

UNIVERSITY OF  
BIRMINGHAM

BCRRE



**BIRMINGHAM CENTRE FOR RAILWAY  
RESEARCH AND EDUCATION**



**BCRRE 2018/19**

**Annual Report**



**BIRMINGHAM CENTRE FOR RAILWAY  
RESEARCH AND EDUCATION**



UNIVERSITY OF  
BIRMINGHAM

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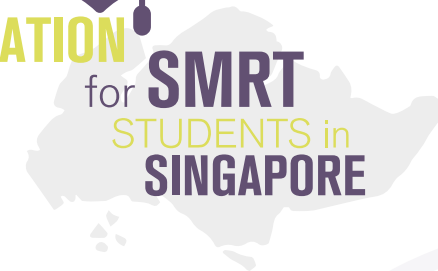
# OUR YEAR IN NUMBERS

the **UK's** FIRST  
**HYDROGEN**  
TRAIN  
with



**500+** passengers  
at Rail Live  
**2019**

**1<sup>st</sup>** GRADUATION  
for **SMRT**  
STUDENTS in  
**SINGAPORE**



**92** registered  
PhD STUDENTS



**2<sup>x</sup>**  
INDUSTRY  
awards  
**WON**



**1<sup>st</sup>** UK INSTITUTION  
to offer degree  
apprenticeships  
to level **6 & 7**

**53**  
live  
research  
PROJECTS



**1** SPIN-OUT  
company  
established



**600+**

 railalliance  
members

**2** inaugural lectures



**61**  
EVENTS

LAUNCH of

BCRRE  
BLOG

&

Linked in  
PAGE

**19** projects  
LAUNCHED



**51** PRESS  
RELEASES

**100+**  
research  
papers  
published

BCRRE in  
the  
NEWS ...

...featured on  
THE TIMES  
BBC Breakfast  
BBC Midlands Today



our TWITTER following has  
**DOUBLED**  
within twelve months

# ABOUT BCRRE

We are enabling the rail industry to prosper – from training future generations of railway engineers. Developing world-leading technologies, we collaborate with industry and academia to drive rail innovation globally.

The Birmingham Centre for Railway Research and Education (BCRRE), part of the School of Engineering at the University of Birmingham, is the largest university-based centre for railway research, education and innovation in Europe. With more than 160 researchers and staff developing world-leading new technologies and products for trains, railway systems and infrastructure alongside renowned global higher education programmes. Our focal points of world-class education, research and innovation in all aspects of rail technology will deliver more reliable and efficient railway systems across the UK and throughout the world.

We continue our role in the UK Rail Research and Innovation Network (UKRRIN) as lead academic partner and home to the Centre of Excellence in Digital Systems. UKRRIN is a unique partnership between industry and

academia where, by working together, we can deliver a step-change in rail transport through development and application of new technologies.

In 2018, we incorporated the Rail Alliance into BCRRE. Rail Alliance is a key part of BCRRE and provides B2B networking and enterprise support to the rail industry. We have a community of over 550 organisations spanning the entire supply chain as well as a growing number of international members.

The Rail Alliance is also a founding member of the European Rail Clusters Initiative which was established to enable collaboration between rail cluster networks and provide greater support and networking between their member organisations.

[www.railalliance.co.uk](http://www.railalliance.co.uk)  
[www.ukrrin.org.uk](http://www.ukrrin.org.uk)  
<https://eurailclusters.com/>

# NEW ROLE FOR BCRRE – INDUSTRIAL FELLOWS

Over the last two years we have recruited four Industrial Fellows who will act as a key interface between BCRRE and its industrial partners.

Here is what they will be doing:

- Creating the link between Academia and Industry
- Working with industrial partners to identify opportunities for programmes and projects to bid for
- Developing, proposing, planning, carrying out and project-managing research and innovation, knowledge and technology transfer projects
- Supporting research staff to deliver first class research and innovation
- Enabling dissemination of the research and innovation outputs in high quality publications and conference proceedings.

The Industrial Fellows are Rachel Fisher, Richard Thomas, Marcelo Blumenfeld, and Steve Mills.

Rachel is an expert in: multi-hazard transport system modelling; the effects of extreme weather on the resilience of the national rail

network (GB); and economic strategy decision making regarding climate change mitigation and adaptation strategies.

Richard is a leading expert in cybersecurity in railway. This expertise includes cybersecurity of the UK and EU Rail Networks, ERTMS standardisation, security assessments, NIS Directive Supply Chain research, and cybersecurity education.

Marcelo is a transport systems specialist. His expertise includes sustainable travel new technologies, sustainable neighbourhood planning, and introducing innovation and new technology for future railway systems.

Steve is an expert in passenger train design and supply, safety approval and certification, innovation, research and development and Notified Body, Designated Body, and RISAS certification.

**They are part of the BCRRE's Centre of Excellence in Digital Systems and will be focusing on its delivery as part of BCRRE's UKRRIN activities in 2020. The team will also continue working on European funded Horizon2020 and Shift2Rail projects.**



RACHEL FISHER



MARCELO BLUMENFELD



RICHARD THOMAS



STEVE MILLS



## University of Birmingham

September kicked off the academic year with a new students joining undergraduate, Masters and PhD programmes, including the first cohort taking the new Railway Safety and Control Systems MSc programme and the delivery of our first dedicated programme of study focussing on railway communications and signalling systems.

A team of a dozen academic and commercial staff attended Innotrans in Berlin where we presented the results from some of our significant projects, held a prestigious dinner at the British Embassy and signed a Memorandum of Understanding with Porterbrook, launching the ambitious HydroFLEX project to develop and test the UK's first full-size Hydrogen train.



Signing MoU with Porterbrook at Innotrans

## SEPTEMBER 2018



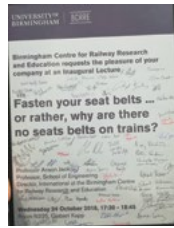
Rail Vehicle Expo, Derby

October's Rail Vehicle Expo, in Derby, had the team demonstrating the Hydrogen Hero locomotive (together with rides for visitors) and promoting our new collaboration with Porterbrook.

Professor Anson Jack delivered his inaugural lecture on seat belts and safety on trains to a packed lecture room. We also attended the Global Light Rail Awards event, where Dr Ning Zhao and Dr Zhongbei Tian celebrated with Edinburgh Trams who were Highly Commended in the Best Environmental and Sustainability Initiative for their implementation of Ricardo Rail's Smart Drive product, itself developed together with BCRRE.

SEPT  
2018

## OCTOBER 2018



Anson Jack's inaugural lecture



Global Light Rail awards

OCT  
2018

# TIMELINE OF PROGRESS AND ACHIEVEMENT

# 2018/19



Rail Alliance launch event, Birmingham

## MARCH 2019

Two big events this month: first off we launched the new-look Rail Alliance to a full house at Millennium Point in Birmingham. Later the same month we launched the ERDF-funded DIGI-RAIL project and introduced the rail supply chain to the funded consultancy and project opportunities available to eligible SMEs.

Two talks finished off the year's Prestige Lecture series: Tom Butcher, Head of Scientific Consultancy at the Met Office, spoke on Weather and climate services: enabling a resilient and efficient digital railway; and Malcolm Holmes, Executive Director of West Midlands Rail Executive and Director of Rail for Transport for West Midlands, talked on A Rail Revolution for the West Midlands.

We contributed to the RIA Innovation Conference in Telford and helped out at the Big Bang Fair, showing off Hydrogen Hero on the Network Rail stand and giving rides to visitors on the UK's first Hydrogen-powered locomotive. Our latest Memorandum of Agreement was signed with the Connecting Places Catapult, to develop a deep academic alliance.



DIGI-RAIL launch event, Birmingham

MAR  
2019

## APRIL 2019



Degree Apprenticeships launch event

APR  
2019

Prof Felix Schmid gave a series of Masterclasses in Rail, in Australia and, back at home, the rest of the Education team launched our programmes of Level 6 and 7 degree apprenticeships.

We hosted our UKRRIN lecture at Birmingham on Digitising the Railway, presented by Stuart Calvert of Network Rail and our own Clive Roberts. Our Rail Alliance colleagues completed a successful networking mission to the USA as part of the PERES project.

Kevin Blacktop was elected Chair of Worcester branch of the IMechE.





First cohort of PG Cert graduating students at SMRT



Rail Alliance Memorandum of Understanding signed



Prof Bridget Eickhoff's inaugural lecture

DEC  
2018

NOVEMBER 2018

NOV  
2018

DECEMBER 2018

November saw the first big celebration of the year, with the very first cohort of successful completers of our unique PG Certificate in Urban Railway Engineering (Singapore) which we deliver to engineers from Singapore Mass Rapid Transit.

We also hosted the first (RI)TRAK workshop in Birmingham: (RI)TRAK is a new infrastructure asset management tool, developed by Dr Michael Burrow and his group.

The UKRRIN annual conference was held in London. We celebrated the first full year of UKRRIN by hearing about projects across each of the Centres of Excellence and helping new ideas to be generated between Industry and Academia.

An exciting month for BCRRE when we signed a formal Memorandum of Understanding with the Rail Alliance. From January 2019, the activities of the Rail Alliance would be absorbed into BCRRE, enabling the UK's foremost rail industry trade association to strengthen and enrich its services into the supply chain.

Our second inaugural lecture of the year took place: Professor Bridget Eickhoff presented her work on Mind the Gap (how to improve boarding and alighting from trains) to another packed room. Elsewhere in the world, Clive Roberts delivered a talk in Hong Kong about global railway technology developments and a group of our academics and PhD students contributed to the IEE International Railway Conference on Intelligent Rail Transportation in Singapore.

JAN  
2019

JANUARY 2019

The calendar year's first Railway Prestige lecture was given by Rebecca Riley, Director of the University's CityREDI research and policy group, where she discussed industrial strategies in uncertain times. We hosted and contributed to the Railway Industry Association's Unlocking Innovation Scheme – Data in Rail event to another packed room and the month also saw us promote the Greater Birmingham & Solihull LEP area Rail Mentor and Get Into Rail Schemes which we deliver via the Rail Alliance.

FEBRUARY 2019

FEB  
2019

Robert Hopkin and Dr Marcelo Blumenfeld promoted BCRRE at the Middle East Rail expo in Dubai and discussed research and education with key representatives from the region. Back at home, Mark Thurston, Chief Executive of HS2, presented the second Railway Prestige lecture on Creating a Positive Legacy for the UK Rail Sector.

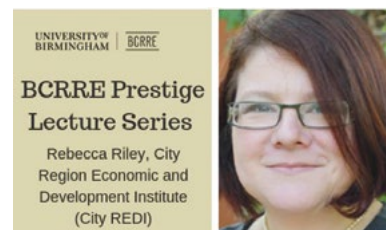
We also signed a Memorandum of Understanding with Indian organisation, Intellex, to develop railway asset management projects and joined a meeting with the University's India Institute and Deputy High Commissioner in Hyderabad, Andrew Fleming, to discuss opportunities.



Middle East Rail, Dubai



Kevin Blacktop becomes Chair of Worcester branch of the IMechE



Rebecca Riley



TIMELINE CONT. ON NEXT PAGE

**MAY 2019**

We took part in the Railtex exhibition, showing off BCRRE, UKRRIN and Rail Alliance to a wide audience. We took the opportunity to hold a series of networking events for the Rail Alliance community during the conference period.



Railtex exhibition, Birmingham

Alex Burrows and Dr Jenny Illingsworth visited Belgrade to sign Letters of Intent with the Rail Cluster for South East Europe and with Belgrade University's Faculty of Transport and Traffic Engineering. The Rail Alliance's international activities extended to hosting a meeting of the ERCI in Birmingham where we discussed future opportunities with the Cluster.



Signing Letter of Intent with the Rail Cluster for South East Europe

**JUNE 2019**



Rail Live, Long Marston

MAY 2019

CONT.

**BCRRE**

JUNE 2019

**AUGUST 2019**

The usual holiday month didn't stop us welcoming a group of 16 and 17 year-olds to take part in the Railway Engineering Smallpiece Trust course run by the Education group. And work continued apace on HydroFLEX developments towards next year's mainline testing.



Railway Engineering Smallpiece Trust

AUG 2019



HydroFLEX Celebration

**SEPTEMBER 2019**

We made sure we didn't suffer from post-summer blues by celebrating our HydrFLEX success with the team from the University and Porterbrook. Not content with just one train to be converted, Porterbrook also provided a high speed train for the BCRRE team to work on too.

The big event for September was our Rail Alliance Destination Decarbonisation event at Long Marsden, with HydroFLEX demonstrated and seminar topics covering aspects of decarbonising the railway. The event coincided with the first visit to Birmingham by our colleagues from Serbia. Later the same month, Alex Burrows and Eli Rees-King presented BCRRE and Rail Alliance at the popular Trako show in Poland and kicked off a number of new collaborations in the region.

Closer to home, we took part in the launch of the West Midlands Grand Rail Collaboration and were named in the Mills & Reeve Midlands Innovation 50 list of most forward-thinking businesses in the region.

SEPT 2019



BCRRE leases HST from PB



BCRRE named in Midlands Innovation 50



Trako fair, Poland

JUNE 2019



HydroFLEX launch, Long Marston

The big event of this month – and the year – was the successful launch of HydroFLEX, the UK's first full-scale Hydrogen train, at Long Marston. Not only did we show off the train – completed in just 9 months – but we also gave rides to visitors and presented both the full size train and the Hydrogen Hero locomotive within our wider presence of BCRRE, UKRRIN and the Digi-Rail project. We also celebrated being awarded First of a Kind funding from Innovate UK, for HydroFLEX Mainline Testing during the 2019-20 academic year.

Elsewhere, Clive Roberts chaired the Africa Rail conference in Johannesburg and University colleagues attended the UK-China Knowledge Exploration Forum in Guangzhou. Back at home we hosted the 3rd Joint Digital Railway conference, together with Digital Railway and RIA and we celebrated with Abtus who won the Rail Industry Innovation Award for the best small scale project.

Our new Industrial Advisory Board held its first meeting and the renovated and improved TRAIN rig in Derby reopened. Our own student society, RailSoc, won the 2019 EPS Societies' Awards Industrial Award.



First of a Kind funding awarded for HydroFLEX Mainline Testing



Abtus win Rail Industry Innovation Awards



# TIMELINE OF PROGRESS AND ACHIEVEMENT 2018/19



New Industrial Advisory Board launched

JUNE 2019



RailSoc EPS Societies' Awards 2019 win (Industrial Award)

JULY 2019

After a busy June, July was a little quieter: we presented Rail Alliance and Digi-Rail at the Trans City Rail event in Birmingham and signed a new Memorandum of Understanding with NTRI, India.

Our MSc European Study Tour group returned from Eastern Europe, where they had visited sites in Amsterdam, Cologne, Austria and Poland.



JULY 2019



NTRI Memorandum of Understanding signed



# RESEARCH

As lead partners of UKRRIN our Centre of Excellence in Digital Systems is developing; Sept 18 we broke ground and the topping-out will have taken place in December, ready for the building to open in summer 2020. We welcomed new UKRRIN industrial partners this year, including Porterbrook, Worldline and Furrer + Frey, with more to come. On the back of UKRRIN membership we also signed a new 5-year agreement with Network Rail to cover research, development and innovation during CP6.

## BCRRE RESEARCH HIGHLIGHTS IN 2018-19

- Innotrans 2018 – agreement to develop HydroFLEX with Porterbrook, discussions on new projects and disseminating outputs from current ones
- We published over 100 academic papers in many international journals
- We attended conferences and research seminars around the world
- Started off 19 new research projects during the year
- Started developing the UK’s first digital twin of part of the railway network
- Welcomed new UKRRIN partners
- Signed agreement for research, development and innovation throughout CP6 with Network Rail

Key projects of note this year have to include HydroFLEX, the UK’s first full-scale Hydrogen-powered train, and the successful completion of S-CODE, an EU-funded project under the Shift2Rail theme which included partners from industry and academic from across Europe. Commercialisation of research outputs is something of a holy grail for many researchers and this year’s ICURe (Innovation to Commercialisation) programme, funded by Innovate UK, has been a draw for three of our research colleagues. The first of these is the newly-formed spinout company, MoniRail, headed by myself together with Dr Mani Entezami and external consultant, Peter Ainsworth. MoniRail is commercialising an in-service train data analytics platform coupled with an Inertial Measuring Unit which enables continuous monitoring of track and train: an NMT-in-a-box which provides actionable condition monitoring information which predicts failures and allows for preventative maintenance on a more accurate, more timely basis than the NMT allows.

Other research highlights include creating railway system digital twins; developing new railway asset management systems; upgrading our aerodynamic facilities; looking at issues which can affect ride

quality; rail technical strategies for low-income countries; effects of climate change, weather and earthquakes on railway systems, infrastructure and structures; data models and blockchain opportunities; on-vehicle track switches; and traction energy models, to name just a few of this year’s research themes.



**Professor Clive Roberts,**  
Head of BCRRE

# RESEARCH

## HydroFLEX and Hydrogen infrastructure

In June 2019, we unveiled HydroFLEX – the UK’s first hydrogen powered train – at Rail Live 2019.

The partnership between University of Birmingham and rolling stock company Porterbrook has been successful in developing a hydrogen train from an existing electric train in just nine months! For the rail industry, this radical project has been ground breaking, not just in what it has delivered but how it has delivered it with astonishing pace and agility.

HydroFLEX was launched at Rail Live, a major rail trade event held at the Quinton Rail Technology Centre, and is now being further developed for operational testing on the UK mainline railway at the end of 2019, having received Innovate UK First of a Kind funding. At Rail Live over 500 rail professionals, media, stakeholders and Government officials had the opportunity to ride the train and speak to the engineering team. HydroFLEX has generated significant press coverage and social media coverage both in the UK and internationally since its launch – which was broadcast live on BBC Breakfast News!

With considerable emphasis from politicians and the media on both climate change and air quality, the UK rail industry has been

tasked with decarbonising the railway and removing all diesel-only trains by 2040. As a result, the railway needs to rapidly reduce the large number of diesel trains in operation and hydrogen/battery technology (as used by HydroFLEX) will be key to this. BCRRE is leading the way in undertaking R&D and practical innovation to support the decarbonisation of the railway.

Meanwhile Stephen Kent, Research Fellow, has been looking at the infrastructure needs for a Hydrogen powered railway as part of RSSB’s decarbonisation theme.

RESEARCH

## Digital Twin

Dr Lei Chen, specialist in railway operations simulation, and his team of researchers have been developing a Digital Twin of the West Midlands railway network.

According to Research Fellow Dr Gemma Nicholson, a digital twin is a dynamic digital profile of an object, system or process. It makes use of design data to generate a simulated system so we can, first of all, understand what makes up the system. From there, we can add in real time data gathered in the physical world or use the simulated system to test questions and decisions: “what might the railway do if X changes?” or “how can we find best value from a railway?”

The Birmingham team is undertaking a year-long project to develop a digital twin model for the West Midlands railway network to support operational analysis, planning and optimisation of the network. To do this, the group modelled the geographical area, track layouts, rolling stock and signalling systems;

existing passenger and freight timetables; and existing dispatching rules. From there they added a capability to run timetable simulations and have looked at the effects of disruptions, traffic management, network improvements and different timetable options across the network.

All of this has been with the ambition to support short and long-term network operational analysis, planning and optimisation – of services, costs, energy and new services such as reopened lines through the city.



## UKRRIN Data Platform

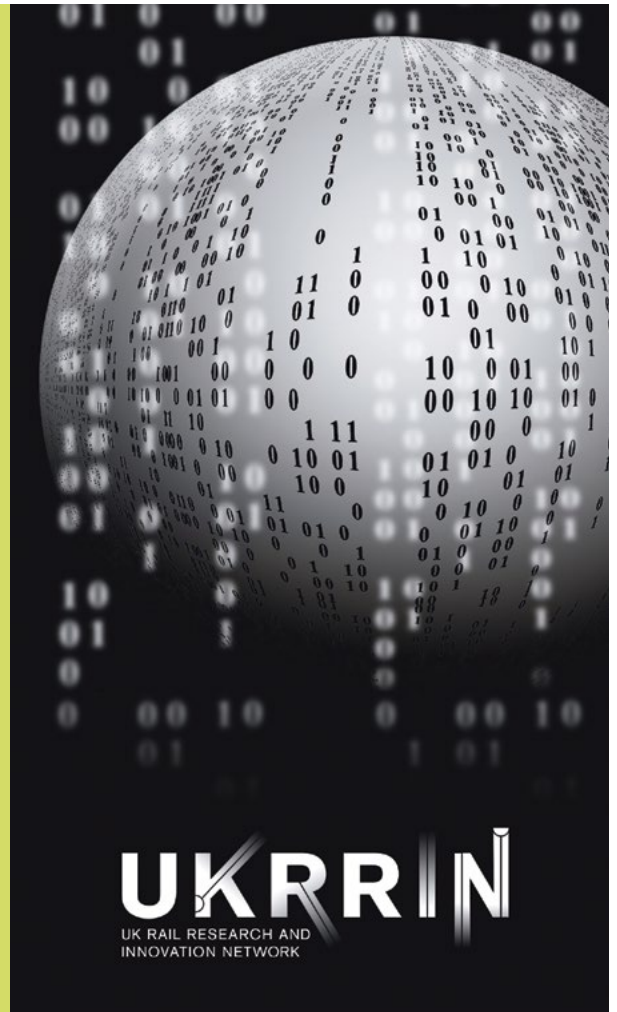
As part of the support offered by CEDS to the wider UKRRIN network, a research data platform is being setup providing both live and archived access to public data from across the industry, alongside data contributions in-kind from the UKRRIN industrial partners.

A first of its kind for research usage within the GB rail industry, the UKRRIN data platform will be an invaluable tool for answering cross-interface questions about the performance of the railway, enabling data sets not normally available in combination to be queried as a single resource, and driving forward research in areas including the development of digital twins for GB rail, multimodal journey management and effective communication to the customer,

cross-interface Remote Condition Monitoring, and the application of AI and Big Data Analytics to industry data.

Through UKRRIN involvement with the recently established Rail Data Council, the UKRRIN data platform is also providing an avenue for the industry to trial aspects of the technical and governance frameworks that will be needed for the cross-industry data sharing platform announced in the Rail Sector Deal.

Although there are obvious differences in scale and availability requirements between a platform for research usage and one intended to provide an industry-grade service offering, the UKRRIN platform will provide a neutral space in which potential use cases can be trialled (leading to an improved understanding of the value offered by any industry-wide platform), where theoretically-sound governance arrangements can be put through their paces "in the wild", and where gaps in industry data provision can be identified, enabling business cases for the collection of that data to be identified at an early stage.



## Cybersecurity

In January 2019, we embarked on a two year project with the Birmingham Centre for Cyber Security and Privacy, in partnership with the UK National Cyber Security Centre (NCSC) and the Research Institute in Trustworthy Inter-Connected Systems (RITICS).

This project is a continuation of a strong relationship between the two research centres at the University, with the aim of aiding the industrial supply chain and operators to assure components to meet the European Union Network and Information Systems (NIS) Directive.

From the perspective of the supply chain, the project is identifying trends in vulnerabilities, identifying appropriate controls, and producing guidance for the supply chain on these issues.

For operators, we are identifying techniques to aid system owners to enhance their attestation and assurance processes. Finally, specific guidance will be developed for in-depth testing of these devices, where manual processes must be employed, on how best to conduct these analyses.

The research undertaken in this project will be validated with the rail supply chain and operators to ensure that the right guidance is available when it is required and to maximise effectiveness. The ongoing work of this project has been highlighted at a number of our events, including Raitex, RAIL Live, RITICS Showcases and Rail Alliance briefings.



# RESEARCH

## Aerodynamics

The University of Birmingham's Transient Aerodynamic Investigation (TRAIN) facility reopened this summer following a £1.5m renovation and upgrade as part of the UK Collaboratorium for Research into Infrastructure and Cities (UKCRIC). The vision of the UKCRIC is to create, operate and coordinate multi-disciplinary research programmes to make UK national and local infrastructure (such as transport, water, waste, energy and ICT systems) to be fit for purpose for supporting societal development in a changing world.

The TRAIN rig is a unique facility which allows us to examine the aerodynamic effects created by moving vehicles and the impact on their surroundings. Its instrumented 1/25th-scale, 150m long track allows researchers to fire models at speeds of up to 80m/s (or close to 180mph) to examine aerodynamic effects including slipstream development, pressure effects of

passing vehicles, aerodynamic effects due to train design and size, aerodynamic effects of passing trains on trackside structures and pressure development through tunnels (including the sonic boom effect). Recent railway aerodynamics projects have included works for Network Rail, RSSB, High Speed 2, ARUP and Bombardier.

The newly re-opened TRAIN rig now has a large, 45m extension which has allowed us to increase its crosswind capabilities by adding a 30-fan return flow crosswind tunnel into a 7m wide, 15m long stretch of the running track. What this means for research is that we now have the capability of a much larger flow fetch and better controlled flow characteristics, meaning experiments and analysis can provide more detailed outputs under a greater variety of conditions. Other elements of the renovation include thermal insulation for improved climate control and new walls separating the different zones of the track, for improved measurements.

Importantly, a large part of the UKCRIC upgrades was to increase the facilities scientific instrumentation capabilities. Major equipment purchases include a bespoke LaVision 3-D tomographic volumetric PIV system, capable of measuring flow volumes of 0.5m<sup>3</sup>, a 48 channel triple wire system and 18 multi-hole pressure probes capable of measuring velocities in 3 dimensions and static pressure. The renovation work has also focused on productivity and ease

of use in the facility, which has led to a bespoke designed 'plug and play' system to measure pressure making use of the increased number of pressure transducers.

It's not all train aerodynamics. Dr David Soper, Lecturer in Aerodynamics and Manager of the TRAIN facility, recently analysed the effects of platooning lorries as part of an EPSRC funded project. This was the first major project to capitalise on the UKCRIC upgrades. In light of innovative technologies surrounding connected and autonomous vehicles and proposed platooning methods, it is of vital importance to understand the aerodynamic implications of vehicles travelling in close proximity.

Through developing a novel on-board data measurement system, the aerodynamics team was able to simultaneously measure the surface pressure on eight platooning vehicles, calculate the subsequent load forces, as well as measure the aerodynamic flow development. Results indicate a complex interaction of vehicle wakes which could potentially lead to vehicle instabilities in certain platooning conditions.





# RESEARCH

## S-CODE

S-CODE (Switch and Crossing Optimal Design and Evaluation) was a 3-year project, led by the University of Birmingham with a consortium of industry and academia from across the UK and Europe.

The project aimed to overcome the challenges faced by today's switch and crossing by exploring radically new concepts and technologies. A consortium of nine organisations for this Horizon 2020 project was led by BCRRE and their collaborative efforts developed five new concepts for future switches and crossings (S&C), in addition to more than 20 technological solutions. The concepts and technologies developed for different components of a future S&C were evaluated based on their technological impact, readiness level and their whole life-cycle costs. These have included: novel actuators designs using magnetic levitation; developing laser scanners to collect condition monitoring data; writing new mathematical algorithms for analysis of condition monitoring data; developing composite sleepers and self-healing concrete.

Consequently, those solutions with the greatest potential have been highlighted for further development. Many of the innovative solutions developed were digitally modelled alongside a selection of physical demonstrations at workshops hosted by project partners in countries across Europe. The workshops were well attended by academics, railway industrial partners, and key individuals from across the rail sector. BCRRE hosted one of these workshops in October 2019 and this opportunity was used to showcase our facilities and capabilities to industrial partners across the UK and further afield.

Our contribution to S-CODE and the outputs delivered have been featured in railway magazines, published in journals and presented at a number of academic and industrial conferences, meetings and exhibitions. Moving forward, the simulations and demonstrations created will be used in future exhibition events, including InnoTrans, to continue to raise the profile of the research conducted at the BCRRE. Furthermore, the team are in detailed discussions with Network Rail about how some of the S-CODE outcomes can be used in future work with us as a linked third party in the IN2TRACK2 (Shift2Rail) programme.



## Geotechnical and Asset Management

The geotechnical and asset management research group is interested in these issues in the context of linear transport, with the focus being on roads and rail.

With 7 research students and 3 core members of staff, the year has seen the group undertaking new projects and making new connections around the world. Current projects include new PhD projects in railway drainage asset management and detailed research in developing a risk-informed

programming level tool for railway drainage asset management funded by both Network Rail and EPSRC's Impact Acceleration Account (IAA). Dr Manu Sasidharan has been building on his own PhD studies with Intellex Consulting Services and Network Rail to develop a commercial piece for software, RiTRAK (Risk Informed TRack), for railway maintenance investment appraisal.

The tool uses risk-informed whole-life analysis that considers total transport costs, taking into account future cost and benefit uncertainties, so that infrastructure companies can plan economically-efficient preventative asset management for new and existing railway track infrastructure. In practice, this means that the tool can be used by strategists to compare different maintenance strategies over the lifetime

of the railway track using a risk informed approach and thereby identify the strategy which is most likely to provide the greatest return on the investment.

In addition to funding from the IAA a comparable amount has been provided by Intellex Consulting Services is a UK based SME (with main office in Mumbai, India) to develop the software platform. To facilitate the development of RiTRAK and its marketing, the Research team visited Mumbai in July 2019 for meetings with Director of Ministry of Indian Railways Central Zone and Planning Director of Mumbai Rail Vikas Corporation.





# EDUCATION

2018-2019 has been a busy year for development in education at BCRRE. New staff, new programmes and new ways of delivering our programmes have all been underway.

A number of staff changes have occurred: Dr Holly Foss has been appointed Director of Education; Mr Rob Hopkin was appointed Head of Development (Education); Mrs Joy Grey has been promoted and appointed to Industrial Liaison Officer; Ms Zena Green joined the team as our International Teaching Fellow; and we have welcomed Mr Stephen Cotterill as Education Support Administrator.

This year has seen the 25th cohort of Railway Systems Engineering and Integration MSc students join us. Additionally, we have celebrated the first cohort of the MSc Railway Safety and Control Systems programme, which was developed from the former Railway Risk and Safety Management MSc in collaboration with the Institution of Railway Signal Engineers. The aim of this collaboration is to align our teaching with their examination requirements – more news is expected to follow throughout the coming year.

Developments have also occurred in our breadth of programmes. We are pleased to be the first institution in the UK to provide Level 6 and Level 7 Degree Apprenticeships in Rail Engineering. These are available at Level 6 through our Civil and Rail Engineering BEng and Electrical and Rail Engineering BEng pathways and, at Level 7, through our Railway Systems Engineering and Integration MSc. Our work on these programmes has seen us recruit Degree Apprentices from Siemens, Hitachi, Colas, and Ricardo joining our programmes this September.

As part of our commitment to continuous improvement, we are developing these MSc programmes with enhanced modules, revised content and new study patterns to be delivered from 2020.

Additionally, we are looking forward to welcoming Level 7 apprentices from Network Rail in January and extending our partners from September 2020.

**Dr Holly Foss**  
Director of Education



**MS ZENA GREEN**



**GRADUATION JULY 2019**

# EDUCATION

# EDUCATION

In June this year we staged the inaugural meeting of our Industrial Advisory Board (IAB) – chaired by Amey's Simon Higgins MBE (Market Director (Consulting & Rail)) with Joy Grey as its Secretary in her new role as Industrial Liaison Officer. Established in June 2019, the board is made up of members from across industry including the Rail Delivery Group, Network Rail, HS1, HS2, West Midland Trains, Government Departments (DfT, BEIS), the Rail Safety Standards Board, the Rail Accident and Investigation Board and others.

This Board concluded its second meeting in September and its role is to support the educational provision and development at BCRRE through building and maintaining rapport between industry and academe. This rapport can only lead to our courses

better addressing the industry need; our next meeting is scheduled for Spring 2020 with an extended membership to include the sector's institutes, institutions, societies, etc.

In support of the changes faced by industry in the wake of digitisation of the railway, we are developing a PG Cert Digital Railway qualification to be offered to Network Rail's senior leadership – this course considers both the national and international impact of digitisation of the railway and includes visits to Denmark, Netherlands and Germany. The pilot course is due to take place in Mid-2020.



INDUSTRIAL ADVISORY BOARD

## University of Birmingham

Further afield, in 2019 we began collaborating with Michigan State University to develop CPD and short courses for urban rail and transit in North America. We are also working with Hong Kong Mass Transit Railway (MTR) to develop distance learning study options for Railway Safety and Control Systems at post graduate level, with further international collaborations currently in development but due to come on stream during 2020. Our continued support to the Singapore Mass Rapid Transit (SMRT) Corporation in developing their graduate engineers has seen the graduation of our first cohort of Post Graduate Certificate in Urban Railway Engineering (Singapore) with 43 students graduating as well as celebrating the achievement of 2 SMRT employees as Visiting Lecturers.



### Degree Apprenticeships

In February, we became the first UK institution to offer rail degree apprenticeships. Degree apprenticeships represent a new education route which brings together university study and the invaluable on-the-job training typical of an apprenticeship.

Our Level 6 Rail & Rail Systems Senior Engineer and Level 7 Rail & Rail Systems Principle Engineer apprenticeship enables students to get high-quality teaching coupled with a guaranteed graduate job at the end. The Level 6 programme can be chosen via part-time study (block release for the equivalent of one term at a time over 5 years) or full-time (which is two full academic years at Birmingham, back for the summer between years 1 and 2 and with a full year in industry between years 2 and 3). This means Birmingham is the only institution where

this flexibility is offered in the context of our research-based teaching.

At Level 7, apprentices take the programme over 3 years: half of the MSc modules are taken in each of the first two years and the third year is for the research project and end point assessment. Both levels allow the apprentice to take their learning and apply it into the workplace quickly, benefiting both parties: the apprentice can see where their learning is relevant to their organisation and the wide rail industry; the employer benefits from upskilled, educated staff members.

Companies already involved include Hitachi Rail, Colas Rail and Ricardo Rail apprentices from each organisation starting their programmes in September. The term starting in January will welcome a cohort from Network Rail and the 2020/21 academic session will see even more new apprentices from further across the industry. BCRRE will work in close collaboration with the employer throughout an apprenticeship, ensuring the apprentice completes a portfolio of evidence towards meeting the apprenticeship standard.





# ENTERPRISE

The last 12 months have seen BCRRE take a big leap forward in terms of the work we have been doing and the development of our profile and reputation in the global rail industry. As one of the largest specialist railway research, education and innovation centres in the world we are at the cutting-edge of rail R&D and have strong working partnerships with a large number of industrial organisations.



## BCRRE EVENT HIGHLIGHTS IN 2018/19

- Innotrans 2018 (September) – agreement with Porterbrook, Embassy Dinner
- RVE (October) – Hydrogen Hero
- UKRRIN 1st Annual Conference (November)
- Rail Alliance launch (March)
- SEE Mobility Fair (May) – agreements signed
- Railtex (May)
- Rail Live (June) - HydroFLEX
- Destination Decarbonisation (September)
- TRAKO (September)

I was particularly pleased with the announcement of our inclusion in the Midlands Innovation 50 in September 2019, recognising us as one of the fifty most innovate organisations across the whole of the Midlands in the UK.

Our work is getting more and more recognition as leading the way in developing the future technologies that will transform the railway – in particular by delivering the twin targets of digitalisation and decarbonisation. Our Research Group are world leaders in both of these fields and we are keen to ensure that we are also growing the volume of work we undertake to turn that research into practical research and innovation activity.

In that context I must mention HydroFLEX. Our partnership with Porterbrook has been a major highlight for BCRRE, creating a high-performing team from across BCRRE and Porterbrook that has delivered a very high profile piece of engineering innovation that has rightly been recognised by the industry, by Government and indeed by the media as well.

In the following pages you will get a flavour of the range of work that my team have been delivering in partnership with our Research and Education Groups. The integration of the Rail Alliance into BCRRE has really raised the bar for our work with industry, particularly small and medium-sized enterprises. In addition our membership of the EU Rail Clusters Initiative has set in train a number of exciting projects and opportunities for us across Europe.

The DigiRail project is now gaining momentum in terms of companies we are working with and this has seen the project expand geographically.

Finally I want to pay tribute to the team who have grown in number quite significantly over the last year and who have all got stuck in to ensuring we successfully deliver this vast array of diverse projects and activities. The next 12 months will be even more exciting and I look forward to continuing to build our collaboration with our many partners to deliver the innovation that the railway of the future requires.

**Alex Burrows**  
Managing Director

# ENTERPRISE

# RAIL ALLIANCE – AT THE HEART OF THE RAIL SUPPLY CHAIN

At the beginning of this year the Rail Alliance entered a new chapter in its history when it was formerly integrated as part of BCRRE. Building on its reputation as the largest b2b rail community in the UK and the go-to organisation for doing business in rail, the Rail Alliance has gone from strength-to-strength and, by December 2019, membership in the community increased to over 600.

Spanning the entire rail supply chain, the community forms a rich and diverse network and as it grows, so does the knowledge within and also the connections to be leveraged. Sitting at the very heart of the rail supply chain, the Rail Alliance acts as a valuable resource for UK rail businesses, and provides a number of high quality business focused benefits from networking opportunities, knowledge transfer, market intelligence, company profile raising in addition to access to business advice specific to rail or international programmes and much more.

We are also very proud of the representation within the community from other sectors – such as aerospace, automotive, oil and gas and nuclear to name but a few. This adds even great diversity to the community bringing fresh innovation and new ideas to further enhance and enrich the R&D/I processes within the sector.

The revised business model has been deliberate in offering a new freemium membership option for organisations to join the community and has resulted in exponential growth. We have been extremely encouraged by the value the community has placed on joining the Rail Alliance community with the active conversion from a freemium option to full community partner status a true endorsement from the sector.

With the backing of the University of Birmingham via BCRRE, the Rail Alliance is in an even stronger position to support the rail supply sector and assist organisations within the community to navigate what can often be a complex market environment – whether a company is new to the sector or looking to develop rail business as an established organisation in rail.

The Rail Alliance is fiercely proud of its community – a community with a passion to thrive and achieve through collaboration, networking and innovation.



SIGNING LETTER OF INTENT WITH SOUTH EAST EUROPE RAIL CLUSTERS

**Our mission is to be the UK's number one rail supply chain partner of choice – the critical link between rail buyers and suppliers.**

## European Rail Cluster Initiative

Several years ago the Rail Alliance made an important decision which saw it playing a key role as one of the founding members in establishing the European Rail Cluster Initiative (ERCI). It was a decisive milestone and the cooperation agreement was officially signed during InnoTrans 2010 in Berlin.

ERCI is now the leading meta-cluster of the railway industry in Europe uniting 14 innovation clusters from 16 European countries. Together, the ERCI helps to connect the ideas and interests of close to 2000 small and medium-sized businesses in the industry and is their voice and lobby at

European level. It helps member companies to grow – through improved access to European partners and customers, accelerated technology transfer and joint marketing in, and outside, of the EU.

Over the past years, ERCI has established governance structures and has established itself as the European railway cluster network.

In May 2019 BCRRE hosted its first steering committee in Birmingham.

ENTERPRISE

# railalliance



# PERES – PROMOTING EUROPEAN RAIL EXCELLENCE OUTSIDE OF EUROPE

PERES 4i-partnership, was awarded under the umbrella of the EU cluster collaboration platform in January 2018. An 18-month programme of which Rail Alliance is one of four ERCI partners appointed to deliver it alongside DITECFER (Italy), i-Trans (France), BTS Rail Saxony (Germany) and the Serbian Railway Cluster for South-East Europe RCSEE. PERES is led by Italian cluster DITECFER.

The project involved analysing 250 SME's across the clusters to identify a value chain on a European scale. After some further market analysis and questionnaires, the USA and India were identified as target markets to deliver the first trial trade study mission. Recognising that the US market had some advantages over India for the first mission, a programme of targeted meetings was arranged with rail organisations based in the Midwest. Proximity was important to maximise the time and also the opportunities for the organisations attending the mission so Chicago, Cleveland and Pittsburgh were chosen as the locations to visit. The feedback

received was positive and the PERES team were able to claim a first success in the delivery of this new initiative. The project was successfully completed in July 2019 with a closure event taking place in Brussels. There are now plans underway for PERES phase 2.

In September 2019, BCRRE and the Rail Alliance exhibited at trade fair TRAKO that took place in Gdansk in Poland. During the fair a presentation was delivered by the PERES team including Rail Alliance on the outcomes of PERES and was attended by an international audience keen to find out how they could get involved in PERES phase two.



## OTHER NEWSWORTHY ACTIVITIES



**MARCH:** We visited Dresden to meet BTS Saxony (the Saxony Rail Cluster and a ERCI partner), the Technical University of Dresden and one of the Fraunhofer Institutes located in Dresden focused on advanced materials.

**MARCH:** We launched the new-look Rail Alliance and the freemium-based community membership model to an audience of over 300 members and supporters, at Birmingham's Millennium Point.

**MAY:** we signed Collaboration Agreements with the Rail Clusters of South East Europe (RCSEE) and the University of Belgrade's Faculty of Transportation and Traffic Engineering. These collaborations will see closer relationships with the cluster and Faculty, for Rail Alliance members to reach into South Eastern Europe and for

the two universities to work together on new research, education and innovation opportunities.

**MAY (AGAIN):** we hosted the ERCI Steering Committee in May and we held productive meetings, discussing the long-term vision for the group and activities we will offer for our member companies.

**SEPTEMBER:** Eli and Alex showcased BCRRE and Rail Alliance at the bi-annual TRAKO exhibition. We met up with new and current colleagues from across Europe, including a visit from Rail Minister, Chris Heaton-Harris. We took the opportunity to give presentations on Rail Alliance and what it can mean to the Eastern European rail industry community.



# UNIVERSITY OF BIRMINGHAM



DIGI-RAIL is a business support programme, part-funded by the European Regional Development Fund, to provide innovation support to SMEs for the development of digital products, processes and services for the rail industry.



The aim of the programme is to solve challenges within the railway sector and access the increasing number of digital rail commercial and research opportunities that currently exist in the UK and internationally.

With a focus on SMEs in the West Midlands, the initiative offers numerous benefits to members including (but not limited to)

- **Access to world-class technical expertise from the university**
- **Demonstration infrastructure**
- **Bespoke 1-to-1 consultations**
- **'Get into Rail' workshops and seminars**
- **Collaborative research projects**

Since its official launch in March 2019, the DIGI-RAIL programme has recorded tremendous success. With 52 sign ups so far,

it remains well on track to enabling regional businesses to take full advantage of the opportunities the digital railway brings.

The programme is currently providing R&D expertise to beneficiaries for the development of new products and services for condition monitoring of rail infrastructure, light rail systems, railway assets maintenance, and many more. The programme is also supporting SMEs to develop data-driven solutions and improvements to tackle key challenges faced in the rail sector.

A new focus for 2020 will be the inclusion of the Black Country as an eligible area for the programme. Businesses based in this area will get cost-free support and access to opportunities in the rail supply chain.  
[www.birmingham.ac.uk/digi-rail](http://www.birmingham.ac.uk/digi-rail)

# LOOKING FORWARD

## KEY EVENTS:

**OCTOBER 2019:** World Congress for Rail Research in Toyko: BCRRE academics will be presenting papers and the UKRRIN team will be handing over hosting for the 2022 congress which will be in Birmingham

**NOVEMBER 2019:** Second cohort of SMRT PG Cert successful completers receive their certificates

**NOVEMBER 2019:** Second annual UKRRIN conference in Birmingham

**FEBRUARY 2020:** Destination Digitalisation showcase event in Birmingham

**MAY 2020:** Infrarail in London

**MAY 2020:** Destination Decarbonisation at Long Marston

**JUNE 2020:** Rolling Stock Networking in Derby

**JUNE 2020:** Rail Live at Long Marston

**SEPT 2020:** High Speed Rail education conference in Birmingham

**SEPT 2020:** Innotrans in Berlin

**SEPT 2020:** First cohort of new-look MSc programmes will start

**NOVEMBER 2020:** New Centre of Excellence in Digital Systems building opening event.

**NOVEMBER 2020:** Cyber Security event in Birmingham

## EXCITING NEW DEVELOPMENTS INCLUDE:

- New internationally-delivered programmes of study
- New-look MSc programmes
- HydroFLEX mainline testing
- New building opens and Centre of Excellence in Digital Systems opening event
- New BCRRE Centres of Excellence launching
- Project output events (e.g. S-CODE)
- Outreach and public engagement activities



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