

UNIVERSITY OF  
BIRMINGHAM

BCRRE

**BIRMINGHAM CENTRE FOR RAILWAY  
RESEARCH AND EDUCATION**

**BCRRE 2017-18**

**Annual Report**



**BIRMINGHAM CENTRE FOR RAILWAY  
RESEARCH AND EDUCATION**



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BIRMINGHAM**

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# FOREWORD

I am delighted to be able to present the first BCRRE Annual Report. Although we have been undertaking research in Railway Systems at the University of Birmingham for nearly 50 years, this is the first time we have issued an annual report.

It has been a particularly good year for us at BCRRE. Over the last 12 months our work in bidding and securing £92M to form the UK Rail Research and Innovation Network (UKRRIN) culminated in a launch event at the House of Commons in February. Also in February we were honoured to be invited to Buckingham Palace to receive the Queen's Anniversary Prize for Higher and Further Education in recognition of our work in advanced engineering and innovative technology in support of the UK rail industry. Construction of our new UKRRIN Centre of Excellence in Digital Systems began earlier in the year, and we have recently held a ground breaking ceremony to mark the beginning of formal construction. We are looking forward to the complete building being handed over to us in March 2020.

As a result of further significant investment from the University, BCRRE continues to grow in size, breadth and reach. We have increased our staff numbers considerably over the past 12 months. In early 2018 we recruited Professor Roger Dixon who

moved with a number of his team to BCRRE from Loughborough University. We have also recruited Alex Burrows as a Director for BCRRE: Alex will oversee the growing professional services team which has been lucky enough to make a number of key appointments over recent months. We also have recruited a number of new research fellows, and we are looking forward to a new cohort of PhD, MSc and undergraduate students starting in the new academic year.

2018 sees the launch of our new MSc programme in Railway Safety and Control Systems, which is endorsed by the Institution of Railway Signalling Engineers, and provides a new route to IRSE membership. We have contributed to the specification for rail industry apprenticeships over the last year, and we are looking forward to developing new courses for the industry over the coming year. We have also been working with a number of our industrial partners to develop bespoke education programmes for their staff – stretching from programmes for new graduates through to senior executive technical and business skills courses.

Our research interests continue to grow. Our work on Digital Twin technology, Zero On-Site Testing, Next Generation Switches, Intelligent Infrastructure and Hydrogen Traction are developing particularly exciting work, which we are looking forward to disseminating over the coming year.

Our international profile continues to grow. We have continued to work extensively in

Asia and Europe, and have developed new relationships that have started research projects in South America and Africa.

The work we are conducting on behalf of the Department for International Development is particularly important, and will develop further relationships and opportunities in sub-Saharan Africa and South Asia. In December we will be chairing a special session on transport data at the IEEE International Conference on Big Data in Seattle on transport data, and co-chairing the 3rd instalment of the IEEE International Conference on Intelligent Rail Transportation in Singapore. Closer to home, we have also initiated a new project to work with SMEs across the West Midlands region who work, or have potential to work, in the area of digital rail technology.

**I very much hope you enjoying reading our Annual Report. I do hope that we will have time to work together over the coming year.**

A handwritten signature in black ink, appearing to read 'Clive Roberts', written over a light-colored background.

**Professor Clive Roberts**, Head of BCRRE



It is with much pride that we publish our first BCRRE annual report. BCRRE is a thriving Centre with a passionate, enthusiastic and highly capable team of people across our both our commercial and professional services team and our academic group.

In the last 12 months BCRRE has been extremely busy – working on a number of exciting research projects and further developing our world-class rail education offering. In addition, the launch of the UK Rail Research and Innovation Network has been transformational in enabling us to build our collaborative activities with the rail industry and other rail schools across the UK. We have also seen building work begin on the new School of Engineering and the Centre of Excellence in Digital Systems which will be our new home in 2020.

This new facility will be a fantastic resource for the BCRRE team and our colleagues and collaborators from industry and academia to work with us to deliver the railway of the future.

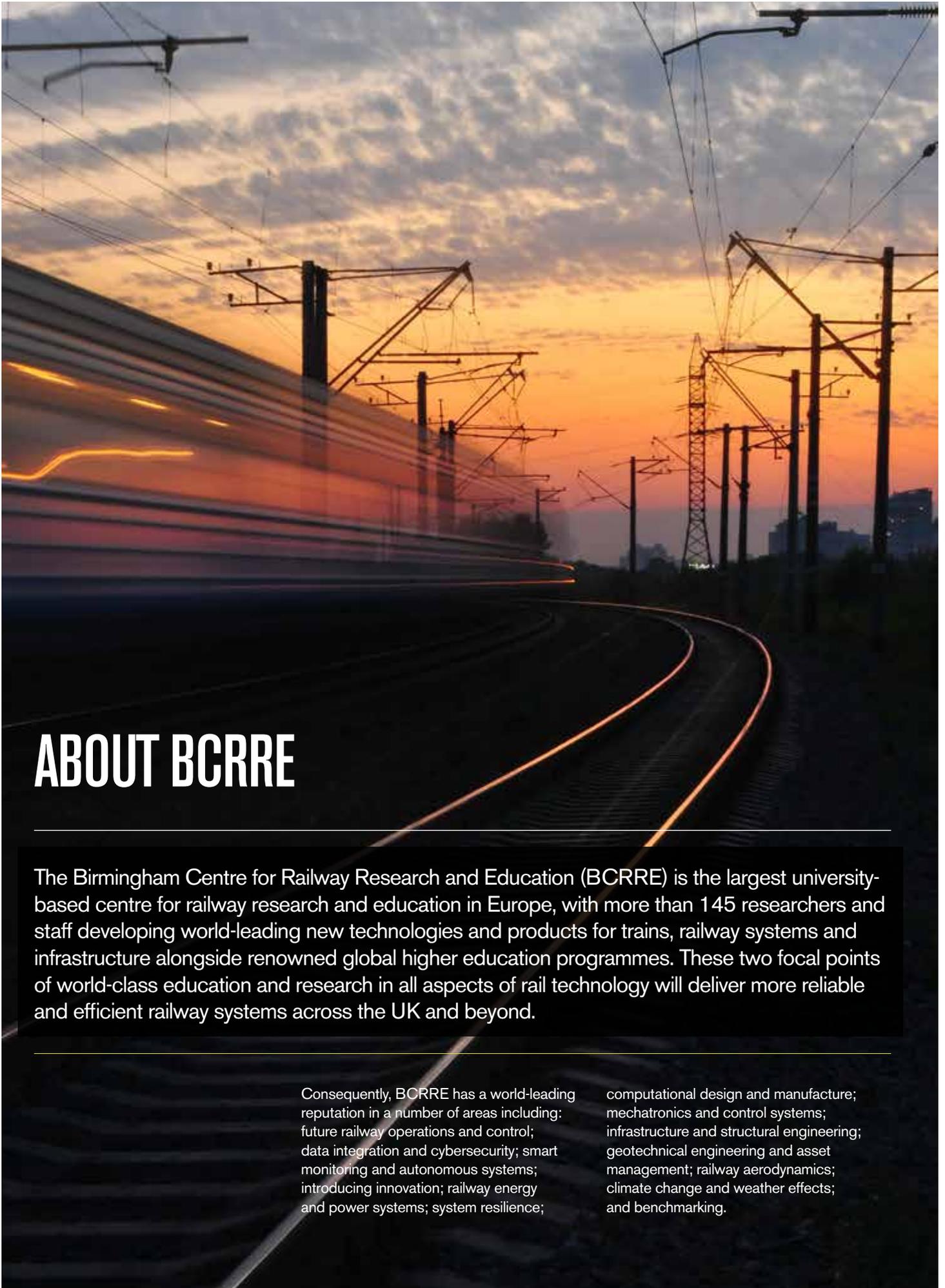
Our BCRRE 2025 Strategic Business Plan sets out our aims and priorities for how we intend to continue the development of BCRRE and achieve sustainable growth.

A key objective for BCRRE is to demonstrate the importance of R&D and innovation to the rail industry and to showcase our role as a key part of that industry. Over the next 12 months, we will be proactively championing the case for rail R&D investment and boosting UK rail innovation activity which is very much aligned with the current position of the UK Government as set out in the Industrial Strategy.

The UK rail industry is a fantastic place to work and to be a part of – I hope that we convey our enthusiasm and commitment to growing railway research and education activity and playing our part in championing the railway.

A handwritten signature in black ink, appearing to read 'Alex Burrows'. The signature is stylized and fluid.

**Alex Burrows**, Director, BCRRE



# ABOUT BCRRE

The Birmingham Centre for Railway Research and Education (BCRRE) is the largest university-based centre for railway research and education in Europe, with more than 145 researchers and staff developing world-leading new technologies and products for trains, railway systems and infrastructure alongside renowned global higher education programmes. These two focal points of world-class education and research in all aspects of rail technology will deliver more reliable and efficient railway systems across the UK and beyond.

Consequently, BCRRE has a world-leading reputation in a number of areas including: future railway operations and control; data integration and cybersecurity; smart monitoring and autonomous systems; introducing innovation; railway energy and power systems; system resilience;

computational design and manufacture; mechatronics and control systems; infrastructure and structural engineering; geotechnical engineering and asset management; railway aerodynamics; climate change and weather effects; and benchmarking.

# INTRODUCING THE NEW BCRRE SENIOR LEADERSHIP TEAM

The newly-established **BCRRE Senior Leadership Team** is responsible for leading BCRRE, setting the strategic vision and ensuring that BCRRE continues to deliver innovative railway research and education, sustaining our growth and position as a world leader in our field.



**Professor Clive Roberts,**  
**Head of BCRRE**

Lead for BCRRE; overall responsibility for current research, education and consultancy activities in the UK and overseas, as well as the advancement of BCRRE in line with the Strategic Business Plan; lead for large Centre-wide activities; lead for UKRRIN.



**Professor Anson Jack,**  
**International Director**

International face of BCRRE; building and maintaining international relationships; ownership of institutional knowledge for overseas relationships and activities; host/lead contact for international visits; owner of strategy for international opportunities.



**Professor Roger Dixon,**  
**Research Director BCRRE**

Lead for the REF; institutional knowledge and planning of BCRRE capabilities; PGR student experience and enrichment; coordination of bidding and ownership of best practice.



**Alex Burrows,**  
**Managing Director**

Leads the Commercial and Professional Services team; management of the Centre; responsible for commercial activities, external engagement, business development, delivery, corporate services; lead representative for BCRRE to industry and Government.



**Professor Felix Schmid,**  
**Director of Education**

Owner of Education Strategy; oversight of existing programmes and development of new programmes; strategy direction and leadership of processes/approaches; lead for best practice for delivering education.



**Dr Holly Foss,**  
**Deputy Director of Education**

Lead for the development of future courses and collaborations; lead for equality, diversity and inclusion.

## INTRODUCING BCRRE 2025: OUR SEVEN-YEAR STRATEGIC BUSINESS PLAN

Alongside the publication of this first ever BCRRE Annual Report, we are also delighted to publish our first strategic business plan for BCRRE: BCRRE 2025.

BCRRE 2025 is our plan for continuing our trajectory of sustainable growth, combined with maintaining and enhancing our world-class

capabilities in railway research, education and innovation activities.

**This strategic business plan is structured around three overarching objectives:**

- (1) Sustaining our position as a world leader in railway research and education
- (2) Developing our capabilities
- (3) Working with our partners to transform the rail R&D landscape.

Download your copy at  
[birmingham.ac.uk/railway](http://birmingham.ac.uk/railway)

SEPT  
2017



OCTOBER 2017

BCRRE's annual Prestige Lecture series began with Chris Gibb and Piers Connor discussing the 2016 Gibb Report to the Department for Transport on the Govia Thameslink Railway (GTR) Franchise. Thirteen BCRRE colleagues and associates travelled to Singapore to deliver six modules to the Urban Railway Engineering (Singapore) cohort of 251 students.



SEPTEMBER 2017

The 2017/18 academic year began with 125 Birmingham-based students enrolling on new postgraduate taught programmes of study, continuing programmes and CPD modules. The new postgraduate research student community reached over 120 full- and part-time students. The 23rd year of RSEI and the 5th year of RRSM kicked off with the working and induction weekends.

OCT  
2017

# TIMELINE OF PROGRESS AND ACHIEVEMENT

# BCRRE 2017/18

MARCH 2018

Rachel Eade MBE joined BCRRE as Business Development Manager with a focus on local business engagement and developing research partnerships. Rachel had held positions in the West Midlands Manufacturing Advisory Service and continues to operate her own consultancy supporting the region's automotive industries.

The largest group yet of 17 colleagues and associates travelled to Singapore to deliver a further six modules, including the last modules for the first cohort who will graduate in November 2018.



MAR  
2018

APRIL 2018

Alex Burrows joined BCRRE from Alstom to lead our Commercial and Professional Services team.



APR  
2018

BCRRE successfully hosted the inaugural International Seminar for Rail Education and Training, welcoming over 100 professionals from industry and academia across the globe. This three-day conference included two days of presentations from global academia and industry experts, and a third day kindly hosted by the National College for High Speed Rail. We took the opportunity to sign Memoranda of Understanding with Southwest Jiaotong University and with MTR.



**NOVEMBER 2017**

The second Prestige Lecture featured Stuart Calvert of Network Rail on the Digital Railway of the Future. The University of Birmingham launched its Technical Academy, celebrating and developing the key functions of technical support across the institution. BCRRE's Hydrogen Train took pride of place in the event.



**DECEMBER 2017**

Birmingham hosted the first Digital Railway Delivering Differently conference, in partnership with Network Rail and the Railway Industry Association (RIA), welcoming over 200 delegates and 20 exhibitors who had braved some of the UK's deepest snow for years.

Presenters included Head of BCRRE Professor Clive Roberts, Digital Rail's Stuart Calvert and David Waboso, and RIA's David Clark. The audience found out about the digital rail strategy, what it means to their organisations and where support for innovation is available.

The exhibition fostered new networks across the supply chain and case studies on the Early Contractor Involvement initiative demonstrated exciting opportunities.



**FEBRUARY 2018**

The UK Rail Research and Innovation Network (UKRRIN) was formally launched at a Reception in the Houses of Parliament. The Rail Minister, Jo Johnson MP, joined BCRRE and our academic and industry partners to celebrate the launch and to congratulate the partnership, committing £92m of public and private investment in UK rail R&D over the next ten years.



Professor Clive Roberts joined the Chancellor and Vice-Chancellor at Buckingham Palace to receive the Queen's Anniversary Prize for Higher Education.



**JANUARY 2018**

Mark Phillips of RSSB gave the next in the series of BCRRE Prestige lectures, presenting the case for an independent rail system authority. BCRRE hosted representatives of RSSB, Shift2Rail and Innovate UK who outlined their programmes, results to date and collaboration opportunities, together with ongoing programme participation in a post-Brexit Europe. Information was also provided on other Shift2Rail projects, H2020 and the European Rail Research Advisory Council (ERRAC), and practical sessions focused on consortium building and elevator pitches for project support.



TIMELINE CONT. ON NEXT PAGE

MAY  
2018

**MAY 2018**

Six staff led 45 students on the 22nd and 23rd European Study Tours which took in Portugal, Spain, and France, and Germany, Belgium and France respectively, to provide students with vital real-world applications of railway systems.

Professor Roger Dixon joined BCRRE from Loughborough University to lead our Mechatronics and Control Systems Group.



**JUNE 2018**

Dr Holly Foss joined BCRRE full-time as Deputy Director of Education, having previously shared her time as a Teaching Fellow between BCRRE and another School.

CONT.



Robert Hopkin joined BCRRE as Head of Research and Education Development, coming from the Rail Alliance where he maintains a non-executive director position.



JUNE  
2018

# BCRRE

BCRRE wins the University of Birmingham Research Impact Award for Outstanding International Impact.



SEPT  
2018

**SEPTEMBER 2018**

BCRRE took part in the ground-breaking ceremony for the new School of Engineering building. This will become the new home for BCRRE and our UKRRIN Centre of Excellence in Digital Systems in Spring 2020.

BCRRE is at Innotrans 2018 in Berlin: announcing new projects and partnerships; providing updates on key themes and research projects; and fostering new and existing collaborations.





BCRRE's Hydrogen Hero was the star of the show at Rail Live as the first operational hydrogen fuel cell train running with passengers in the UK, including a feature on the BBC News. The BCRRE team led a strong presence representing our Centre and the UK Rail Research and Innovation Network. Our Innovation Theatre was also a huge success.



### JUNE 2018

The week after Rail Live, Hydrogen Hero followed up with a fantastic third place finish (and the first-placed student team) at the IMechE Railway Challenge held at the Stapleford Railway.



## TIMELINE OF PROGRESS AND ACHIEVEMENT

# 2017/18



### JULY 2018

### JULY 2018

BCRRE successfully hosted the Digital Railway Delivering Differently 2 conference, again in partnership with Network Rail and the Railway Industry Association. Professor Clive Roberts and Alex Burrows both gave keynote presentations on Digital Railway technologies, current international experience in digital train control systems, and on the proposed Rail Sector Deal with Government.



Professors Clive Roberts and Anson Jack won the University of Birmingham Founders Award for Excellence in Business Advancement. This was in recognition of their leading involvement in the successful establishment of the UK Rail Research and Innovation Network, bringing together industry and academia in a £92m partnership to drive UK rail research and development.



Professor Clive Roberts joined the Midlands Engine Innovation and Enterprise Board, and Alex Burrows joined the Rail Supply Group Council and the Midlands Rail Forum Board. The Commercial and Professional Services team began to take shape with further recruits joining, including Kevin Blacktop from Network Rail.

# WORLD-LEADING R&D CAPABILITIES

1

## FUTURE RAILWAY OPERATIONS AND CONTROL

The team delivers world leading research to promote the development of advanced railway traffic management and train control systems to make better use of existing railway infrastructure in terms of capacity, cost, energy and customer satisfaction.

### **Railway simulator development**

Macroscopic and microscopic railway simulator development for railway research, that analyses and evaluates different scales of railway networks with different signalling systems, rolling stock, operation rules and timetables. It has capabilities to integrate with other tools.

### **Railway traffic management and train control**

Advanced algorithm development for railway traffic management; research on application of Driver Advisory Systems, ATO over ETCS; simulation, testing and evaluation for railway traffic management systems; and research on standards of next generation digital railway traffic management; innovative train control systems.

Most projects take place in collaboration with industrial partners, where we are developing advanced railway traffic management algorithms and analysing traffic management system performance.

Several journal papers from our research team have been published in the top railway journals such as IEEE ITS Magazine, IEEE Transaction on ITS, Transportation Research Part C, Safety Science, IET Transaction on ITS.

### **Railway system optimisation**

Railway system optimisation for energy saving; and railway wireless data communication system modelling and optimisation.

Simulation and testing lab for railway systems:

Railway system design validation and verification; and hardware in-loop testing.

**Team: Dr Lei Chen (lead)**

As the largest specialist railway research and education centre in Europe, BCRRE combines a wide range of world-leading capabilities in rail-focused disciplines.

**Our UKRRIN Centre of Excellence in Digital Systems comprises FOUR core areas of work:**

### **Current and recent projects**

#### **ONTIME (EC FP7)**

This EU FP7 project is to integrate railway timetabling, real-time train rescheduling and operations management, with driver advisory systems for advanced traffic management.

Capacity4Rail (EC FP7) EC FP7 project aiming to increase capacity for rail networks through enhanced infrastructure and optimised operations.

#### **DEDOTS**

This RSSB funded project seeks to provide decision support for system designers, as well as leading to improved methods for real time control of railway operations.

#### **Energy optimisation strategies for metro systems**

We are completing a number of projects to develop and implement metro system energy saving optimisation strategies.

We expect to drive out energy savings of over 10% on specific Metro systems as a result of this work.

#### **CBTC system simulation and testing platform**

A research project to create a simulation and testing platform for CBTC systems.

#### **COMPASS**

A new alternative train control system to backup ETCS with Siemens, Park Signalling.



2

## DATA INTEGRATION AND CYBERSECURITY

The Data Integration and Cyber Security team deals with fundamental questions around the representation, storage, and processing of rail industry datasets, with the aim of delivering actionable information to industry staff. Recent activity by the team in this area has been focused on how data should be managed in order to ensure that known quality levels are maintained, and that the wider context that the data fits in is correctly captured. Recent projects include the data integration elements of a degraded mode signalling system proof-of-concept (with Siemens Rail Automation and Park Signalling), the data-driven prediction of climate-related (wind, heat) delays to services (Network Rail), and contributions to the Shift2Rail Canonical Data Model (CDM) proposals.

The team's security work is mainly focused on the Operational Technology (OT) elements of the railway, and is performed in conjunction with security experts from the University of Birmingham's Security and Privacy Group based in the School of Computer Science, and the Research Institute in Trustworthy Inter-connected Cyber-physical Systems led by Imperial College.

OT systems present several unique challenges to the security community, as they are characterised by long service lives, low patching / update rates, and in many cases (including rail) a significant geographical spread of assets.

Work recently completed by the team as part of the three-year SCEPTICS project began to develop approaches for identifying and managing risks to OT systems within the rail domain, and this activity is now being taken forward in a further two-year programme of work funded by the National Cyber Security Centre (NCSC).

**Team: Dr John Easton (lead)**

3

## SMART MONITORING AND AUTONOMOUS SYSTEMS

The Smart Monitoring and Autonomous Systems theme builds on the BCRRE hardware and algorithms team's extensive experience in the field of instrumentation and condition monitoring system development. This expanded theme allows these fields to be brought together with complementary skills in robotics and autonomous systems to develop the next generation of automated railway inspection and monitoring.

In addition to novel automated inspection technologies and processes, the Smart Monitoring and Autonomous Systems theme will further the development of condition monitoring hardware with increasing ranges of sensors applied in a broadening range of applications. Communications networks and low power / energy harvesting devices will allow ubiquitous deployment of monitoring systems using an Internet of Railway Things framework, or targeted systems to be deployed in the most challenging of environments. In addition to new hardware, the theme will see the development of new algorithms and the production of data processing toolboxes that can be used in a range of applications.

The Smart Monitoring and Autonomous Systems theme also encompasses the UKRRIN Centre for Excellence in Digital Systems' capacity for independent verification through specific asset test rigs, and its sensor and acquisition technology library.

**Team: Dr Edward Stewart (lead)**

4

## INTRODUCING INNOVATION

Core to the success of UKRRIN will be the realisation of research outputs into commercial products, processes and systems. This theme will bridge the gap between research and technology introduction, enabling the railway industry to get there sooner, improving the industry's bottom line and reputation, and supporting the UK's export agenda.

Within this theme we will work closely with other members of BCRRE and our industrial co-investors in UKRRIN to create and disseminate knowledge in for the benefit of the industry. Key activities will include road-mapping of benefits to aid investment and process decision-making; aligning stakeholders together to enable rapid technology adoption; identifying benefits and structuring stakeholder incentives; and carrying out system integration testing to speed up approvals.

**Team: Prof Anson Jack (lead)**

WORLD-LEADING CAPABILITIES



**FURTHER CAPABILITIES INCLUDE:**

**Power and Energy System optimisation**

The Power and Energy Systems Optimization research team have worked on a number of challenging industry funded research projects which have delivered large benefits for the railway industry.

These projects include work funded by ATOC (now the Rail Delivery Group) where our team developed the methodology for partial fleet metering, thereby saving DC train operators significant costs in the introduction of metered rolling stock. The research team are also active on the international stage and are currently undertaking a research project for SMRT in Singapore which aims at whole system energy optimization.

Our optimization work has also been of benefit closer to home on the Edinburgh Tram Network, where in collaboration with Ricardo Rail we have implemented the company's SmartDrive product. This is currently making savings of around 17% of traction energy demand. We are expecting to deploy SmartDrive more widely in the coming months as other tram and light rail operators seek to deliver energy savings.

Our work for RSSB has also recently involved developing Road Maps, Options, and an Expert System to assist the industry in its mission towards decarbonisation. We are

also supporting this through our leading work on Hydrogen trains we are currently developing plans to roll this out on the mainline as a solution for decarbonised railways for the future  
**Team: Dr Stuart Hillmansen (lead)**

**Power Electronics and Drives**

The Power Electronics and Electrical Drives research group tackles fundamental challenges of modelling, simulation and control of power converters as applied to traction drives and railway electrification systems. The group works on a number of research projects at various technology readiness levels (TRLs). These projects include work funded by EPSRC and the EPSRC Centre for Power Electronics to develop the new generation of traction systems that includes battery and fuel cell powered electrical drives, which will facilitate the transition to electrification of current diesel fleets.

The group is also active on railway electrification systems and the research funded by RSSB has informed the railway industry on the benefits and challenges of replacing single-phase transformers for AC railways with three-phase to single-phase AC/AC converters, which would enable a much higher level of integration and energy inter-exchanges between railway power supplies and power grids.

On the international arena, the group is currently working on a large H2020 European project with eight EU partners to develop a new power electronics-based smart soft-open

point that will enable a controlled connection between the railway power supply and the renewable energy sources and energy storage of local distribution grids, whereby significantly reducing power losses of both networks.

The project is expected to deliver a practical demonstrator that will be tested and validated on Metro de Madrid in Spain. The group has been recently invited to join the "Clean Cluster" of the EU, which informs the EU Commission on the progress and future directions of low TRL projects on smart grids and storage.  
**Team: Dr Pietro Tricoli**

**Mechatronic and Control Systems**

The Mechatronic and Control Systems group draws its research funding and experience from a range of sectors, but with a particular focus on rail. Rail research includes: design of railway track switches (projects such as IN2RAIL, REPOINT and S-CODE), new concepts for mechatronic vehicles using active suspension and guidance, condition monitoring systems for railway vehicles and infrastructure, and, model-based control estimation and load management for electric vehicles.

The group's skill-set is founded on the science and mathematics of control engineering and includes: Modelling and Simulation, System Identification, model-based estimation and control design, Fault-detection, Fault-tolerant, Health/condition monitoring.  
**Team: Professor Roger Dixon (lead)**



### **Computational Design and Manufacture**

The team is currently working on the following projects; S-Code (radical switch and crossing design); SMRT IRJ Project (developing new monitoring device and propose optimize design for IRJ); SCT project (design of condition monitoring system for switch and crossing).

**Team: Dr Hassan Hemida (lead)**

### **Infrastructure and Structural Engineering**

The Infrastructure and Structural Engineering group has extensive international expertise in transport infrastructure engineering and management, successfully dealing with all stages of infrastructure life cycle and assuring safety, reliability, resilience and sustainability of rail infrastructure systems. We also have outstanding skills in business management and continuous improvement of customer experience.

The group has produced more than 350 technical publications and over 120 authoritative reports. Many collaborative projects have been successfully delivered to industry and public bodies in diverse areas of rail engineering, track engineering, track components, structural and geotechnical engineering, maintenance and construction. Current featured projects include the award-winning RISEN ([www.risen2rail.eu](http://www.risen2rail.eu)), which has already led to over 120 open-access

publications in the area of rail infrastructure resilience and advanced monitoring in the face of multi hazards and extreme events. The project has won an official recognition as 'excellent innovations' by the EU commission.

**Team: Dr Sakdirat Kaewunruen (lead)**

### **Geotechnical Engineering and Asset Management**

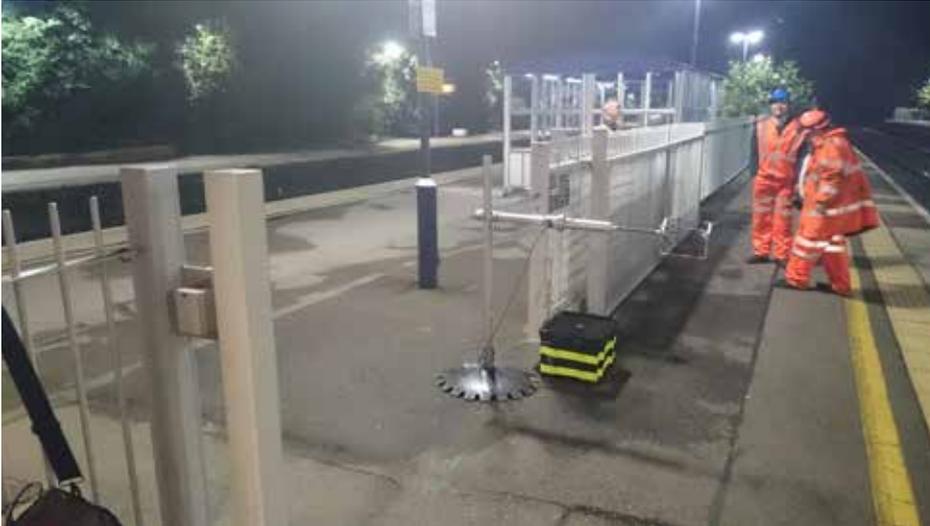
The Geotechnical Engineering and Asset Management research team works closely with industry to produce unique, world-class solutions in railway track infrastructure asset design, monitoring, maintenance and remediation areas.

The dedicated team of two academic members of staff, one research fellow and five research students are currently working on a number of industry funded research projects including: improving the performance of existing railway track through a variety of novel railway track remediation and maintenance techniques (for Network Rail), incorporating novel risk informed techniques and tools within drainage maintenance management (for Network Rail with support from the University's Impact Acceleration Fund), utilizing whole life and whole system risk cost informed approaches to improve railway track investment decision making (with Intellex utilizing EPSRC follow on funding), and helping to scope the railway research agenda in Developing Countries (for the Department for International Development).

**Team: Dr Michael Burrow (lead),  
Dr Gurmel Ghataora**

**WORLD-LEADING  
R&D CAPABILITIES**

## FURTHER CORE CAPABILITIES INCLUDE:



### Railway Aerodynamics

Railway aerodynamics is covered by a team of four academics and three research fellows from the Wind Engineering and Aerodynamics group in Civil Engineering. The team run two major experiment facilities: the Transient Aerodynamics Investigation (TRAIN) rig based in Derby and the Atmospheric Wind Tunnel in the Civil Engineering labs on campus.

A broad range of research is undertaken covering full and model scale experimental studies, as well as complex numerical simulations. Recent projects include EPSRC project entitled 'The measurement of train aerodynamic phenomena in operational

conditions', which included additional full scale aerodynamic measurements on the West Coast Mainline supported by the Railway Safety and Standards Board.

In addition EPSRC project entitled 'Track systems for high speed railways: Getting it right' and EP/M012581/1 entitled 'The aerodynamics of close running ground vehicles' required novel experimental techniques to be developed at the TRAIN rig.

The group have also recently undertaken consultancy works for Network Rail High Speed (£60k).

**Team: Dr David Soper (lead)**

### Climate Change and Weather Effects

The Climate Change and Weather Effects team are working on several projects. These include developing quantitative methods to evaluate the UK transport network's resilience to extreme weather events and the effects of climate change (FUTURENET); Proof-of-concept in mapping operational delay data caused by severe weather-related events in both time and space (REWARD);

Identifying best practice and developing new methodologies to assist transport operators, authorities and transport system users to mitigate the impact of natural disasters and extreme weather phenomena on transport system performance (MOWE-IT); Operation of trains through flood water where various different scenarios were modelled to assess behaviour at different speeds and different levels of flood; the TRaCCA project (funded by RSSB), first reviewed and provided a platform for the dissemination of existing knowledge on climate change impacts for all sectors of the rail industry, and assessed gaps in the existing knowledge to set priorities for further research into climate change vulnerabilities.

This laid the groundwork for a further eight strands of work which will enable a step-change in the weather and climate resilience of the GB railway.

**Team: Dr Andrew Quinn (lead)**



## Benchmarking

The benchmarking team, led by Professor Anson Jack, conducts research into the relationship between safety and performance, the reporting of sustainability indicators for High Speeds Railways, the costs and benefits of platform screen doors, the evaluation of different options for level crossings, the development of strategy in the rail sector, the safety evaluation of new and complex systems, governance on Heritage Railways and initiated a formal benchmarking activity covering health and wellbeing for the rail sector in the UK.

New projects have been started looking at the use of power in the industry, and also the relationship between engineers and leadership. 2019 will see the launch of an international benchmarking association that provides both private comparisons and internationally recognised comparators.

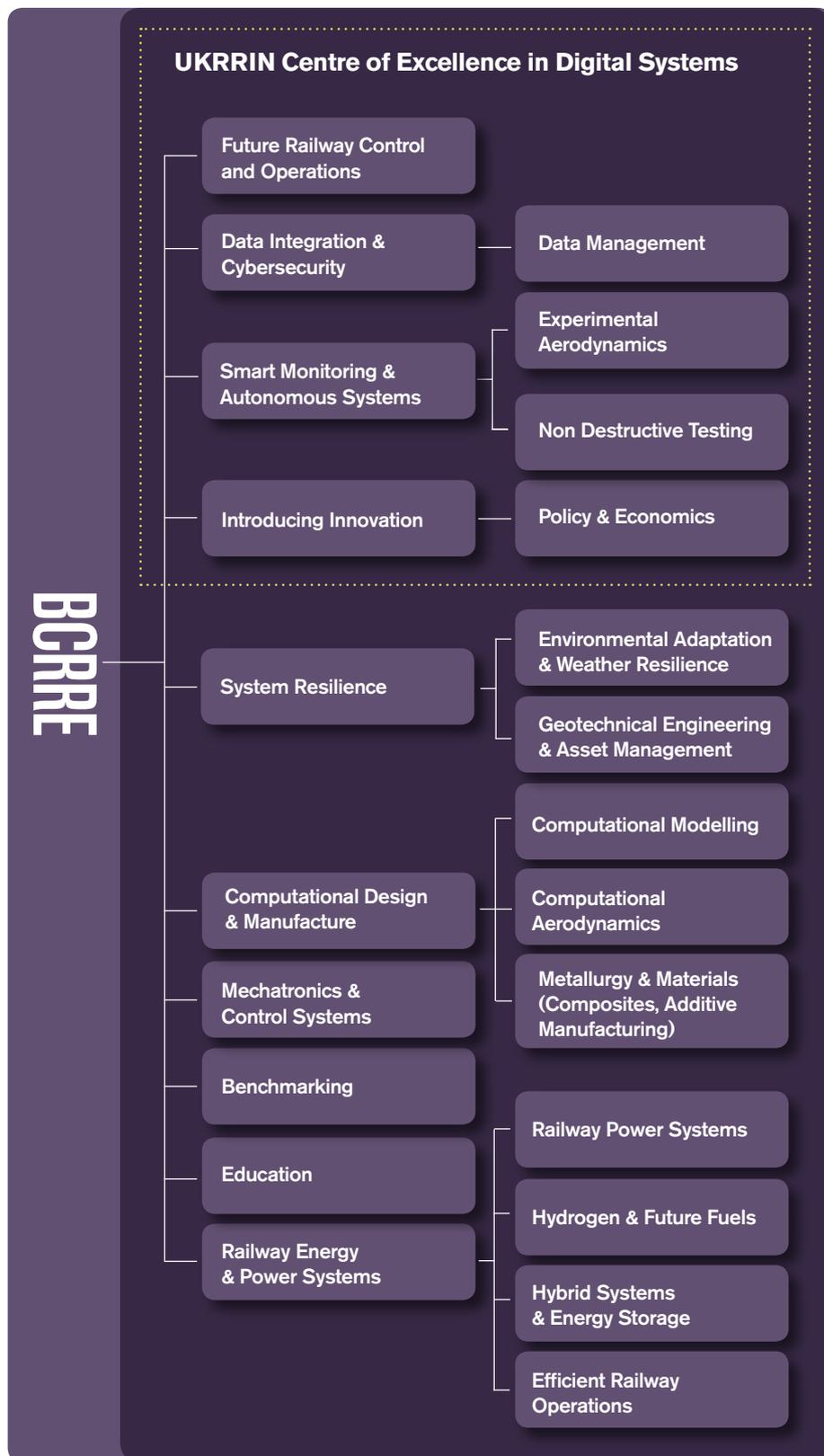
**Team: Professor Anson Jack (lead)**

## Education

The Education group leads the railway engineering undergraduate pathways, two taught MSc programmes, one MRes programme and one international PGCert, alongside a range of external programmes such as a short course for 16 and 17 year olds with the Smallpeice Trust.

As well as educating the next generation of railway professionals, the team focuses on best practice for railway systems teaching and learning, as demonstrated through the establishment of ISRET and the innovative methods for applications of learning such as the study tour and working weekend.

**Team: Professor Felix Schmid (Director of Education), Dr Holly Foss (Deputy Director of Education), Dr Charles Watson, Heather Close, Stephen Kent, Dr Hongsin Kim.**



# EDUCATION TO DEVELOP TRANSFORMATIONAL SKILLS AND LEADERSHIP

Since the arrival of the MSc in Railway Systems Engineering and Integration in 2005, educational provision has been at the heart of BCRRE. We welcome around 150 students each year and are home to a diverse range of study options, from undergraduate modules and masters' programmes, to postgraduate research and PhDs. With BCRRE at the centre of local, national and international development in railway systems education, this range of programmes is only set to grow further.

## PROGRAMMES

- Civil and Railway Engineering BEng, MEng
- Electrical and Railway Engineering BEng, MEng
- Railway Systems Engineering and Integration PGCert, PGDip, MSc
- Railway Safety and Control Systems PGCert, PGDip, MSc
- Railway Systems Integration MRes
- Urban Railway Engineering PGCert\*
- Railway and Systems Engineering PhD

\*Collaborative programme with SMRT, only available in Singapore

## CPD MODULES

- Railway Operations and Control Systems
- Rolling Stock Infrastructure and Interactions
- Practical Ergonomics for Railway Systems
- Strategic Business Management for Railways
- Railway Traction and Electrification Systems
- Principles of Railway Control Systems

## Studying at BCRRE

All Birmingham-based programmes are available for study on a full- or part-time basis. For international students, a form of distance-learning is also available whereby students travel to Birmingham for blocks of teaching, while completing their learning and assessed work from home.

In addition, industry-based professionals attend individual modules as part of their continuing professional development to develop enhanced technical knowhow, systems knowledge and skills.

## Experienced and inspirational teaching

BCRRE's education programmes are delivered by full-time teaching-focused academics, academics pursuing teaching and research, industry experts and other university departments. Together, they contribute to the successful running of our programmes ensuring a world-class education.

Our staff offer a huge range of expertise, having worked in diverse areas of the railway industry, and are supported by academic and professional qualifications to match. Our academics are members and fellows of engineering institutions and higher education institutes, ensuring unrivalled professional quality and specialisms across the board.



## A diverse and dedicated student body

We are very proud that BCRRE attracts students from all walks of life and corners of the globe. Some join us straight from an undergraduate degree while others have twenty or thirty years of industry experience. From Africa, the Americas, Australia, China, Europe, India, Southeast Asia and many other countries, they come as career changers or life-long rail enthusiasts. What they all share is a commitment to enhancing their knowledge and skills in the field of railway systems.

Our graduates are highly sought after, with many progressing to high-level careers in the railway industry and academic institutions. Recent graduate destinations have included the Chinese Bureau of Standards, Union Pacific Railroad, SNC Lavalin, Thalys, Atkins and the BBC.

Our worldwide alumni network is well established and covers all industrial areas and a wide range of expertise. Alumni provide invaluable contributions to our programmes, with many returning to Birmingham to deliver guest lectures providing real-life industry perspectives and up-to-date academic inputs.

## Collaborations and industry partnerships

Industrial engagement is a core element of our education programmes. Taught by academics with significant industry experience and by industry-based guest lecturers, students also benefit from site visits, the introductory working weekend, industry placements and the much-valued European Study Tour. All of these offer students crucial practice-oriented perspectives and know-how in the application of technical and non-technical railway systems concepts, including hands-on activities away from the classroom.

But at BCRRE, industrial engagement goes beyond classroom expertise and site visits. Academic partnerships enhance a number of our courses, such as the collaboration with the University of York's High Integrity Systems Engineering group and Beijing Jiaotong University which combines the leading thinking of three expert centres.

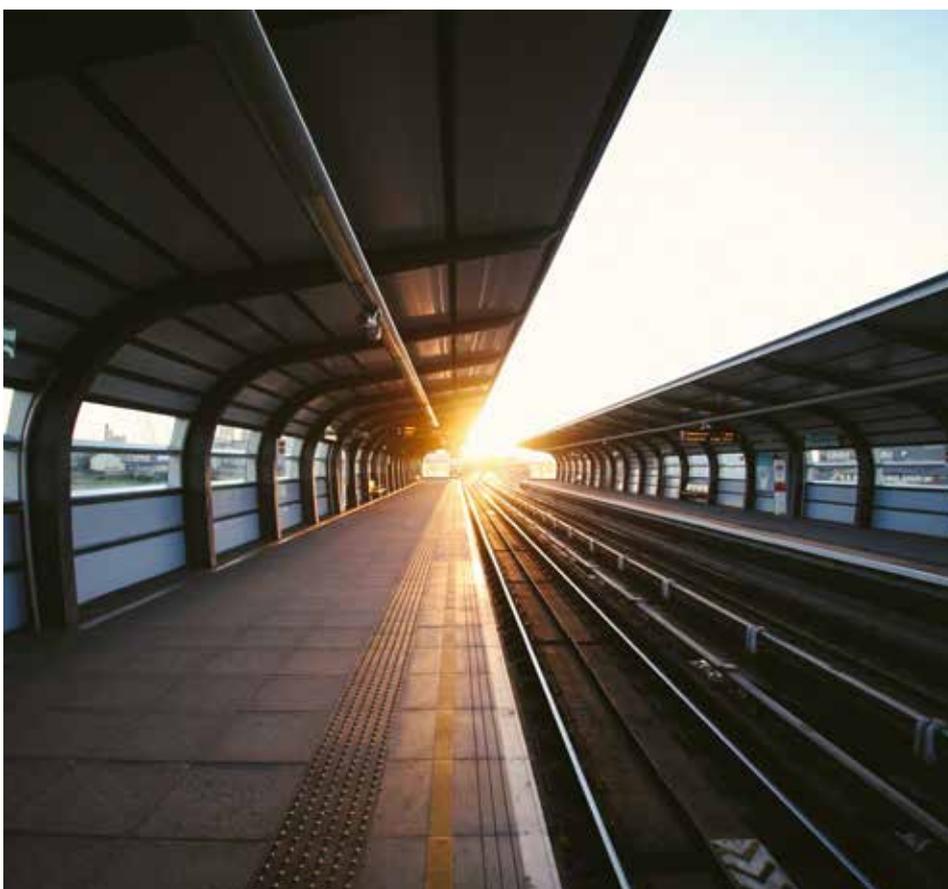
In 2018 we created a Railway Control Systems pathway as part of a review of the postgraduate programme in Railway Risk and Safety Management. This pathway is directly linked to accreditation by the Institution of Railway Signalling Engineers (IRSE).

## PROGRAMME SPOTLIGHT

The 2018 launch of the renamed MSc in Railway Safety and Control Systems showcases BCRRE's approach to continuous improvement. Established in 2013 in collaboration with the University of York and with financial support from the Lloyd's Register Foundation, the remit of the programme had been to provide railway industry experts in risk and safety management by combining expertise in railway systems engineering and risk management for a total system understanding.

The new name is reflective of a new structure within which the programme offers three specialist pathways for study:

- Risk and Safety Systems
- Risk and Safety Operations & Organisation
- Communications and Control



Our Urban Railway Engineering (Singapore) programme, commissioned by the main metro operator in Singapore, is also the result of a direct collaboration in course design, management and delivery between industry and academia.

In order to develop and formalise our industry engagement, in 2018-2019 we will launch our new Industrial Advisory Board, specific to railway education, and will engage more directly with industry via our new Head of Development, Rob Hopkin, and our incoming Industrial Fellows.

All pathways share essential modules on railway safety and risk management, while the third pathway was created in response to the needs of the Institution of Railway Signalling Engineers. Successful completion of the taught part of this pathway is expected to result in exemption from the IRSE examination.

Establishing this pathway has involved the creation of new modules encompassing classroom study and project-based learning, using a range of learning techniques to support student development.

## Bespoke courses

Alongside our taught higher education programmes, with most modules available for CPD, BCRRE develops and delivers bespoke short courses for and with industry. In the past, we have delivered 12 programmes for London Underground and hosted cohorts of engineers from SNCF's École Supérieure des Cadres de l'Infrastructure for a tailored programme on Britain's approach to railway management. Another long-standing short course is the Smallpeice Trust Railway Systems programme; a three-day residential STEM course for sixth form students.

Previous courses have been designed and delivered in conjunction with Angel Trains, the École Nationale des Ponts, Her Majesty's Railway Inspectorate, the Railway Accident Investigation Branch, Etihad Rail and Israel Railways. Most recently, BCRRE has been contracted by Bombardier to deliver an introduction to railways programme.

Educational research and best practice Higher education is undergoing a period of substantial change with the reshaping of its provision to develop socially engaged, digitally literate citizens ready for the challenges of the globalised 21st-century industry. We are witnessing a critical period for the railway industry at a time of significant local, national and global growth, which is resulting in ever-increasing demand for skills, people and R&D.

At BCRRE we believe that teaching and educational research, alongside technical expertise, are the best way to address the specific challenges of railway development as a socio-economic resource and an integrated technical system of systems.

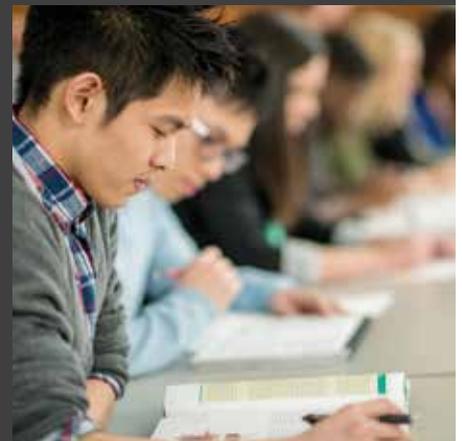
To this end, we have established the International Seminar on Railway Education and Training (ISRET). ISRET provides a forum to discuss how trainers and educators can address the needs of the railway industry and to consider best practice and pedagogies for delivering skills and knowhow.

The inaugural seminar attracted participants from around the globe encompassing industry and academic education and training professionals. With a forthcoming publication, biennial seminar, and the establishment of an expert board, the inaugural event became a starting point in an exciting development pinning together technical and educational expertise.

In further support of this strategic objective to put critical pedagogies at the centre of our railway education, this year we have welcomed a full-time lecturer in Railway Systems Education, Dr Holly Foss, as an academic member of staff dedicated to this aspect of BCRRE. Developing best pedagogic practice is a key aim and means that we have the technical, contextual, and educational expertise to support students, and industry, for railway sector growth.

## Programmes under development

BCRRE is currently working on developing new programmes in the area of digital railway leadership and degree apprenticeships at level 6 and 7 for railway engineering and railway systems engineering, in order to address key areas for sector-wide support and development. All programmes are embedded in the research culture of BCRRE.



## THE FUTURE FOR OUR EDUCATION DELIVERY

The BCRRE 2025 strategy is committed to sustainable growth and development to enhance our standing as a world leader in railway education and research. Our dual approach combining industry know-how and teaching expertise will allow us to achieve an even greater respect and reputation among staff, students and the railway sector. BCRRE is, and will continue to be, the place where national and global industry and academia find best practice in railway engineering and operations.

# A LOOK AHEAD FOR BCRRE

Next year promises to be even more exciting for BCRRE...

## KEY EVENTS:

**SEPTEMBER** – Innotrans 2018

**NOVEMBER** – the first UKRRIN Annual Conference

The first students to complete the Urban Railway Engineering (Singapore) programme will celebrate their success at a bespoke ceremony in Singapore led by Pro Vice Chancellor for International, Robin Mason, and attended by UoB and SMRTi staff.

**MARCH** – the RIA Innovation Conference

**JUNE** – Rail Live 2019



## Education

Our first IRSE-accredited Masters in Railway Safety and Control Systems course will be delivered and we will expand our short course offerings with CPD accreditation.

## New School of Engineering building

The new School of Engineering building will take shape rapidly over the course of the year. We will be planning how to make best use of the new space to provide a world-class experience for students and for our industry partners.

Our next Prestige Lecture series starts off in October. Check [birmingham.ac.uk/railway](http://birmingham.ac.uk/railway) for details.

## Industry

We will be further expanding our collaborative activities with industry partners through UKRRIN. BCRRE will be playing a much more proactive role in championing the value of investment in R&D and innovation activity to support the UK rail industry.

## DigiRail project

DigiRail will develop a unique Digital Rail Demand-led Demonstrator which will bring together national and international rail industry buyers with the regions businesses and research expertise to solve challenges within the industry and access the increasing number of digital rail commercial/ and research opportunities that exist in the sector.

It will build on BCRRE's established partnerships with major players in the rail industry including Network Rail, HS2, RIA, RSSB and TfL and a range of expertise in key domains of Digital Rail, including Traffic Management; the European Train Control System; Automatic Train Operation; Energy Management; Rolling Stock Design; BIM; Smart Ticketing; Future Wireless Networks; Fault Management; Station Information Systems; IoT and Cyber Security.

DigiRail will establish a cluster of Digital Rail Demand-led Demonstrators (with staff distributed across Greater Birmingham and Solihull, Coventry and Warwickshire) to showcase and offer long-term innovation support to businesses looking to develop digital products and services for the rail industry.



	NAME	ROLE
	Clive Roberts	Professor of Railway Systems and Director of BCRRE
	Felix Schmid	Professor of Railway Systems Engineering, Programme Director MSc in Railway Systems Engineering and Integration & Railway, Safety and Control Systems.
	Anson Jack	Professor in the School of Engineering, and Director, International at the BCRRE
	Roger Dixon	Professor of Control Systems Engineering
	Holly Foss	Deputy Director of Education and Lecturer in Railway Systems Education
	Stuart Hillmansen	Senior Lecturer in Electrical Energy Systems
	Lei Chen	Birmingham Fellow and Lecturer in Railway, Traffic Management and Train Control
	Edd Stewart	Lecturer in Electrical and Electronic Engineering
	John Easton	Lecturer in Data Science and Cybersecurity
	Michael Burrow	Senior Lecturer in Infrastructure Asset Management
	Gurmel Ghataora	Senior Lecturer and Admissions tutor for Postgraduate taught programmes
	Sak Kaewunruen	Senior Lecturer in Railway and Civil Engineering and Coordinator, RISEN
	Andrew Quinn	Senior Lecturer in Atmospheric Science and Engineering and Deputy Director of Education for the College of Engineering and Physical Sciences
	David Soper	Lecturer in Vehicle Aerodynamics, TRAIN Rig Manager
	Pietro Tricoli	Senior Lecturer in Electrical Power & Control
	Dr Mayorkinos Papaalias	Senior Lecturer in Metallurgy and Materials

## APPENDIX 1: BCRRE STAFF

NAME	ROLE
 Heather Close	Teaching Research Fellow
 Stephen Kent	Teaching Research Fellow
 Hongsin Kim	Teaching Fellow
 Charles Watson	Teaching Fellow

## BCRRE COMMERCIAL AND PROFESSIONAL SERVICES

NAME	ROLE	NAME	ROLE
 Alex Burrows	Director	 Sarah Yeo	Field Trials Officer
 Rob Hopkin	Head of Development	 Joy Grey	Senior Programmes Administrator
 Kevin Blacktop	Head of Delivery	 Nadeen Taylor	Centre Administrator and Events Coordinator
 Jenny Illingsworth	Head of Operations	 Mary Winkles	Research Administrator
 Rachel Eade	Business Development Manager	 Charanjeev Nandra	Education Support Administrator
 Michelle Morgan	Communications and Engagement Officer	 Adnan Zentani	Laboratory Manager
 Katherine Hayward	Project Manager	Rhys Davies	Computer Systems Specialist
 Sarah Jordan	Project Manager		

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