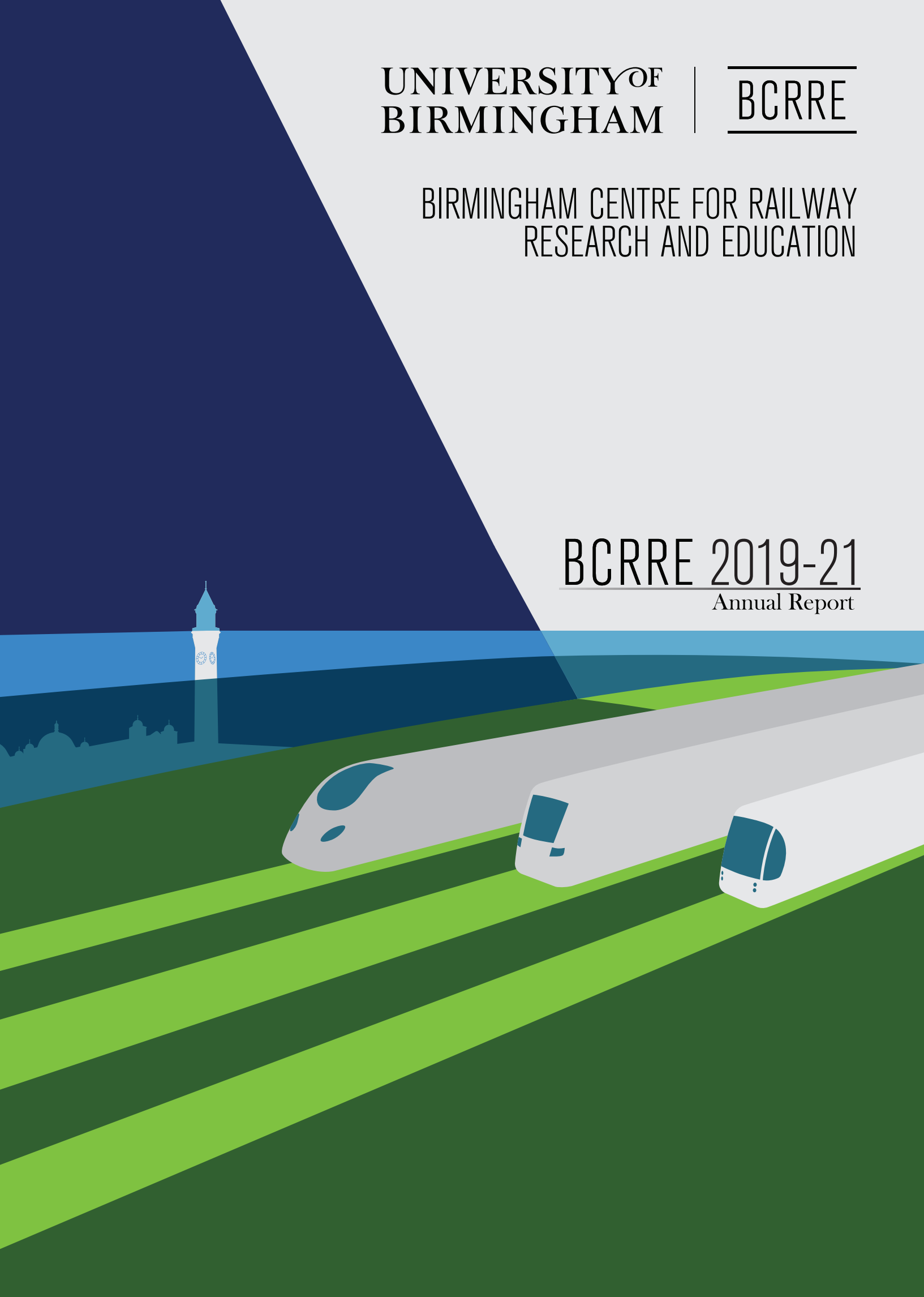UNIVERSITY OF BIRMINGHAM | BCRRE

BIRMINGHAM CENTRE FOR RAILWAY
RESEARCH AND EDUCATION

BCRRE 2019-21

Annual Report

UNIVERSITY OF BIRMINGHAM

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FOREWORD

Welcome to the BCRRE Annual Report - as ever it has been as busy year. One thing we have certainly learnt this year is that even a global pandemic cannot stop the continued growth and success of our activities.

November 2020 saw us moving into the first part of our new home – the UKRRIN Centre of Excellence in Digital Systems, a £16.4M purpose build facility that will allow us to further develop research and innovation activities.

During the last year we have initiated a number of important research projects, including the development of unique operational simulations for HS2 and a series of decarbonisation projects that will be showcased at COP26 in Glasgow in November 2021. We are incredibly proud of our contributions to the UN Climate Change Conference, particularly the specific involvement of HydroFLEX, the hydrogen train we developed with Porterbrook, which will be used by Network Rail as a meeting venue and a method of transporting VIP delegates throughout the conference.

Our education activities have significantly expanded over the last year. New initiatives include: two further cohorts of Level 7 Principal Engineer Degree Apprentices starting with us; the development of a formal relationship with Indian Railway's National Railway and Transportation Institute, which has already seen students from India commencing a year of their MSc studies with us in Birmingham; and the development and delivery of a Postgraduate Certificate course for Network Rail on Digital Railway Leadership. We have also helped Ethiopia and Saudi Arabia develop plans for future railway education institutes, both of which we hope to play a key role in going forward.

In the Summer of 2020 the University was selected by the UK Government's Department for Education as the partner to take over the ownership and operation of the National College for Advanced Transport and Infrastructure (NCATI). At the end of April 2021 after a very significant amount of work, the transfer of ownership took place, and a new Principal – Ian Fitzpatrick – began the following month. Since the takeover NCATI has been reinstated on the Register of Apprenticeship Training Providers (RoATP) and we have welcomed a new cohort of students in September 2021. More than ever NCATI is needed to provide skilled training for those developing careers in all part of the railway, as well as adjacent industries.

As ever we have been busy supporting SMEs through Rail Alliance and our DigiRail programme. This year we have grown our DigiRail programme. In addition to delivering the programme across Birmingham and Solihull, the Black Country, Coventry and Warwickshire, we are now able to support SMEs with innovation projects in the Nottingham and Derby region (through a programme led by the University of Derby) and the Sheffield City Region in partnership with Unipart. We have also launched Phase 1 of RaisE (Rail Accelerator and Innovations Solutions Hub for Enterprise) in collaboration with Siemens Mobility.

In 2022 BCRRE will co-host - with RSSB - the World Congress on Railway Research, which will take place at the International Convention Centre in Birmingham between 6th and 10th June 2022. We will also be marking our 50th birthday. We had better start baking a cake!

I very much hope you find our Annual Report informative and useful. As ever, if you feel that we can help with your current research, education or introducing innovation initiatives, please do get in touch.

Professor Clive Roberts
Head of School of Engineering

RESEARCH

A major highlight this year has been the completion and handover of our new UKRRIN Building - home to BCRRE and the Centre of Excellence in Digital Systems. This offers us the facility to work collaboratively alongside our industrial partners in a state-of-the-art research environment, which is unique in UK Rail. With our existing research equipment successfully moved and our new labs and kit commissioned we now move confidently from the preparation to the execution and delivery phase of our new Centre. Despite the challenge of Covid-19, our research year has been as busy as ever we have signed an important framework agreement with HS2 Ltd and initiated some exciting projects. We have been busy in working across a broad range of significant research projects to support the development of future railways.

In our Digital Systems theme, projects include developing digital twins; working on digitally-enabled design and evaluation for new-concept track switches and pantographs; and looking at the wheel-rail behaviour around novel joints. We have had an exciting year in the area of Sensing & Automation, with many infrastructure and vehicle monitoring projects. We are delighted to have developed and demonstrated in the field the feasibility of a new automatic method for monitoring and testing pantographs (with zero manual intervention). We continue our innovative work on Future Railway Operations & Control, focussing on national and international projects. These link back to our work on digital twins for rail. Our work on Data Integration & Cybersecurity is helping to ensure the usefulness and security of railway data for the future. We have also made great progress in our work on resilience and carbon reduction and were thrilled to conduct the UK's first mainline tests of a zero emissions hydrogen train.

Finally, we are immensely proud to have been working together with colleagues at RSSB to continue the preparations for the UK to host the World Congress on Railway Research (WCRR 2022) in Birmingham.

Highlights during the year include:

- We opened our new UKRRIN CEDS building
- Continue to work closely with our Industrial and Academic partners in UKRRIN
- Signed off strategic agreements with HS2 Ltd
- We continued our excellent relationship with Network Rail under our framework agreement, working across several projects of European and UK-wide importance
- Our team published over 100 peer-reviewed research papers
- We kick-off 25 new research projects
- We conducted mainline trials of the UK's first Hydrogen Train
- We began development of a Rail digital twin to support the 2022 Commonwealth Games
- We welcomed new UKRRIN partners from industry and academia.

Professor Roger Dixon
Professor of Control Systems Engineering

EDUCATION

2020-2021 has been another remarkable year for Education within BCRRE, made possible by the relentless hard work, dedication, and enthusiasm of staff and students alike.

Our well-established Birmingham-based MSc programmes in Railway Systems Engineering and Integration and in Railway Safety and Control Systems continued, with delivery moved online due to the COVID-19 pandemic. This change saw staff and students demonstrate exceptional resilience in transitioning to new ways of working, teaching, and learning for the zoom classroom. In the midst of this, BCRRE welcomed its largest cohort of new students in September 2020, with 73 candidates joining for MSc study from across the UK and the globe. Students include full-time, part-time, and degree apprentices from a range of backgrounds, experience, and nationalities.

Meanwhile, the move online was not the only change for the MSc programmes. In September 2020 we additionally launched our new MSc programme design, with a simplified module structure and enhanced materials allowing for more in-depth examination of key critical issues informing railway engineering today, such as digitalisation, decarbonisation, and skills and innovation. Students have seized these opportunities and demonstrated excellent performance throughout.

With options for in-person celebration limited by the pandemic, graduation ceremonies were also delivered online for the 55 graduates of the class of 2020. The class of 2021 are now eagerly finishing dissertation projects and awaiting the results of many years of hard work. Over 50 master's students have demonstrated a fantastic achievement in working towards completion of their degree programmes during a year like no other. December 2021 looks set to be a great occasion and we look forward to enjoying it with our graduates.

Beyond our MSc programmes, we celebrated two major milestones. Firstly, 2021 represented the culmination of our 5-year project with SMRT, Singapore metro operator, to deliver a postgraduate certificate in Urban Railway Engineering. With the final teaching sessions unable to be delivered in person, this programme too, faced a move online facilitated by the extraordinary efforts of staff and students. UK staff faced a series of very early starts to teach at a reasonable time in Singapore, whilst students gave up their evenings to the programme. Our warmest thanks go to our partners in SMRT for the pleasure of collaborating on this project over the past 5+ years. We are thrilled to have a cohort of more than 250 alumni from this programme and look forward to working together in the future.

Secondly, this year, we welcomed the start of a pilot postgraduate certificate in Digital Railway Leadership, developed in collaboration with Network Rail. This 18-month programme is geared towards the next generation of leaders within the rail industry, facing up to the challenges of digitalisation.

Further afield, Spring 2021 saw the University of Birmingham begin its collaboration with the National College for Advanced Transport and Infrastructure (NCATI). This partnership represents a significant development in supporting skills, education, and training across the sector at all levels of further and higher education. Within BCRRE we are excited to be part of this and to working closely together.

We now look forward to 2021-2022 and the start of a new academic year that promises to be as vibrant as the past 12 months.

Dr Holly Foss
Director of Education

ENTERPRISE

The BCRRE Enterprise team undertakes two core roles – the first is to provide commercial and professional services support to our research and education activities; the second is to engage with the global rail industry to foster collaborations and to provide enterprise and innovation support to organisations to drive innovation.

The Enterprise team have performed above and beyond expectations over the last eighteen months as the pandemic has hugely impacted the industry, the market and our ways of operating. Industry engagement and outreach has been hugely challenging but we have been able to adapt our approach and use our agility, to continue to engage with and support businesses through our Rail Alliance and DigiRail activities.

Our work across Enterprise and Innovation has seen a large number of projects come into being and be successfully delivered. Our work as a part of the UK Rail Research and Innovation Network has seen us work with our industry partners to deliver projects such as HydroFLEX,

the UK's first hydrogen train. Over the last 18 months BCRRE has signed framework agreements with both Network Rail and HS2 Limited, which has driven growth in our R&D/Innovation activities.

We have also maintained our international perspective and continued our collaboration on projects with partners around the world, with initiatives continuing to be driven forward in South America, South East Europe, Africa and Asia Pacific in particular.

Our membership of the European Rail Clusters Initiative (ERCI) – as Rail Alliance – has enabled us to collaborate on several EU-funded projects as well as be a part of a successful pan-European initiative working with rail supply industry SMEs.

Highlights during the year include:
- Rail Alliance was the first supply chain community to move all content online in March 2020 and make it available at no cost to all members
- 23 online Rail Alliance event sessions, including 3 open "Destination" conferences
- 12 Stay Connected informal webinars
- We successfully delivered the HydroFLEX project and made history with the UK's first Hydrogen-powered train to run on the mainline
- Won the Guardian Award for Business Collaboration (HydroFLEX with Porterbrook)
- 2 framework agreements signed to grow research, development and innovation activities
- Widened reach across Europe with two new ERCI projects

Alex Burrows
Director

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

the **travelled MAINLINE**

our **Linked in** following has **DOUBLED** to **1700**

2x

INDUSTRY awards **WON**

96 registered **PhD STUDENTS**

46 live **research** PROJECTS

new **£16.4m**

UKRRIN
UK RAIL RESEARCH AND
INNOVATION NETWORK

BUILDING OPENED

800+
railalliance members

51+

BCRRE
BLOGS

from industry
AND ACADEMIA

56
EVENTS

58 PRESS RELEASES

100+
research
papers
published

BCRRE **in**
the
NEWS...

...featured on
THE TIMES
BBC Breakfast
Evening Standard

1600

2300

our **TWITTER following** has
INCREASED BY 700

A new purpose-built centre designed to deliver specialist research in digital railway engineering is now open here at BCRRE, at the University of Birmingham.

The Centre of Excellence for Digital Systems showcases successful collaboration between academia and industry, as the university has partnered with the **UK Rail Research and Innovation Network** (UKRRIN) to commission the facility, with £16.4m in funding from Research England.

The Centre sits within the **Birmingham Centre for Railway Research and Education** (BCRRE) and is set to unite existing academic and industry capabilities to innovate and support transformational change within the rail technology sector, globally.

Procured through the Constructing West Midlands framework, the 3,000m^2 facility offers a variety of contemporary and flexible design and research spaces. These will provide the space and environment to act as an incubator for innovation, strengthen collaborative research partnerships and enable us to provide excellent teaching facilities. Open offices, meeting rooms, seminar rooms and event spaces will enable industry partners to come and work directly with University experts and researchers.

The facility also has project labs, light electronics labs and state-of-the-art equipment including cab simulators, a signalling control centre, and a cybersecurity test lab, along with electronic fabrication and technology assets to enable high quality, fast-paced research, through to proof-of-concept and testing.

The centre houses specialist research in digital railway engineering, focusing on railway control and simulation, data integration, cybersecurity, condition monitoring and sensing, and improved methods for technology introduction.

Andrew Stephenson, Minister of State for Transport, formally opened the new purpose-built centre in July 2021.

Opening the building, Mr Stephenson said: "This new Centre will have a pivotal role in ensuring our country's proud rail engineering past continues into a bright future.

"It is vital that UK is front and centre of transport innovation as we Build Back Better from the pandemic, and along with the National College for Advanced Transport and Infrastructure, the Centre will provide valuable training, new skills and real opportunities for people entering the sector for the first time.

"We will continue to work closely with the Centre as it strives to attract a diverse range of talent to the transport sector."
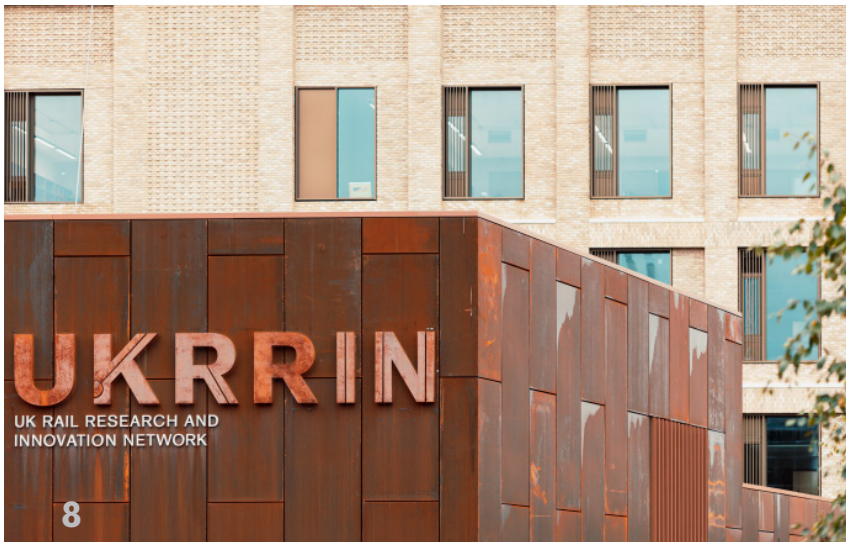
DIGITALISATION

The Centre of Excellence in Digital Systems at the University of Birmingham brings together existing academic and industry capabilities. It will innovate new areas, supporting transformational change in rail technology across the globe. The Centre of Excellence in Digital Systems is part of the UK Rail Research and Innovation Network (UKRRIN), a network of Centres supporting new innovation in rail transport.

Dr Lei Chen
Senior Lecturer

Our capabilities, which sit within the UKRRIN theme of Future Railway Systems, Operation and Control, continue to go from strength to strength and in the last year we have enjoyed working on new research projects including the EC Shift2Rail PERFORMINGRAIL project; CRRC Sifang High Speed Maglev System Optimisation; CRRC Zhuzhou Institute Metro signalling system optimisation; Network Rail Platform Docker; and HS2 resilience simulation.

These research outcomes have the potential to be applied to global railway industry to enhance the impact on railway system modelling and simulation, traffic management and control. We enable railway operators to try their ideas in the virtual world before they are implemented in the real world, allowing for optimisation of services, efficiencies and system-wide control.

The team at BCRRE has also developed an innovative railway simulation tool, ReMoD, which can generate high quality 3D railway scenarios quickly and easily. This tool allows us to enhance our capability in railway 3D related research and development by speeding up the creation of digital twins and enabling us to visualise ideas more efficiently and effectively.

With off-site activities curtailed, the 2020/21 year has seen the BCRRE data team expand on its capabilities in the Machine Learning domain.

Throughout 2020, work with **Zipabout** (funded by RSSB under their data sandbox plus call) saw the team develop a data-driven approach to the estimation of arrival times, achieving improved performance over traditional methods in cases where the service experienced delays. The random forest model used was built on a method previously trailed at small-scale in the EU funded IN2RAIL project. This allowed us to reduce the complexity so that it could feasibly be deployed at national scale.

Dr John Easton
Lecturer

Over the summer of 2020, work with MSc students from the School of Computer Science allowed the team to develop prototype algorithms that were capable of learning & replicating signallers' route setting decisions at a complex junction, using historical movement data. From September 2021, the team will be taking this work forwards in a new PhD project that will determine the potential for generalisation of the techniques to all major mainline junctions, and the extraction of the underlying rulesets learnt by the model.

In late 2020 & early 2021, projects with Network Rail investigated the feasibility of predicting track fixity values from design characteristics, combined with geological, loading, and climate data. A parallel project has looked at the implications for track geometry evolution between inspection campaigns based on similar parameter sets.

Trespass is a growing issue for mainline railways. Computer vision offers the capability to monitor large stretches of the network with minimal human intervention, but the costs and logistics of deploying CCTV at scale make it difficult to achieve this with conventional cameras. In spring 2021, work by final year students at BCRRE delivered a prototype system based around a COTS embedded computer and camera, small enough to be powered using solar panels, which could monitor its local environment, classify a nearby moving objects, and raise an alarm / return an image to a control centre if further investigation was necessary (e.g. if the trespasser was human).

Introducing Innovation

Introducing Innovation is one of the four UK Rail Research and Innovation Network (UKRRIN) themes led by the University of Birmingham, as the host of the UKRRIN Centre of Excellence in Digital Systems. This theme was specifically sought by the UKRRIN Industrial Partners to provide support to the rail supply industry by: facilitating the process of innovation; collaborating with industry partners to undertake innovation projects; and enabling the introduction of innovation into the rail industry.

Alex Burrows
Director

Our strategy for the Introducing Innovation theme is focused on delivering a clear outcome – increased successful innovation activity in the rail supply industry. The outputs are an increased volume of innovation activity (a greater number of projects and actors involved in innovation) and an increased value of rail innovation activity undertaken (more investment in innovation and greater value generated from the innovation activities).

We have broken the theme down into 6 areas of activity: Innovation Models and Systems Engineering; Benefits Identification and Realisation; Testing and Validation; Innovation Landscape, Foresight and Horizon Scanning; Accelerating Innovation; and Business and Operating Models. These areas will be driving our research and provide focus for our priority areas of work in the coming 12 months. We are currently looking at the UK rail innovation landscape on behalf of the Rail Supply Group and will be delivering key research for them in 2022.

This year, in spite of the impact of the pandemic, we have continued to successfully develop and deliver a number of collaborative innovation projects with a range of industry partners. A headline project has undoubtedly been our HydroFLEX project with Porterbrook that has seen us develop the UK's first hydrogen train which successfully undertook test runs on the mainline railway in Autumn 2020. The work has continued and will see the final production version take passengers at the UN COP26 conference in Glasgow in November 2021.

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BCRRE turns 50

Look out for more information and our line-up of activities in early 2022.

UKRRIN Centre of Excellence in Passenger Experience

There is increasing recognition across the UK rail industry that a focus on better understanding and, where possible, exceeding the needs of as many potential passengers as possible will be key to the next phase of modal shift, where rail can expect to see increasing competition from the convenience of other public transport options.

We are working with the Universities of Cambridge, Nottingham and Southampton to establish a new Centre of Excellence that will focus wholly on the passenger. It will play a key role in supporting the UK rail industry as it moves towards a passenger-centred approach to the design and delivery of all rail services. It will help to reduce obstacles facing passengers at all stages of their journey, from deciding to travel to reaching their destination safely. The core of this new approach is to think inclusively about the needs, wants, aspirations and concerns of everyone who would like to travel by rail, not just the able bodied, or existing rail users.

BCRRE will lead the theme on digital accessibility and connectivity within the Centre of Excellence which is expected to launch in early 2022.

DECARBONISATION

The Birmingham Centre for Railway Research and Education (BCRRE) has launched the Centre of Excellence in Rail Decarbonisation, focused on supporting industry and government to lead research and develop the solutions that will deliver rail decarbonisation through six of our core capability areas.

Our research and industrial application has provided many decarbonising solutions and we continue to do so to support the requirement for the UK to achieve Net Zero emissions by 2050.

Climate Adaptation & Rail Resilience

At the same time as we are undertaking work to decarbonise the railway and mitigate climate change, it is important to ensure the future railway is resilient and, where necessary, adapted for future climates. On behalf of the Office for Rail and Road (ORR) we worked with Climate Sense Ltd to undertake a review of Network Rail's Weather Resilience and Climate Change Adaptation (WRCCA) plans. This project examined the most recent (second revision) Route Level WRCCA Plans and compared them against international standards of best practice for climate change adaptation. The evaluation provided a number of recommendations for Network Rail to action in order to continue to mature and expand its asset management capability, adaptation actions and future climate resilience.

Dr Andrew Quinn
Reader in Atmospheric Science and Engineering

Under this research theme there is also work underway to support climate change adaptation and resilience for transport in low-income countries (LICs) in Africa and South Asia. Funded by the Foreign, Commonwealth and Development Office (FCDO) and part of the 5-year High-Volume Transport (HVT) Applied Research programme managed by IMC Worldwide, BCRRE is leading research for Adaptation for Transport Resilience to Climate Change (AfTR-CC). . We are working on AfTR-CC together with the Transport Research Laboratory to describe the current state of knowledge and capacity for LICs in these two regions to address climate change and adapt their transport systems for future climates. It will highlight the current state of the art and identify the challenges and gaps in existing knowledge that need addressing to ensure future mobility in African and South Asian LICs. The outputs of this work will be showcased at the UN COP26 conference in Glasgow in November.

UKaid
from the British people

Beyond Hydrogen, Sustainable Traction Systems

In addition to traction power requirements, energy is used across the whole life cycle of rolling stock. This means there are carbon emissions for the commission, operation, maintenance, midlife overhaul and decommission of all trains. A BCRRE team is currently undertaking a research project on behalf of RSSB to create a whole life cycle assessment framework for rolling stock to minimise carbon emissions across the whole life span of trains. The development of such a framework will enable carbon reduction options to be identified and to inform future changes to the Key Train Requirements which, in turn, ensures that future rolling stock has a lower capital and operational carbon footprint than existing trains.

Dr Stuart Hillmansen
Reader in Railway Traction Systems

Our research is supporting the FDCO-funded Climate Adaptation & Rail Resilience programmes, identifying novel traction systems for a sustainable railway future in low income countries (LICs). This research aims to address the specific challenges for LICs in the global south in order to enable sustainable railway transport for future mobility. The research has applied modelling and simulations of relevant case studies, whereupon we will investigate solutions that address their technical lifecycle requirements, taking into account the social, economic, and geopolitical contexts.

The role of power electronics towards "net zero" in railway transport

Electric railways are large consumers of electricity and require strong power supplies from the power grid. However, the progressive penetration of renewable power sources is changing substantially the characteristics of traditional power grids and there will be in the future a much higher need to control the load and generation profiles. Power electronics is the key underpinning technology to achieve that and it is expected that their use for rail electrification systems will considerably grow in the near future.

Dr Pietro Tricoli
Senior Lecturer

The BCRRE power electronics team is currently undertaking the H2020 E-Lobster project with 8 EU partners to improve synergies between the rail traction and power distribution networks using soft open point converter. A prototype has been developed and currently under test in the lab and will be installed for real-life demonstration in Metro de Madrid, Spain, in December 2021.

Also, we are working with several industrial partners to develop a new power-converter based battery chargers for EV connected to the 25 kV electrification network and our lab-based demonstrator is currently under testing and ready for March 2022. Finally, our Shift2Rail work on the ground-breaking research on Medium Voltage DC electrification systems, in partnership with the University of Cluj-Napoca, Romania, has entered into the final stage, with the construction of a lab demonstrator that will be completed in April 2022. Our interim results have been successfully presented at a join workshop of Shift2Rail projects on railway electrification systems.

Finally, work is underway to demonstrate in the lab a new 3x25 kV electrification system that minimises the imbalance on the grid and hence, mitigate the need of a strong power supply. An international patent has been recently granted on this and the group will now work to engage industry for further development.

Sustainable Infrastructure

Dr Sak Kaewunruen
Reader in Railway and Civil Engineering

We have been looking at eco-friendly construction and railway materials that enhance cleaner and lower carbon infrastructure; low-carbon materials including high-damping and self-healing concrete, 3D printing composites; and self-sensing materials that can monitor cracks and damage. Combining structural mechanics and the principles of dynamics with practical experimentation using advanced simulations, artificial intelligence and data science, we have built up a clearer understanding of how infrastructure failure happens and how to prevent or mitigate against it. Much of our recent work has been with the ambition of enhancing the service life of infrastructure and reducing waste to minimise whole-life cost, energy and Carbon footprint. Along the way we also contributed to the development of two ISO/BSI standards for railway concrete and plastic sleepers.

We have been making use of digital twins in this research theme, including a 6-dimensional building information modelling (6D BIM) digital twin for lifecycle management of rail infrastructure systems. The use of BIM for railway infrastructure systems has the potential to improve the overall information flow of planning and design; manufacturing pre-assembly and logistics; construction and installation; operation and management; and demolition of the asset. All of this means it is possible to achieve better performance and quality throughout the lifecycle. Based on integrated information of railway asset infrastructure, the 6D BIM has the ability to assess economic, management and sustainability parameters, and to achieve a balance among them. This insight will significantly benefit collaboration and communication among engineers, project managers, technicians, and senior management, as well as provide the basis for designing infrastructure systems where there is an ambition to reduce energy usage to zero.

Geotechnical Engineering and Asset Management

During the year, the group was awarded two research contracts by Network Rail to develop
(i) a tool to predict the rate of change of railway track alignment and
(ii) a durable, climate resilient economic innovative drainage product.

The predictive tool developed for the first project is making use of data sets on railway track inventory, condition, utilisation, climate and geology to develop a machine learning algorithm which can predict track movement.

Dr Michael Burrow
Reader in Infrastructure
Asset Management

The work will enable track engineers to make better assessments of the risk of a lack of clearance developing in the future from changes in the lateral and vertical track alignment. The importance of the work is that it will improve the accuracy and reliability of Network Rail's gauging assessments and thereby help it to meet its obligations to the Office of Rail and Road in CP6.

The second project was commissioned by Network Rail as part of the Shift2Rail research programme and consisted of developing and testing an innovative low maintenance product for railway drainage. The developed synthetic evapotranspiration system enables moisture to be controlled under the track and within earthworks.

The importance of this highly innovative natural approach is that it reduces the need for conventional track drainage, reduces risks associated with drainage failure and could significantly reduce the life cycle costs of both the railway track and drainage assets.

Aerodynamics in Rail

Dr David Soper
Lecturer in Vehicle
Aerodynamics

The railway aerodynamics theme is covered by a team of four academics and one research fellow from the Wind Engineering and Vehicles Aerodynamics research group. The team operates two major experiment facilities: the Transient Aerodynamics Investigation (TRAIN) rig based at the RTC Business Park in Derby, and the Atmospheric Wind Tunnel in the Civil Engineering laboratory on the Edgbaston campus. A broad range of academic and industrial research is carried out by the group, covering full- and model-scale experimental studies, as well as complex numerical simulations, in the areas of aerodynamics and wind engineering.

The group is currently conducting a range of fundamental and applied research studies, utilising the core team expertise and facility capabilities. In line with the aims of the Centre of Excellence for Rail Decarbonisation, the group have been successfully working on RSSB project 'T1234 – CLEAR2 Air Quality on Trains - HVAC and Exhaust Interactions Study' to understand the dispersion of exhaust pollutants from diesel rail vehicles, through characterising interactions with the aerodynamic flow. The work has included full-scale experiments at the Ecclesbourne Valley Railway, model-scale testing at the TRAIN rig facility and a wide range of computational simulations using the University of Birmingham BlueBEAR computing environment.

Also in the theme of decarbonisation, the group has recently undertaken a project for a freight rolling stock company to characterise the aerodynamic performance of a particular railway wagon, with a view to considering potential aerodynamic improvements to support rail decarbonisation and minimise overall railway emissions.

A further on-going project utilising the unique approaches offered by the TRAIN rig facility is that of EPSRC V010689 - The aerodynamic interaction of platooning and overtaking vehicles. This research is considering the aerodynamic flow development associated with autonomous vehicles travelling in a platoon configuration and potential aerodynamic instabilities which could be created for other road users. Additionally, the facility has also hosted researchers from elsewhere in BCRRE in line with research conducted by Prof Roger Dixon on a EU H2020 project to understand RFID tags and readers.

ADVANCED TRANSPORT & INFRASTRUCTURE
NATIONAL COLLEGE

In May 2021 the University of Birmingham formally launched the new National College for Advanced Transportation and Infrastructure (NCATI) – previously the National College for High Speed Rail. This unique and special collaboration between Higher and Further education heralds a new future for learners, industry partners and local communities to secure the skills and education the rail and wider transport and infrastructure industry need.

As part of the University group, the new NCATI will produce a new generation of highly skilled professionals to lead Britain's future rail, transport and infrastructure workforce. NCATI will draw on the University's internationally-recognised rail expertise and, with strong industry and a wide range of partners, will help address the sector's skills gaps, particularly in the Midlands and the North where the College's two locations are situated: Birmingham and Doncaster.

Prof. Clive Roberts
Head of School of Engineering

The launch is the culmination of a rigorous process where my BCRRE team worked with University of Birmingham and NCATI colleagues and the Department for Education to secure a successful, sustainable and inclusive future for the College. We have worked hard to ensure its current suite of programmes will be supplemented by new offerings, developed in collaboration with the industries the new College will serve. We've been joined by a new Principal, Ian Fitzpatrick, who will lead the College in its mission to be world-class in the provision of national education outcomes in the rail, transport and infrastructure sectors.

At state-of-the-art campuses in Birmingham and Doncaster, the new NCATI will provide high quality education and training with a distinctive local offering that specialises in Railway and Transportation Engineering. In addition, a hub and spoke model will see NCATI collaborating with education partners around the UK, ensuring it fully plays its role as a National College.

Apprenticeships will be a fundamental part of the NCATI curriculum moving forward. Following a thorough application process, the new NCATI has been accepted onto the Register of Apprenticeship Training Providers and is now preparing for new apprentices to join the College in the coming months.

We have been encouraged so far by support from across the industry, where the message that the College will play a crucial role in upskilling the workforce for the breadth of careers which companies including HS2 and Network Rail are creating.

The Rail Alliance

In the previous BCRRE report, the Rail Alliance was particularly proud to have identified its 600th member and then we went into lockdown ... we were concerned that we would not maintain the momentum that we had achieved but we need not have worried – the Rail Alliance membership now stands at more than 800 and counting.

Whilst part of this success is down to the Rail Alliance's 'freemium' model (allowing members to access premium Rail Alliance content for free), we also dispensed with membership charges during 2020 and the first quarter of 2021 as a service to the supply chain. We believe that we were the only railway sector supply chain community to offer this gesture to industry at a time when confusion was at its highest and our ability to interact with our members was still in its infancy.

Nonetheless, such a surge of interest in our membership during an international pandemic clearly showed the appetite for companies with digital solutions or those seeking to diversify into the rail supply chain – or simply to grow their business – to take up the membership offer from the Rail Alliance to work together with us here at the BCRRE for a better future, even if that very future was being played out during uncertain times.

For a networking organisation like ours, it really hurts not being able to return to face-to-face events just yet and, even when we can, we will use our judgement with care and concern for our membership – following the wise mantra 'just because you can doesn't mean you should'. However, we are hopeful that we can return to face-to-face events later in 2021 and have a full of range of events already planned for 2022. As a consequence, we re-introduced the membership charge but, taking into account the fact that we spent 2021 still, in effect, locked down, we set the Silver level membership for 2021 at half the normal price. With our ambitious plans for 2022, we will revert to our normal competitive membership charge for membership at £500+VAT per company and all renewals will fall in the month of January 2022. We will continue to offer a Bronze Membership (free of charge) to those who need the most basic of information or who simply need signposting to other 'destinations' in the industry such as RISQS or Network Rail's Design for Reliability standard ... this basic membership offers a pay as you go service for those who wish to attend events however at £150 +VAT each, joining as a paid-for member may offer considerable saving over the 12 months of membership.

Working with the European Cluster Initiative

During the past 18 months, we have staged events collaboratively with the European Railway Cluster Initiative (ERCI). These have included the South East Europe Mobility fair in September 2021 as well as standalone collaborative activity where we staged an online seminar all about the 'Management of Pandemic Issues' with innovative solutions being offered from our fellow European clusters (of which there are 16 spread across all of Europe representing 17 European nations – see www.eurailclusters.com).

Additionally, the ERCI celebrated its 10th birthday in 2020 and from its humble beginnings as a collaborative project that sought initially to increase the competitiveness of SMEs across Europe as well as highlighting and championing innovation from the SME base, it has grown into an organisation encompassing more than 2500 member companies spread across 17 nations from Spain in the west to Turkey in the east and from Sweden in the north to Italy in the south.

DIGI-RAIL

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 over 200 SMEs engaged 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 the Digi-Rail project has been the inclusion of the **Sheffield City Region** 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, with partner **Unipart Rail**.

See some of the success of the project **here**.

Here are some of the companies that the DIGI-RAIL team have supported.

Support Programmes for the Industrial Community

In addition to the Digi-Rail programme we have much more to offer the supply chain and SME community. Over the last year we have been able to get involved in regional industrial support programmes, innovation support programmes and initiated our own programme of open-access short courses.

Innovate 4 Rail is a programme which supports manufacturers in the Derbyshire and Nottinghamshire (D2N2) local enterprise partnership region. It is led by the University of Derby and taps into the BCRRE academic expertise in digital technologies; systems engineering; asset management; passenger experience; digital twins and simulation systems; data analysis; cyber security and application of the Internet of Things; condition monitoring; predictive maintenance; traffic management; energy and decarbonisation; and BIM applications. Eligible SMEs can access at least 12 hours' support from the team, including workshops and events; one-to-one advice and support, and collaborative projects.

Over 2020 and 2021 we have extended our West Midlands reach and industrial network, enabling even more support for innovation and business development into the rail industry. Rachel Eade MBE is now providing eligible SMEs in the West Midlands with at least 12 hours' business support under the Greater Birmingham & Solihull LEP Growth Hub's Account Management programme. This multi-disciplinary programme provides advice, guidance and funding for businesses and entrepreneurs across the Greater Birmingham area.

Adding to this opportunity is our involvement in the Innovation Alliance for West Midlands, a West Midlands Combined Authority programme which pulls together the many business and technical support programmes for the benefit of SMEs across the region. It is a coalition of organisations active or interested in science and technology-based innovation across the West Midlands and it has key objectives: to build and maintain a thriving innovation ecosystem; and to stimulate and catalyse a pipeline of innovation activity. BCRRE's contribution is part of the Virtual Innovation Team in Transport and Manufacturing technologies, where we are hosting the Innovative Manufacturing Working Group alongside a regular newsletter which summarises opportunities for product, service and process developments.
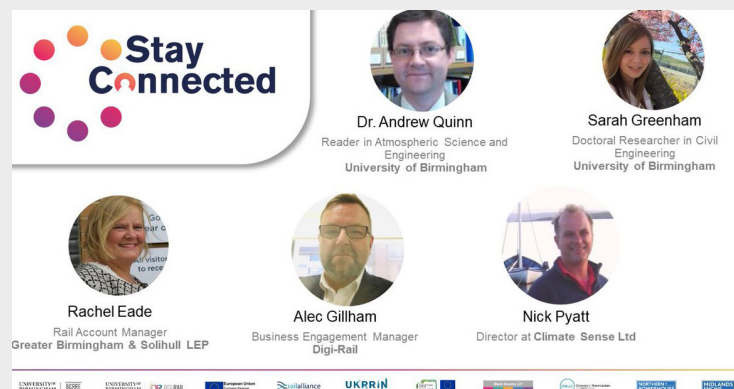
In April 2020 we launched the Stay Connected series of Zoom-based webinar discussion events. We expected a handful of people to join each month's session to hear about a chosen theme and to have a short discussion together. When we decided to pull together a relatively informal webinar we didn't expect to welcome 70+ people regularly, and we didn't expect to hear from a huge range of speakers across a wealth of topics ranging from business recovery to technical innovation themes to specific supply chain opportunities on, for example, the new University Station right here on our doorstep! All this means we have a full programme of Stay Connected events coming up for the remainder of 2021 and for 2022 as the appetite for coming along to an informal webinar event remains strong for our industrial community.

Responding to feedback from our SME community, we put together a few more informal sessions, where we gave participants an introduction to the rail industry and outlined the steps they might need to enter the rail sector. The first iteration of this short series of online meetings was so popular we repeated it, honing the content and delivery. Again, the popularity and feedback from the participants has been encouraging enough for us to launch the Get Into Rail programme: a five-part webinar-discussion course for companies of any discipline to understand the nuances, challenges and requirements of joining the rail supply chain. Look out for news of the Autumn 2021 "season" which is funded for eligible SMEs in the West Midlands, D2N2 and Sheffield City Regions under our Digi-Rail, GBSLEP and Innovate4Rail programmes, and is available at a competitive cost for companies from elsewhere or who are not eligible for the European Regional Development Funding.

Further responding to Get Into Rail feedback, we are now working on a new series, titled Fast Track 4… which will have a number of themes, commencing in November 2021 with Fast Track 4 Innovation for companies engaged in and wanting to engage in new product/service development. We will be able to fund attendance for eligible SMEs in the same regions, and again we are keeping the cost to an accessible minimum for other organisations. You can find out about the course and how to sign up via Alec Gillham, Business Engagement Manager, on c.a.gillham@bham.ac.uk

The University of Birmingham, East Riding Yorkshire Council and Siemens

Work has started on a new multi-million-pound rail research and innovation facility on the site of Siemens Mobility's new manufacturing site in Goole, East Yorkshire.

The development will include a £50m centre of excellence developed between **Siemens Mobility** and the **University of Birmingham**.

Called the Rail, accelerator and innovation solutions hub for Enterprise (RaisE), the development will provide 3,200m² of commercial floor space made up of grade-A office and workshop accommodation, high quality conferencing facilities, and a communal café hub that will act as a focal point for the business park.

The first phase of the development is being delivered by East Riding of Yorkshire Council and is expected to be completed by late 2021/early 2022.

This £8.1million project has secured £1.5m from the European Regional Development Fund (ERDF) and £1m from the Getting Building Fund, via the Hull and East Riding Local Enterprise Partnership (HEY LEP), to help finance the project.

The collaboration between Siemens Mobility and the University of Birmingham will be carried out in phase 2 of the project.

In July 2021 East Riding of Yorkshire Council celebrated a key milestone in the construction of the multi-million pound RaisE business centre in Goole with a 'steel signing' launch event.

In accordance with the current COVID protocols, up to 30 people from the council, Siemens Mobility, University of Birmingham and Willmott Dixon attended the site for an opportunity to see first-hand the progress of the RaisE business centre and observe the final plans.

Several speeches were also made by key stakeholders reflecting on the project before the eagerly anticipated steel signing occurred with the leader of the council, Councillor Jonathan Owen, chief executive Caroline Lacey and Siemens Mobility's managing director Sambit Banerjee the first to add their signatures to the steel.

Jo Binstead, Head of Education and Skills at Siemens and UKRRIN Chair said, "the RaisE Business Centre is clearly on its way. And so now, not satisfied with just the Business Centre part of our vision, we are working on RaisE Phase 2, this takes us beyond the enterprise part of RaisE and towards the innovation and solutions hub element of RaisE, it has automation, digital systems and rail decarbonisation at its core, and like the original UKRRIN, it will be a public-private investment within the UKRRIN Network".

HYDRO FLEX

Zero emissions for a greener railway

From humble beginnings as a PhD research project and BCRRE's regular entry to the Institution of Mechanical Engineering's Railway Challenge, the HydroFLEX project was born in 2018 when we demonstrated the Hydrogen Hero narrow-gauge loco at Rail Live and it caught the eye of Porterbrook. We signed an agreement that September during the Innotrans trade fair and the team started work towards the prototype train which was unveiled as the UK's first full-scale hydrogen train during the 2019 Rail Live exhibition.

Supported by £750,000 in grant funding from the Department for Transport's First of a Kind Scheme, and following almost 2 years' development work and more than £1 million of investment by both Porterbrook and the University of Birmingham, HydroFLEX made history on 29th September 2020 as the first-ever hydrogen-powered train to run on the UK mainline.

Unlike diesel trains, hydrogen-powered trains do not emit harmful gases, instead using hydrogen and oxygen to produce electricity, water and heat.

The team is now developing the first prototype production version of HydroFLEX. The ground-breaking technology behind the trains will also be available by 2023 to retrofit current in-service trains to hydrogen, helping decarbonise the rail network and make rail journeys greener and more efficient. Meanwhile, visitors to the UN COP26 conference in Glasgow in November will be able to see the current HydroFLEX train and take a ride.

The project aims to roll out UK-produced hydrogen trains onto the rail network in the near future; further exploit hydrogen propulsion technology; and develop the hydrogen supply chain to support the technology.

We were not the only people interested in the success of HydroFLEX. The mainline testing achievement was picked up across the BBC, including on BBC One Breakfast, local BBC news, Radio 4 and Radio 5, and in the daily press including The Telegraph, The Times, the Evening Standard and The Guardian. It's also been one of BCRRE's most popular social media features, being retweeted by Hons Grant Shapps, Geoff Marshall, Guy Opperman, Adam Vaughan, Preet Gill, John Murton, Claire Gott, and many more.

To cap off the achievement, we also won the Guardian Award for Business Collaboration of the year 2020!
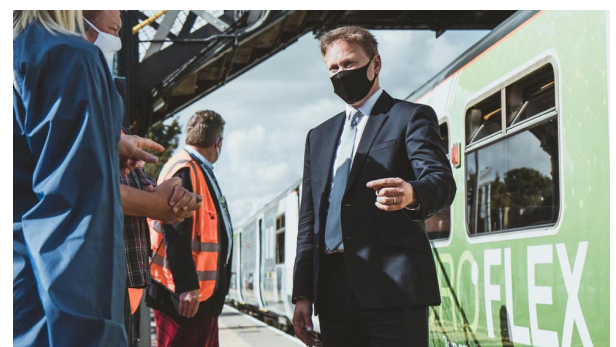
WCRR
BIRMINGHAM UK | 2022

The World Congress on Railway Research (WCRR) is the world's largest international congress on railway research, founded by SNCF (France), DB AG (Germany), Trenitalia (Italy), RTRI (Japan), RSSB (UK), TTCI (USA) and UIC.

WCRR was first held in 1994, hosted by SNCF, and the coming WCRR 2022 in the UK will be the 13th Congress. From the beginning, WCRR has aimed to provide opportunities for an overview of railway technical development and to discuss its future direction from the management perspective of the world's railway operators. WCRR is the only cross-thematic congress in the world dedicated to the subject on innovation in the railway sector, addressing everyone from railway companies to industry and research institutions.

Hosted by the University of Birmingham and RSSB **WCRR 2022**, will be held in Birmingham, UK from 6 – 10 June 2022, with a major gathering for the global railway research and innovation community to exchange ideas, and will also be a great opportunity to present the technology of your organisation to railway experts from around the world.

WCRR
BIRMINGHAM UK | 2022

#wcrr2022

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Birmingham

World Congress on Railway Research 2022
Reshaping our railways post-pandemic: Research with an impact

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