were a 10%-20% fuel saving, which equates to a network-wide saving of £1.8bn over the 40-year average lifetime of a train when based on the entire UK DMU fleet's current fuel consumption of approximately 736 million litres per year.

The most recent funding competitions

RTS: HOW YOU CAN GET INVOLVED

RSSB's Head of Strategy for the RTS Trevor Bradbury is inviting more suppliers to contribute to the development and delivery of the RTS.

This is because delivering on the 30-year strategy and the Capability Delivery Plan requires the co-ordinated effort of all parts of the rail industry and supply chain in order to succeed.

Bradbury and his delivery team continue to regularly meet with stakeholders and attend industry events but are requesting even further input in order to ensure that as many people as possible understand the RTS vision and have an opportunity to help shape it.

Further input is also needed to help meet emerging challenges such as cybersecurity and Digital Railway.

He says: "I am passionate about making this succeed and suppliers will be fundamental to that, which is why we're taking it to a whole new level in the next Control Period.

"We'll be doing things in a much bigger way and it will look markedly different while building on the foundations laid in CP5.

"The doors are open so please come and talk to us if you want to see a step change in UK rail capabilities. We've had some successes since 2012 and some things could have gone better, but we've learned a lot from CP5 in order to deliver better in CP6."

Bradbury says that his team are currently gearing up to commence a new CP6 programme with a focus on getting new products through to market by looking at new commercial models, giving equal focus to industry readiness alongside technological readiness, and running more pathfinder projects that deliver whole system technology demonstrators.

If you want to speak to the delivery team or set up a meeting, email railtechnicalstrategy@rssb.co.uk

“The projects we are involved in are proof that we're providing solutions to problems that the rail industry is facing right now.”

Neil Webster, Innovation Programme Director, RSSB



run by RSSB include its Rail Accessibility Competition which closed for entries on November 30 2017 and its TOC'17 competition for train operators that closed in May.

As this issue of RAIL went to press the entries for both competitions had been judged by independent review panels, although no winners had yet been announced.

Now in its fifth year of running, Webster tells RAIL that TOC'17 attracted 19 submissions since opening for entries on November 15 2017.

Successful projects from previous years include Arriva's MyJrny App that provides passengers with real-time journey information, Arriva's Orinoco information app that enables passengers and staff to locate empty seats on an approaching train, and FirstGroup's Mantra high-speed mobile technology system that is designed to improve connectivity between trains and the outside world by using extremely high frequency ('mmWave') wireless data connections between trackside equipment and the train.

Webster says that particular efforts are made to encourage small technology providers and non-rail suppliers to participate, by helping them secure the necessary contacts to partner with TOCs in order to develop their ideas for rail and to become eligible for RSSB funding.

He says: "Last year [for TOC'16] we tried

RSSB is preparing to play a more supportive role to train operators and suppliers in rail innovation. ALAMY.

using technology brokers to help smaller companies link up with TOCs, but this year we ran a series of workshops instead and have been able to give advice directly where there has been an opportunity. This will help rail to benefit from the migration of proven technologies from other industries and to adapt them for the rail sector."

The overall aim of RSSB's Innovation Programme is to render itself redundant, says Webster, as TOCs and other stakeholders grow the confidence to self-fund future projects, having achieved successful outcomes through the competition framework.

RSSB is also evolving, he adds, with plans to offer consultancy services on a fully commercial basis in support of innovative projects, once the industry is in a position to allow financial support to be withdrawn.

"Instead of taking the lead we will support these organisations as our clients and begin changing our role towards becoming a supplier," he adds. "It's about changing the dynamic of RSSB to become more commercial and support individual organisations - not just under the DfT's instructions, which will continue to be one of RSSB's clients.

"The portals within the market have now been opened so it's about giving them the further confidence to spend money and to continue developing these innovative concepts as commercial organisations. We have shown that if the industry buys into it then bringing these products to market will ultimately meet its needs, which are to reduce costs, increase profitability and improve customer service." ■

Innovation goes hand in hand with safety

Sometimes I hear the challenge that health and safety, and the people and organisations responsible for ensuring standards of health and safety, gets in the way of innovation. It should not, it must not, and (I'm quite sure) it does not.

In fact, to meet their legal obligations, duty holders are required to continuously improve health and safety risk, where it is reasonable and practicable to do so.

This means that as technological developments emerge and the costs of implementing improvements reduce, the balance of reasonable practicability changes.

It is not a constant, it is a moving environment, and therefore innovating, using and implementing new technology is critical in improving health and safety.

HM Chief Inspector of Railways **IAN PROSSER** discusses how the Office of Rail and Road is seeking to use innovative technology to improve health and safety in all aspects of the railway

This has been the case not only throughout the history of railways, but also in other safety-critical industrial businesses such as aerospace and the process industries.

And innovation is not only found in hardware, it is also in the processes, techniques and training that help people (the critical element in so many safety management systems) perform their tasks better and more reliably, creating high-reliability organisations.

The Regulator's role in this process is to actively encourage the industry to innovate - not only in terms of engineering, but also in processes and systems, and (crucially) in people management and 'how' to do health and safety management itself. This particularly includes occupational health and safety management, which has needed a big push in the past ten years.

LEVEL CROSSINGS

It is well-known that one of the highest risk areas on the railway is level crossings. There are still approximately 6,500 crossings in operation on the network, despite more than 1,000 being closed in the past nine years.

The issue is that many hundreds of crossings are not protected at all - other than

by the driver sounding his whistle to warn users due to siting issues, or (for example) user-worked crossings with telephones that exist in long signal sections, thus making it difficult for the signaller to know exactly where the train is.

We have encouraged and supported Network Rail to implement new technology on both types of crossings, and we insisted on ring-fenced funding in Control Period 5 to trial the technology.

In the case of EBIGate technology, installed to protect the user-worked crossings in long sections, NR had installed some of the equipment at a number of crossings but then decided to switch it off because of concerns about its SIL (safety integrity level) rating, despite there being a large overall reduction in risk. That is why it is so important to look at the risk you are addressing, and not get hung up on some aspects of reliability ratings.

Another example is the whole area of inspection of the assets. We actively encouraged the use of more automated inspection technology, which offers real benefits in terms of both asset safety and worker safety. It is a clear improvement on relying solely on the eyes of an Inspector

who is sometimes trying to work in circumstances and working conditions that can be very difficult (for example, when it is dark, cold or rain is pouring down).

Inspection on trains, including service trains, is more frequent and reliable. Therefore, we have encouraged developments in this area. For example, we actively supported the development of the Plain Line Pattern recognition train, which assists track inspection.

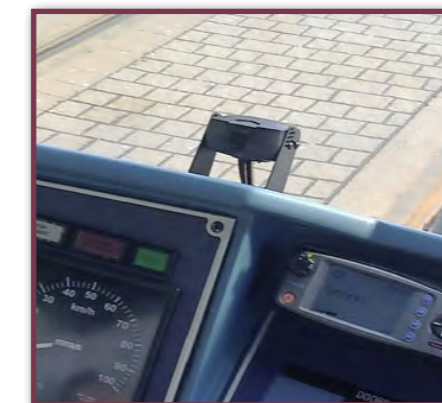
From the Regulator's point of view, the only issue with the introduction of the Plain Line Pattern recognition train was that it took too long!

Innovating in the area of asset management and information, and deploying the latest technology, is critical in terms of improving not just safety,

but also efficiency (value for money) and performance. We feel that the rail industry has been slow in making this happen - but it is happening, and the reduction in overall system risk is partly attributable to its deployment.

Another example of the regulator working with industry to facilitate innovation has been in the tram sector, where we are working together to implement one of the Rail Accident Investigation Branch recommendations from the Sandilands crash in November 2016.

This centred on using technology to add a control that has the potential to help a driver perform their role more effectively. As a result, Croydon Tramlink has implemented a driver vigilance device called Guardian. This is a small device located on the dashboard



ORR is working with tram operators to implement a number of RAIB recommendations following the crash at Sandilands on November 9 2016. This includes the Guardian Driver Vigilance Device on Croydon trams. ORR.

“ Innovating in the area of asset management and information, and deploying the latest technology, is critical in terms of improving not just safety, but also efficiency (value for money) and performance. ”

of the tram (see picture) that provides a warning when certain eye and head movement occurs in a way that suggests distraction or fatigue.

Alongside the sector, we are developing a set of principles to support appropriate implementation of driver aids of this sort, where businesses believe it will help to improve overall safety.

RM3

The other area in which we actively encourage innovation is in how we actually go about ensuring the day-to-day health and safety regulation of the railway.

Our creation of RM3 (Risk Management Model) was about creating a better understanding of the duty holders we are regulating. The sector itself is making use of it to improve their health and safety performance, and that shows the value of innovation from the regulator.

However, we continue to move forward as a regulator, and are actively looking at how we can use artificial intelligence to analyse big data - including in investigation and inspection reports as well as an RM3 analysis to help fully understand the risk landscape, which will help us prioritise our interventions more effectively.

Innovation and deploying new technology is fundamental to taking us forward to achieving improved health and safety, value for money and performance of our railways. ■

CrossCountry 221119 passes Oddingley signal box and crossing on October 16 2016, with the 0915 Bristol Temple Meads-Edinburgh. The Office of Rail and Road has encouraged Network Rail to implement new technologies to improve safety at many of its 6,500 crossings. JOHN STRETTON.





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