Institute for
Transport Studies (ITS)

UNIVERSITY OF LEEDS

ITS RESEARCH REPORT 2020

To mitigate COVID-19 spread in transport, Dr Zia Wadud has won major funding to tackle the pandemic in the global south. Professor Greg Marsden has also won Covid emergency funding for travel data collection. Professor Susan Grant-Muller is leading the ITS team investigating Covid-19 transmission on public transport (see TRACK project later in this report – led by SAGE member Professor Cath Noakes who received an OBE for her services to the Covid-19 response).

Dr Charisma Choudhury was awarded a prestigious Future Leaders Fellowship. The UKRI scheme invests in outstanding individuals across the UK. These research and innovation leaders will be supported to develop their careers while tackling ambitious global challenges. Dr Choudhury is developing next generation mathematical models of travel behaviour that can better predict people's travel activity and journey decisions (see NEXUS project later in this report).

Cycle prioritisation, e-bikes and micromobility are topics that have engaged a number of ITS researchers during 2020. Look in this report for projects led by Dr Robin Lovelace, Dr Ian Philips, Dr Haibo Chen and Prof Susan Grant Muller.

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Highlights of 2020

New research shows that **electrically-assisted bikes** (e-bikes) have the capability to slash carbon dioxide emissions from transport and could offer a safe and sustainable route back to work. e-bikes, if used to replace car travel, have the capability to cut car carbon dioxide emissions in England by up to 50% – about 30 million tonnes per year. Even replacing just 20% of car miles travelled with e-bike travel would mean 4-8 million fewer tonnes of carbon emitted each year. The greatest impact on carbon emissions would come from e-bike use outside urban centres. In Denmark, e-bike routes are already linking cities to towns and villages. e-bikes can help people make longer journeys than conventional cycles, and could bring new transport options to people living outside urban centres. In the post-coronavirus recovery, e-bikes could offer a safe way for people to travel. e-bikes could also help cut the costs of travel in neighbourhoods characterised by low incomes or limited access to public transport.

Dr Ian Philips who led the research as a member of CREDS (Centre for Research into Energy Demand Solutions) said "The strategic potential of e-bikes as a mass-transport option has been overlooked by policymakers so far. As we emerge from the COVID lockdown, e-bikes can be part of the solution to getting people safely mobile once again. We're recommending that governments across the UK should find ways to incentivise e-bike use to replace car journeys. As well as lowering carbon emissions from transport, e-bikes have the potential to improve the mobility options for people and communities at risk of transport poverty."

Rapid Prioritisation of Cycleways in Cities

New cycleways are being introduced in many cities, allowing healthy habits started during the lockdown to continue. Dr Robin Lovelace and Dr Joey Talbot explain how transport authorities must act quickly to take advantage of the current cycling boom. Their research has identified roads where there is both space and demand for cycling infrastructure. Their methods have been used in a nationwide project funded by the Department for Transport (DfT) and transport charity Sustrans to help relieve immediate pressures on the transport system and create long term change. The result is the Rapid Cycleway Prioritisation Tool which provides an interactive map for every transport authority in England. This free and open tool will help ensure that the government's Emergency Active Travel Fund is spent where it is most needed, for maximum long term benefit.

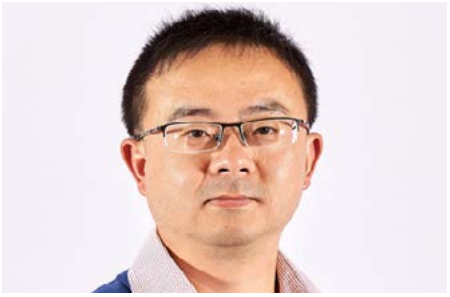
The promotion of cycling and walking is an important aspect of our research.

Daniel Johnson was project co-ordinator on the recently completed EU-funded SMaRTE project. SMaRTE studied both condition based maintenance and the passenger experience. SMaRTE is linked to the cross cutting activities of the large scale Shift2Rail (S2R) programme. The team investigated techniques for predicting the condition of rolling stock components and systems and developed tools to optimise maintenance decision-making resulting in potential 35% maintenance cost reductions. They also studied current and future passenger needs. This resulted in a more holistic understanding of the journey planning process. The team concluded that although ticket price is important for passengers, the ability to book journeys in advance and to find a guaranteed seat were more important. So too were security and safety. Passengers expressed greatest dissatisfaction with station car parking and cleanliness, ticket costs, wifi and power connectivity, and the frequency of peak services. Several of the same factors affected recruitment of non-rail travellers to rail. The team assessed the likely impact of all suggested improvements via three case studies, set around Leeds and Manchester. Implementation of all recommendations was predicted to improve demand by 25-37%. Lowering ticket costs alone predicted demand increase by 9-12%. Yet, 'soft factors' such as cleanliness were also expected to be significant.

Awards

Dr Charisma Choudhury was awarded a prestigious Future Leaders Fellowship. The UKRI scheme invests in outstanding individuals across the UK. These research and innovation leaders will be supported to develop their careers while tackling ambitious global challenges. Dr Choudhury is developing the next generation mathematical models of travel behaviour that can better predict activity and travel decisions (see NEXUS project later in this report).

Bryan Matthews won the Inclusive Mobility Award 2020. His ambassadorship for transport accessibility and social inclusion was recognised by the Intelligent Transport Systems UK Association.



Best online course of all time – The University of Leeds has ranked Transport Systems: Global Issues and Future Innovations as one of the top four. This online course was created by **Dr Yue Huang** (picture above) and is delivered by colleagues from ITS. The course allows learners to discover how the transport sector can develop infrastructures that meet the needs of a 21st century population and introduces learners to what it is like to study for a master's degree at ITS.

Prioritisation of cycleways in cities allows healthy habits started during Covid lockdown to continue.

Dr Thomas Hancock received the Eric Pas award for the best PhD dissertation in travel behaviour research for his thesis entitled Travel behaviour modelling at the interface between econometrics and mathematical psychology. The International Association for Travel Behaviour Research (IATBR) commended Thomas for the quality of his work, noting that his dissertation can "instigate a paradigm shift in travel behaviour analysis" and that "Nobody has been able to operationalize such a distinctive but reasonable method for choice prediction and understanding, including the welfare economics we desire for project and policy evaluations".

Thomas's PhD thesis used the alternative format, based on six papers. This is the third award Thomas has received for his work, following on from the best PhD student paper and most innovative application paper awarded at the International Choice Modelling Conference. Thomas's PhD was part of the ERC funded DECISIONS project and since completing his PhD, he has continued working at ITS as a postdoc in the DECISIONS and NEXUS projects.

Influencing Transport Policy

The Local Government Association commissioned a team led by **Professor Greg Marsden** and **Professor Jillian Anable** to develop policy briefings on reducing carbon emissions from transport. Priorities for the briefings were developed in collaboration with councillors and officers from 27 local authorities, at workshops which took place in London and Leeds in early 2020 before the COVID lockdown began. The briefings offer timely guidance to councils on how transport decarbonisation can support a climate-smart recovery.

Professor Greg Marsden, director of the DecarboN8 network, said: "Different councils face different transport challenges, but everywhere has to act - and to act now. We cannot continue to pass the buck to our neighbours or to the next generation. Our work shows what councils can do today to help cut climate emissions and improve the places where we live and work. Anyone who wants to see these changes in their area can play a role by contacting their council to tell them about the briefings and ask what is being done locally to deliver a climate smart recovery from COVID-19. The briefings are openly accessible on the LGA website (https://www.local.gov.uk/decarbonising-transport):

Decarbonising transport briefings
- Getting carbon ambition right
- The role of buses
- Accelerating the uptake of electric vehicles
- Climate smart parking policies
- The role of land use, localisation and accessibility
- Travelling less and the role of online opportunities
- Growing cycle use"

Dr Ian Philips and **Dr Llinos Brown** presented to the All Party Parliamentary Group of MPs for Cycling and Walking. The webinar theme was 'investing in cycling and walking to achieve net zero'. To an audience of 500 **Ian** presented work on e-bike capability to contribute to transport decarbonisation and **Llinos** presented on the peoples' changing transport experiences during the COVID pandemic and the insights this disruption gives.

Postgraduate researcher **Jeroen Bastiaanssen** examined the impact of transport accessibility to employment prospects of the Dutch and UK labour force, which was recently covered in the advisory report 'Access to the City' by the Dutch Council for the Environment and Infrastructure and presented to the Dutch ministers of the Interior and Transport. The report discusses how people are unable to sufficiently participate in urban life due to issues with amenities, housing and transport. The report advises a fundamental change in transport policies to ensure that people have sufficient possibilities to reach work destinations.

Among her many influential roles **Professor Jillian Anable** has acted as an expert witness at Greater Cambridge Citizens' Assembly, is an academic panel member of Climate Assembly UK, a steering group member of the Electric vehicle and Energy taskforce and Chair of the Research and Evidence group of the National Transport Strategy for Scotland review. Jillian also contributed evidence to the House of Commons Science and Technology Committee report 'Clean Growth: Technologies for meeting the UK's emissions reduction targets' (https://publications.parliament.uk/pa/cm201719/cmselect/cmsctech/1454/145402.htm).

Dr Thijs Dekker was elected as a Regular Board Member for the IATBR Executive Board, and **Dr Charisma Choudhury** is Secretary/Treasurer.

Dr Gillian Harrison was leader of the SP Programme Committee for the European Transport Conference and assisted in planning for transition to online conference.

Dr Kate Pangbourne served as: a member of the Scottish Parliamentary Cross-party Sustainable Recovery Advisory Group; a Board member of ACT TravelWise and a panellist for The Swedish Research Council Formas' call on 'Societal effects and opportunities for transition after Covid-19'.

Visitors

To help develop strategic partnerships for education and research ITS hosted visits from: **Dr Toshiya Hirose**, Shibaura Institute of Technology, Japan was hosted by **Professor Richard Romano**. **Dr Hirose** modelled pedestrian road crossing behaviour using HIKER to help define requirements for automatic emergency braking in vehicles.

Dr Yeonjung Song from Osaka University was hosted by Professor Andrew Smith and worked on rail cost and efficiency and reforms modelling.

Prof Harun Al-Rasyid was hosted by **Dr Chandra Balijepalli** as part of their ongoing e-motorcycles research in Bandung, Indonesia.

Virtuocity is now a well-established simulation research facility. Dr Albert Solernou Crusat and Professor Natasha Merat gave tours of Virtuocity demonstrating the driving, pedestrian (HIKER) and truck simulators notably for MIT REAP, the Human Drive Workshop and research collaborators from Sheffield University.

Staff changes

In 2020 we celebrated the promotions of four staff. **Gustav Markkula** was promoted to Professor of Applied Behaviour Modelling: **Dr Chandra Balijepalli** and **Dr Thijs Dekker** were promoted to Associate Professor. **Ann Jopson**, who is on a teaching and scholarship contract and has acted as our undergraduate co-ordinator, also received a promotion.

Leadership roles transitioned smoothly in 2020 during the COVID lockdown thanks to the competence of new in role: **Professor Simon Shepherd - Director of the Institute for Transport Studies**, **Dr Eva Heinen - Director of Research and Innovation** and **Dr Phill Wheat - Deputy Director /Director for Staff Development**.

New staff and leavers

We welcomed **Dr Mahdi Rezaei** (University Academic Fellow), **Richard Walker** (on secondment from DfT) and 12 researchers: **Amir Kalantari, Aravinda Srinivasan, Chen Peng, Dr Chris Rushton, Dr Ehsan Sadraei, Dr Han Lin, Kadambari Lokesh, Dr Kristofer Odolinski, Dr Llinos Brown, Dr Thomas Haines-Doran, Dr Yi-Shin Lin and Yue Yang**.

We bade farewell to two longstanding academic members: **Jeremy Shires** was our surveys manager for many years, also he co-ordinated hundreds of Masters dissertations and industry-integrated student projects. He was leader of the Economics and Appraisal research group before taking early retirement.

Professor Karen Lucas is a world-leading expert in the area of transport-related social exclusion in the Global North and South. In 2015, she won the Edward L. Ullman Award from the Association of American Geographers, and in 2016, a Women of Achievement Award from the University of Leeds. Karen completed a term of office as ITS Director of Research & Innovation, where a key contribution was her leadership of the very successful 'themes' initiative, and she served as a Deputy Director of the Leeds Social Sciences Institute. We thank James and Karen for their significant contributions to the Institute and the University of Leeds, and congratulate Karen on being appointed to a Chair at the University of Manchester.

Prof Simon Shepherd became Director of the Institute for Transport Studies in April 2020.

Postdoctoral Research Assistants and support staff who left at the end of their contracts were: Muhammad Adeel, Hannah Devine Wright, Jami Pekkanen, Jan Broekaert, Jean-Christophe Thiebaud, Tamara Muroiwa, Chongfeng Wei and Guillhermina Antas-Torrao. We wish them well in their ongoing careers.

PhD Awards

Thirteen postgraduate students celebrated their PhD awards in 2020: **Samuel Adjei Appiah** 'Understanding car ownership among households in developing countries: A case study of Accra, Ghana'; **Anna Correa Pereira** 'Investigation of the aerotropolis concept definition and its transferability from the Global North to Brazil'; **Evangelos Paschalidis** 'Developing driving behaviour models incorporating the effects of stress'; **Lap Kwan Jeff Tjiong** 'Impacts of survey design and model specification on willingness-to-pay estimates from discrete choice models'; **Anthony Ezenwa** 'Smart logistics diffusion strategies amongst supply chain networks in emerging markets: a case of Nigeria's micro/SMEs 3PLs'; **Thiago Guimaraes Rodriques** 'Bridging the accessibility gap to healthcare. The role of urban transport for low-income communities in Sao Paulo, Brazil'; **Peter Atkinson** 'Fitting the bike to the chain: An analysis of transitions towards households integration of multi-modal cycling'; **Rafael Dos Reis** 'Acceptability and impacts of positive incentives for sustainable mobility behaviour: A segmentation approach in Curitiba, Brazil'; **Fangqing Song** 'Understanding mode choice behaviour when new modes come into play'; **Cristhian Figueroa Martinez** 'The built environment and the experience of walking: being a pedestrian in Santiago's deprived neighbourhoods'; **Nur Ubaidillah** 'Determinants of car and motorcycle ownership and use in Sarawak'; **Tamás Nádudvari** 'Implementation of finite mixture models for route choice estimation in large metro networks' and **Taufiq Nugroho** 'Optimal urban goods movement planning taking independent retailer restocking activities into consideration'.

Postgraduate Research Students

During 2020 we had 72 research students at ITS: Khaled Abdullah, Emmanuel Acheampong, Samuel Adjei Appiah, Ilyas Alhassan, Mahmoud Al-Khazaleh, Shaima Almansoori, Maryam Alwari, Zihao An, Jeroen Bastiaanssen, Pinar Bilgin, Jawaher Binsuwadan, Isam Bitar, Martyna Bogacz, Jake Bruce, Fanta Camara, Juan Castellanos-Vanegas, Jina Cheon, David Chikwendu, Rafael Cirino-Goncalves, Christopher Cook, Edmond Daramy-Williams, Patrick Dichabeng, Lawrence Duncan, Umoh Edemeka, Ian Greenwood, MD Bashirul Haque, Probo Hardini, Thalia Hernandez-Amezcua, Lydia Hidayati, Yiming Hou, Rashed Ishmaeel, Amir Kalantari, Rizal Kamaruddin, Naphat Ketphat, Salma Khuky,

Alumni Alvaro Guzman, Allan Peñafiel Mera and Adrian Ortega are modernising the passenger transport service in Ecuador to provide access for all.

Alexandros Kontotasios, Edward Lambert, Gengze Li, Shuwei Lin, Siyi Lin, Henry Lo, Wei Lyu (visiting), Davide Maggi, Tahera Mayat, Ioanna Moscholidou, Haruko Nakao, Lamprini Papafoti, Chen Peng, Mickael Perrier, David Pierce, Vishnu Radhakrishnan, Kacper Rossa, Teekanya Rujinarong, Rosie Samuel, Mohammad Sarker, John Stuart, Sidi Sun, Agung Surono, Ruifan Tang, Tianli Tang, Yvonne Taylor, Oguz Tengilimogul, Jack Thompson, Kai Tian, Panagiotis Tsoleridis, Athanasios Tzigieras, Alexandra Vitel, Sijin Wu, Yue Yang, Zhuoqian Yang, Khatun Zannat and Chenzhao Zhai.

In addition, ITS staff co-supervised 9 students based in other University of Leeds schools: Sakarias Bank (Psychology), Catherine Graves and Lin Zhang (Earth & Environment), Gyeonghwa Lee (Design), Ahmed Alali and Nura Kabuga (Engineering), Colin Caine, Caroline Tait and Eugeni Vidal-Tortosa (Geography),

Alumni

For the first time we offered an online international alumni seminar series. In response to the global pandemic we took the opportunity to invite former students to give presentations from a range of industry experiences. Our guest speakers were Elena Chiari, Galo Cardenas, Lucila Capelli, Karen Gonzalez, Syed Abdul Rahman, Eugenia Rivas, Mojtaba Moharrer, Courtney Groundwater.

More details on our new online international seminar series can be found here, together with seminar recordings **https://environment.leeds.ac.uk/transport-alumni/news/article/5325/its-launches-2020-international-alumni-seminar-series**

Alumna **Rachel Skinner** was inaugurated as the 156th President of the Institution of Civil Engineers (ICE). Rachel studied MSc in Transport Planning and Engineering at ITS and graduated in 2001. In the two centuries of ICE's history Rachel is its youngest and only the second female President.

Rachel is spending her year in office focusing on reaching the government's carbon net zero target for 2050. Rachel explained that civil engineering's input is essential to making this happen, calling engineers to "step up and step in to tackle climate change. Our infrastructure is now, in terms of our processes, the operations and the way we do things, the number one driver of carbon dioxide emissions across the world and those emissions are the cause of climate change. From civil engineers' point of view this is a huge problem but is also a serious opportunity for change and leadership."

Alumnus **Alastair Gordon** has been appointed Chairman of West and North Yorkshire Chamber of Commerce Transport Group. Alastair is a long standing member of our alumni and external partnership community, an active supporter of our Industrial Mentoring Scheme, Annual Employer Days, and our External Advisory Board. He has 23 years' experience of delivering major infrastructure schemes within urban centres and has worked on many of the region's most significant projects including Leeds Arena. "This is a fantastic opportunity, and I'm excited to work with the group to further explore how we can better connect our communities and allow businesses, residents and visitors to travel more easily and effectively."

Three alumni: **Alvaro Guzman**, Executive Director at Agencia Nacional de Tránsito, together with **Allan Peñafiel Mera**, Technical Advisor and **Adrian Ortega**, National Director of Qualifying Titles have changed public transport planning in Ecuador, providing access to transport for all. With the presentation of the IRMOVA Plan, a technical tool using Big Data the objective is to correct inequities. "The objective of this Plan is to promote the social, safe, inclusive and equitable development of citizens through the optimization of fleet use, organization of routes, frequencies and stops and modernization of the passenger transport service."

Alumnus **Naville Geiriseb** (picture above) was invited to present his Masters dissertation research to the World Bank and the Namibian government. His research on the "Evaluation of Alternative Financing Models For Road Transport Infrastructure In Namibia" was awarded the 2019 Frank Lai Award for most impactful, innovating Masters dissertation in the Institute for Transport Studies. During his time at Leeds, Naville was also awarded the prestigious Chevening scholarship and benefitted from the ITS mentoring scheme. There was commitment from the World Bank and Namibian transport sector institutions to use the catalyst of Naville's work to hold discussions about sustainable financing for road infrastructure in Namibia.

Further Alumni news can be found on our dedicated webpage: https://environment.leeds.ac.uk/transport-alumni

RESEARCH PROJECTS

During 2020 ITS secured five research grants relating to COVID-19. The research is described, among 66 of our current projects, in the following pages. Our research is often multidisciplinary and international. The research is grouped under nine thematic headings: Digital Futures, Energy, Transport and Cities, Simulation, Automation, Rail, Connected and Shared Mobility, Air Quality and Health, Choice Modelling.

DIGITAL FUTURES

KARMA

Grant holder: **Professor Susan Grant-Muller**
Investigators: **Dr Gillian Harrison, Frances Hodgson**
Funded by: **Alan Turing Institute Fellowship**
Dates: **October 2018 - May 2022**
Website: **KARMA / https://tinyurl.com/yy9cjwnj**

Abstract: KARMA aims to create a step change in understanding the cross-sectoral impacts of transport schemes by advanced analytics of next generation transport and other urban data (e.g. phone location signals, sensor data and more). The project objectives are to: Create new databases and model interfaces, with interoperability between 'next-generation' data, traditional data and mathematical models; Enhance existing mathematical models of transport-energy, transport-health, transport-security and transport-safety impacts, building new models to fill research gaps; Explore the cross-sectoral implications of existing and new initiatives (such as the use of positive incentives, rewards and gamification) in travel choice; Improve the asset base (ecosystems and platforms) that support increased analysis and use of new digital mobility data, so that improved policies and initiatives can be developed and implemented (e.g ethical frameworks, digital innovation, impact visualisation, business models).

Impact: A new system dynamics model of Transport-Health interactions, capturing the role of New Data, has been developed. This involved the use of a novel on-line tool to engage the expertise of stakeholders from the Transport, Health and New Data communities.

Alumna Rachael Skinner was inaugurated as president of the Institute of Civil Engineers – it's youngest and only the second female president.

Early findings were presented in January and February 2020 by Prof. Grant-Muller at the Maurice Bloch seminar (University of Glasgow) and to the joint UITP/European Committee of the Regions annual event.

RAPHTORY

Grant holders: **Dr Felix Cuadrado, Dr Richard Clegg, Dept of Elec Eng and Computer Science, Queen Mary University London**
Investigators: **Professor Susan Grant-Muller, Frances Hodgson**
Funded by: **Alan Turing Institute/ Queen Mary University (QMUL)**
Dates: **December 2019 to March 2021**
Coordinating partner: **QMUL**
Website: **RAPHTORY / https://tinyurl.com/sp5sd8yw**

Abstract: Dynamic graphs allow for studying of how relationships form and change over time. Although they have many applications, there are no readily available tools and systems enabling their application. Raphtory is a new distributed system that enables dynamic graph analysis starting from very large real-time datasets. This project will improve the functionality and usability of Raphtory so that it can be readily usable by domain-specific researchers. The project will develop a set of use cases for dynamic graphs, starting with urban analytics for mobility incentives.

Micromobility Behavior

Grant holder: **Professor Susan Grant-Muller**
Funded by: **NUMO & WRI**
Dates: **January to December 2020**
Coordinating partner: **NUMO**
Collaborative partners: **Dr Charalampos (Babis) Saridakis, Leeds University Business School, UCDavis (USA), USA city and industry partners**

Abstract: In this study we consider e-scooters as a type of micromobility and the associated challenges as a relatively new mode - travel choices available, governance of the transport sector, data collection, access and utilisation. There is a need to improve understanding of the various population segments that currently engage with this new mode or have a propensity to do so in future. This study is a first stage towards a longer research programme, involving questions on how to apply appropriate marketing methods to different population segments. A survey of users has been developed based on established behavioural modes, with data collection due to take place in four USA cities and one UK city. Survey data will be analysed alongside e-scooter trip patterns and energy implications estimated.

Dr Ian Philips investigated the use of e-bikes during the COVID pandemic to gain insights on green transport and tourism recovery in car dependent rural areas.

ENERGY

Accelerating Innovation in New Mobility Services

Grant holder: **Dr Ian Philips**
Funded by: **ESRC Fellowship**
Dates: **January 2018 to January 2021**
Coordinating partner: **UKERC**
Collaborating partners: **CREDS, TfGM, Enterprise Car Club, LIDA**
Website: **https://environment.leeds.ac.uk/transport/staff/972/dr-ian-philips**

Abstract: The media frequently carries news stories on innovations in cleaner transport technologies (particularly electric vehicles) and visions for how people will travel in the future. These visions are dominated by new mobility services (NMS). They include sharing schemes for cars, bikes and taxis. All are based on Information and Communications Technology (ICT) such as smartphones and apps connecting with 'smart' vehicles and infrastructure and the use of 'big data'. NMS could dramatically reduce energy demand from personal transport but there is also a risk of the familiar story that new products are energy efficient, and thus sustainable, whereas in fact they have negative social and environmental impacts. The project provides small area insights of the extent to which local populations can benefit from either NMS or other interventions whilst simultaneously reducing total car usage and reducing transport energy demand.

This fellowship developed collaborations with a number of private and public sector organisations. We examined decarbonisation questions relating to several NMS using spatial analysis and geographic data science to provide insights for policy stakeholders.

Impact: Examples of projects carried out as part of the fellowship include: (1) Simulation and mapping of the carbon reduction capability of e-bikes (in collaboration with CREDS) This project received significant attention from media and policy makers including presentations to the DfT and the All Party Parliamentary Group on Cycling and Walking. The work has been referenced in policy documents. (2) Another project was a collaboration and data sharing agreement with Enterprise Car Club. We supervised a data science internship at the Leeds Institute for Data Analytics (LIDA) and built an evidence base around the decarbonisation potential of Car Clubs. To further develop this collaboration, we have secured funding for a PhD through the ESRC Data Science and Society Doctoral Training Centre. (3) Working with local businesses, we are currently investigating the use of e-bikes in the Lake District during the COVID pandemic to gain insights on green transport and tourism recovery in car dependent rural areas.

Outputs: Philips I, Walmsley A, Anable J (2020) A Scoping Indicator Identifying Potential Impacts of All-Inclusive MaaS Taxis on Other Modes in Manchester, Transport Findings https://doi.org/10.32866/001c.11524

Mattioli G, Philips I, Anable J, Chatterton T (2019) Vulnerability to motor fuel price increases: Socio-spatial patterns in England, Journal of Transport Geography Volume 78, Pages 98-114 https://doi.org/10.1016/j.jtrangeo.2019.05.009

Transport Climate Emergency

Grant holder: **Professor Greg Marsden**
Investigators: **Professor Jillian Anable, Kadambari Lokesh, Dr Morgan Campbell, Richard Walker**
Funded by: **Local Government Association; CREDS and DecarboN8**
Co-ordinating partner: **University of Leeds**
Dates: **December 2019 to November 2020**
Website: **https://www.local.gov.uk/decarbonising-transport**

Abstract: This project worked with local government stakeholders to create seven policy briefings and webinars which were top provide advice to local authorities. The question was "So, you have declared a climate emergency, what now?" The briefing notes covered how to understand carbon budgeting and target setting to get ambition right and then a series of advice notes developed around the framework of 'Avoid/ Shift/ Improve'. These included cycling, buses, parking policy, travelling less, planning and encouraging the uptake of electric vehicles.

Impact: Over 1000 local government stakeholders registered for the webinars and 2000 downloads of the reports have been recorded

Papers: See website to download

DecarboN8

Grant holder: **Professor Greg Marsden**
Investigator: **Kadambari Lokesh**
Funded by: **EPSRC**
Coordinating partner: **University of Leeds**
Collaborative partners: **University of Manchester, University of Liverpool, Newcastle University, University of Sheffield, Durham University, Lancaster University, University of York, Connected Places Catapult**
Dates: **September 2019 to August 2022**
Website: **https://decarbon8.org.uk/**

Abstract: The DecarboN8 network brings together researchers, industry and government to design solutions which can be deployed rapidly and at scale. We are developing answers to questions such as: How can different places be rapidly switched to electromobility for personal travel? How do decisions on the private fleet interact with the

quite different decarbonisation strategies for heavy vehicles? What is the right balance between infrastructure expansion, intelligent system management and demand management? Will the embodied carbon emissions of major new infrastructure offset gains from improved flows and could these be delivered in other ways?

The answer to these questions is unlikely to the same everywhere in the UK and DecarboN8 pays attention to where the answers might be different and why, to develop an innovative place-based approach to decarbonisation. We pay attention to the major societal implications of any of the changes proposed and we work with diverse sectors and communities to deliver solutions which share the decarbonisation challenge fairly. Round one of the flexible funding has supported work on topics as diverse as E-cargo bikes, community planning, freight fleets and the deployment of emergency active travel roadspace reallocation measures.

Impact: DecarboN8 was a key contributor to the development of the Place-based theme in the forthcoming DfT Transport Decarbonisation Plan and has been involved in the development of decarbonisation strategies for Transport for the North and Leeds City Council.

Papers: https://decarbon8.org.uk/publications/

Cut Carbon Network

Grant holder: **Professor Greg Marsden**
Funded by: **EPSRC**
Coordinating partner: **University of Leeds**
Dates: **September 2019 to August 2023**
Website: **https://cutcarbon.org.uk/**

Abstract: Cut Carbon is a £5m investment in decarbonising transport. Five Decarbonising Transport Networks have been funded to bring together expertise from across academia and industry to lay the groundwork for the use of low carbon technologies across road, rail, marine and air networks. Each network has its own specialist focus area such as examining commercial flights using electric airplanes, smart vehicle to grid connectivity challenges and decarbonising freight transport. The Cut Carbon initiative acts as a one stop shop for finding out about events, funding calls and key network deliverables across all of the networks, recognising the need for a whole system approach to rapid decarbonisation. It will share syntheses of the latest decarbonisation solutions. The network will help connect industry, government and academia to the in-depth studies being conducted within in each of the networks.

STEP – surveying users' responses to Trojan Energy's Electric Vehicle charging technology

UK Centre for Research on Energy Demand Solutions (UK-CREDS)

Grant holder: **Professor Jillian Anable**
Investigators: Professor Greg Marsden, Dr Zia Wadud, Dr Anthony Whiteing, Dr Muhammad Adeel; Professor Karen Lucas, Dr Robin Lovelace, Dr Sally Cairns, Dr Malcolm Morgan, Dr Caroline Mullen, Dr Noel Cass, Dr Tom Haines-Doran
Funded by: **EPSRC**
Dates: **April 2018 to March 2023**
Coordinating partner: **University of Oxford**
Collaborative partners: **University of Leeds (School of Earth and Environment), University of Reading, University of Sussex, University College London, University of Lancaster**
Website: **www.creds.ac.uk**

Abstract: A £19m consortium of 9 academic institutions, CREDS was established with a vision to make the UK a leader in understanding the changes in energy demand needed for the transition to a secure and affordable low-carbon energy system. At ITS Leeds we are leading the Transport and Mobility research strand (there are six strands within the Centre). The transport theme explores where transport energy demands are highest; the constraints and opportunities for transport flexibility; and how to accelerate carbon and energy reduction policies. This theme builds on the Commission on Travel Demand knowledge exchange activity initiated by the DEMAND project (see Annual Research Report 2018).

Electricity SATNAV

Grant holder: **Professor Jillian Anable**
Investigators: **Dr Noel Cass**
Funded by: **EPSRC**
Dates: **September 2017 to February 2020**
Coordinating partner: **Aston University**
Collaborative partners: **University of Southampton**

Abstract: The overall aim of this project was to design a real-time system to enable flexible electric vehicle charging/discharging from/to individual household or commercial renewable electricity resources. Qualitative research investigated the acceptability of peer-to-peer sharing of electricity supply and vehicle charging and the associated business models.

STEP (Electric Vehicle Charging)

Grant holder: **Professor Jillian Anable**
Investigators: **Dr Noel Cass**
Funded by: **Innovate UK**
Coordinating partner: **Element Energy**
Collaborative partners: **IBI (data managers), Trojan Energy (EV charging technology developers), Octopus Energy (billing and back office), Brent and Camden Borough Councils (technology 'hosts'), UK Power Networks (electricity infrastructure partners) and University of Leeds (consumer and attitude research).**
Dates: **December 2019 to December 2021, with possibility of extending to March 2022 due to COVID-related manufacturing delays.**
Website: **https://www.trojanenergyltd.com/step**

Ridehailing services in India - the subject of Dr Choudhury's SPARC Kharagpur research.

Abstract: STEP stands for Subsurface Technology for Electric Pathways. It is a trial installation of Trojan Energy's Electric Vehicle charging technology. The trial is funded by the Office for Zero Emission Vehicles (OZEV) which is an organisation working across several government departments to support deployment of ultra-low emission vehicles (ULEVs). The project is delivered through Innovate UK, part of UK Research and Innovation (UKRI) – the Government backed national funding agency investing in science and research in the UK. The trial will deploy 150-200 EV chargers which are flush to the pavement, and accessed using a lance and cable available to trial participants. The technology is designed to mitigate previously-identified issues with on-street EV charging technologies, such as trailing cables and on-street clutter, which can cause problems for other users of the pavement, such as pram/pushchair and wheelchair users, or the partially sighted and blind. The research involves before-and-after surveying on three categories of research participants: Observers (who may or may not be drivers or EV users), Prospective and Current EV drivers. These participants will be surveyed on their attitudes and opinions on EVs and current EV charging infrastructure, street amenity, and parking, and where appropriate, about their current EV driving and charging behaviours. In addition 'consumer research' questions about the charging technology are included for EV drivers.

Impact: The project is developing commercialisation plans that will target local authorities in the UK in the first instance, as the 'owners' of the streets where the technology will be deployed. There has been interest from other countries as well. The project will enable comparison of Trojan's technology with other chargers, with particular focus on the materiality of low carbon technologies, its impact on users and the justice implications of access to low carbon technologies, to streets, pavements and public space.

TRANSPORT AND CITIES

Inclusive Public Space

Grant holder: **Professor Anna Lawson (School of Law)**
Investigators: **Professor Richard Romano, Dr Ehsan Sadraei**
Funded by: **EU**
Dates: **October 2020 to September 2021**
Coordinating partner: **N/A**
Collaborating partners: **N/A**
Website: **https://cordis.europa.eu/project/rcn/216509/factsheet/en**

Abstract: This project considers the accessibility of public space – focusing on pedestrian access to streets. It explores law's engagement with the exclusion which occurs when streets are designed, operated or managed so as to deny access to pedestrians whose bodies, minds or life circumstances do not 'fit'. Such exclusion is damaging both to individuals and communities. With a view to understanding how states and the EU can more effectively ensure that public space is inclusive, the project aims to deepen understanding of what physical features of streets are experienced as exclusionary in several countries across the world and by whom; how effectively law is used to challenge such exclusion in these countries; and how the problem is perceived and politically challenged. It also aims to foster shared concern about this form of exclusion, and to raise awareness of how law can be used to challenge it.

SPARC-IIT Kharagpur

Grant holder: **Dr Charisma Choudhury**
Investigators: **Dr Zia Wadud**
Funded by: **Ministry of HR Development India**
Dates: **March 2019 to March 2021**
Coordinating partner: **IIT Kharagpur**
Collaborating partners: **Dr Arkopal Goswami, IIT Kharagpur**
Website: **SPARC-Kharagpur / https://tinyurl.com/1roh81pk**

Abstract: Ride-hailing and ride-sharing services, as primarily offered by Ola & Uber in India, have been on the rise. The research investigates the impact of such disruptive transport services on urban travel demand and resulting vehicular emissions. The study is a first of its kind, independent research, being conducted in India. The study's relevance is from the point of view of managing a multimodal urban transport network and subsequently providing seamless access to its users.

Objectives include: Identifying factors affecting users' choice of ride-hailing and ride-sharing transport services (e.g. Uber, Ola, Uber Pool, etc.) in India; Developing methodology to combine traditional and big data for calibration of demand models for ride-hailing and ride-sharing services; Predicting demand of ride-hailing and ride-sharing services in different planning and policy contexts (including COVID-19); Quantifying energy and air-quality impacts of ride-hailing and ride-sharing services.

Outputs:

1. Special session on Ride-hailing and Ride-sharing at the 5th Annual Conference of the Transport Research Group of India, Bhopal which was attended by 50 faculty members, early career researchers and scholars from different Indian Universities as well as representatives of several government agencies.
2. Bhaduri E, BS M, Wadud Z, Goswami A and Choudhury C (2020) Modelling the effects of COVID-19 on travel mode choice behaviour in India, Transportation Research Interdisciplinary Perspectives, V8, Special Issue on COVID-19. **https://www.sciencedirect.com/science/article/pii/S2590198220301846**

3. Goswami A and Choudhury C (2020) Initial findings on effects of COVID-19 on mode choice behaviour in India, paper presented at the UKEIRI Webinar on Smart Cities and Transport.
4. Goswami A and Choudhury C (2020) Developing an integrated land use - transport - emissions model utilising emerging big data sources for quantifying the energy and environmental impacts of ridesharing services, SPARC-UKIERI Webinar, June 2020 (View Recording)

Under Reform

Grant holder: **Professor Greg Marsden**
Investigator: **Morgan Campbell**
Funded by: **ESRC**
Dates: **May 2018 to May 2020**
Coordinating partner: **University of Leeds**
Collaborative partners: **University of Birmingham, School of Planning and Architecture Delhi, Indian Institute of Science Bangalore, World Resources Institute India**
Website: **https://underreform.org/**

Under Reform led by Prof Greg Marsden aims to develop cutting edge insights into how reforming transport governance works, and how best to generate more sustainable transport systems in Indian cities.

Abstract: Under Reform aims to develop cutting edge insights into how reforming transport governance works, and how best to generate more sustainable transport systems in Indian cities. In 2015 the Indian national government launched the Smart Cities Mission, aiming to reform transport governance more effectively than had been managed at individual city level. The project research will analyse previous and planned reforms in four of India's designated smart cities, considering their impact on the prosperity and the quality of life of citizens. The aim is to move beyond simply identifying problems, rather developing an understanding of how to overcome them. The key themes from the project around central-state-local relationships, the use of Special Purpose Vehicles for governance reform and the role of smart experimentation are now at the final stage of write up for publication. Practical implications have been developed in partnership with WRI India and taken to various stakeholder workshops just prior to the pandemic lockdown. The emphasis of the findings has been on longer-term themes of urban governance in India rather than what specifically will happen next with the Smart Cities Mission. This seems particularly important given the impacts of the pandemic on policy priorities and the difficulties of delivering coherent reform programmes.

Papers:
https://underreform.org/category/outputs/

Outputs: Under Reform Co-Investigator Louise Reardon presented on initial findings from the project at the International Public Policy Association's 4th International Conference on Public Policy (ICPP4). underreform.org

Impact: A major stakeholder workshop launched the implications report in Delhi in March 2020. A capacity building summer school was run from IISc Bangalore in March 2020 raising the profile of urban governance as a critical skills gap and research need.

Urban Public Administration and Services (U-PASS)

Grant holder: **Professor Simon Shepherd**
Investigators: **Dr Caroline Mullen, Dr Chandra Balijepalli, Professor Susan Grant-Muller; Dr Gillian Harrison**
Funded by: **ESRC**
Dates: **March 2019 - February 2022**
Coordinating partner: **Vrije Universiteit Amsterdam**
Collaborative partners: **Beijing Jiaotong University, Zhejiang University, Beijing Transport Institute.**
Website: **sbe.vu.nl/nl/afdelingen-en-instituten/spatial-economics/research/projects/u-pass/index.aspx**

Abstract: U-PASS stands for Urban Public Administration and ServiceS - innovation for Innovative Urban Mobility Management and Policy. Motivated by the world-wide shared desire and need for more efficient, reliable and environmentally sustainable urban transport, the U-PASS project investigates how to improve the benefits of transport, while limiting its downsides. The project aims to offer innovations in the design of new services and policies in urban transport, with a focus tradable credits schemes, automated vehicles, electric driving, ride sharing, car sharing, and cycling. The project studies short-run behavioural impacts through real-life experimental studies in both China and Europe, and long-run implications through advanced urban transport modelling approaches. The project began in earnest with a kick-off meeting in Beijing alongside the 7th International Conference on Transportation and Space-time Economics in October 2019. Our work has so far concentrated on governance issues and the initial development of a MARS model for Beijing along with how to represent tradeable permits and bike share schemes within that model. Initial results have been presented via webinar to the JRC.

ELVITEN

Grant holder: **Dr Haibo Chen**
Investigators: **Dr Kaushali Dave, Dr Jo-Ann Pattinson, Dr Junyan Chen, Dr Jianbing Gao, Dr Ye Liu, Professor David Watling**
Funded by: **EU H2020**
Dates: **November 2017 to October 2020**
Collaborative partners: **21 partners in industry and academia (see website for details)**
Website: **www.elviten-project.eu**

Abstract: Electrified L-category Vehicles Integrated into Transport and Electricity Networks (ELVITEN) aims to boost the usage of electrified bicycles, scooters, tricycles and quadricycles (EL-Vs) in the

Investment in cycling infrastructure has many benefits. Knowing where to invest is helped by the Cycle Prioritisation Toolkit used by many Local Authorities. Photo courtesy of Robin Lovelace.

urban environment and ultimately to achieve a mind-shift among users by providing them with a better EL-V experience. This will be achieved by designing and offering replicable usage schemes, consisting of support services, ICT tools and policies. EL-Vs are being tested in Genoa, Rome, Bari, Malaga, Berlin and Trikala. The project has three principal objectives: First, to make users more familiar and facilitate them to use EL-Vs instead of conventional vehicles for their private transport and for light urban deliveries. Second, to collect rich information sets made of real usage data, traces from dedicated ICT tools, and users' opinions after real trips. Third it will generate detailed guidelines and business models for service providers, planning authorities and manufacturers in order to make EL-Vs more attractive and integrated in the transport and electricity networks.

Safer Roads Map

Grant holder: **Dr Robin Lovelace**
Investigators: **Dr Malcolm Morgan, Dr Joey Talbot, Dr Layik Hama (Leeds Institute for Data Analytics, Dr Roger Beecham (School of Geography), Caroline Tait**
Funded by: **DfT**
Coordinating partner: **DfT**
Collaborative partners: **RAC Foundation**
Dates: **April 2020 to October 2021**

Abstract: Active transport can tackle some of the most pressing issues of the 21st century, including air pollution, the obesity epidemic, and transport-related social exclusion. Recognising these wide-ranging benefits, the UK Government has ambitious targets for active transport, as outlined in the Cycling and Walking Investment Strategy (CWIS). Notably, the Government aims to double cycling whilst simultaneously reducing the number of people killed or seriously injured. Much research funded in support of the CWIS, such as the Propensity to Cycle Tool (see below) has focussed on boosting walking and cycling levels, with relatively little attention paid to safety, despite the fact that cycling and walking casualties have not fallen since the CWIS baseline year of 2013. Using data science, this project aims to discover which road safety measures work best to protect pedestrians and cyclists.

Impact: Reproducible code that accesses, cleans and stores intervention data will be published in an R package, with the working title of trafficcalmr. This will lead to a step-change in knowledge on how to access and process historic road calming intervention data, filling an important gap in current knowledge, and providing a robust evidence base on which future interventions can be prioritised and monitored.

Propensity to Cycle Tool (PCT)

Grant holder: **Dr Robin Lovelace**
Investigators: **Dr Malcolm Morgan, Dr Joey Talbot**
Funded by: **DfT/ Luton Borough Council/ Welsh Government**
Coordinating partner: **University of Cambridge**
Collaborative partners: **CycleStreets.net**
Dates: **November 2017 to October 2020**
Website: **www.pct.bike**

Abstract: PCT is a planning support system to improve cycling provision at many levels from regions to specific points on the road network. For further information on the thinking underlying the tool's design, and the methodology used to create it, please follow links in the PCT website.

Impact: PCT's Rapid Cycleway Prioritisation Tool has been used by many Local Authorities to inform their infrastructure investment (supported by a £250m Active Travel Fund from the Government) and planning to encourage cycling during the COVID-19 pandemic. PCT is now in phase 3 and has generated many spin off projects funded, among others, by Local Authorities, Welsh Government, Sustrans and the Norwegian Research Centre.

Outputs: Lovelace R, Talbot J, Morgan M and M Lucas Smith (2020) Methods to Prioritise Pop-up Active Transport Infrastructure. Transport Findings https://doi.org/10.32866/001c.13421

ACTON

Grant holder: **Dr Robin Lovelace**
Investigators: **Dr Joey Talbot**
Funded by: **Strategic Priorities Fund – University of Leeds**
Dates: **December 2019 to March 2020**
Website: **https://cyipt.github.io/acton/**

Abstract: ACTON aims to provide evidence for local authorities, developers and civil society groups to support planning and investment in sustainable transport infrastructure in and around new developments. The award-winning Propensity to Cycle Tool is influencing strategic cycle network plans of Local Authorities ensuring that sustainable transport investment is spent effectively. However, a limitation of the tool is that it is based on data that is becoming increasingly out-of-date. This project will extend the PCT, and accelerate the positive impact it is having by integrating new developments into estimates of cycling potential.To make the results of the research more reproducible and accessible to others, we have also created an R package, which is described on the project website.

Impact: Received follow-on funding for a project called ActDev

Green & Blue Infrastructure

Grant holder: **Dr Thijs Dekker**
Investigator: **Dr Manuel Ojeda-Cabral**
Funded by: **iCASP**
Dates: **July 2019 to March 2020**

Abstract: It's difficult for practitioners to develop successful business cases for Green (parks and green spaces) and Blue (drainage/run off) Infrastructure (GBI). The project has evaluated the appraisal guidance for GBI as provided by the Green Book and the recently developed ENCA guidance by DEFRA alongside a range of tools for assessing the value of GBI investments. Stakeholders involved in the project include WYCA, Leeds City Council and Kirklees Council.

Outputs: Tools review report

Photo courtesy of Robin Lovelace.

Transport Infrastructure Efficiency Strategy (TIES)

Grant holder: **Dr Phill Wheat**
Investigators: **Professor Andrew Smith, Dr Alex Stead**
Funded by: **Innovate UK**
Dates: **April 2015 to March 2022**
Collaborating partners: **30 partners spanning a range of Government departments, Network Rail, Local Authorities, private sector construction, large infrastructure managers and academics.**

Abstract: Our role in this project is to support the Government Strategy on Infrastructure Efficiency and good environmental management. We are piloting systematic work to understand how to improve the performance of major infrastructure projects, such as HS2 and Crossrail, by identifying factors that lead to cost efficiencies. A key aspect is collaboration across multiple disciplines. Instead of organisations working in silos, information will be shared.

CQC Efficiency Network

Grant holder: **Dr Phill Wheat**
Investigators: **Dr Alex Stead**
Funded by: **Local Authorities**
Dates: **April 2015 to March 2022**
Coordinating partner: **measure2improve**
Website: **www.nhtnetwork.org**

Abstract: The CQC Efficiency Network measures efficiency, evaluates the likely impact of changes to practice and process, and provides a stimulus to realizing efficiency savings in road maintenance. We at ITS provide state of the art benchmarking analysis for the Network. Different from traditional methods we benchmark the cost of carriageway maintenance in local authority area on a like for like basis.

Impact: This project was awarded an EPSRC Impact Acceleration Account which supports knowledge exchange and the delivery of impact from EPSRC funded research. CQC is referenced in the DfT's Incentive Fund Self-Assessment Process and contributes to the case for local authorities receiving enhanced incentive funding. Collaboration with the network was funded for a further three years.

HE Social Impacts 2

Grant holder: **Dr John Nellthorp**
Investigators: P**rofessor Richard Batley, Professor Karen Lucas, Dr Eva Heinen, Dr Like Jiang, Dr Han Lin**
Funded by: Highways England
Dates: **November 2019 to May 2020**

Abstract: What effect do Highways England (HE) schemes have on society? In particular, by-pass schemes which remove substantial amounts of through traffic from built-up areas.

Impact: The ITS research team evaluated the current methodology and provided recommendations on how the HE guidance can be updated. The final report covered five impact questions: Journey Quality; Physical Activity; Access to Services; Security and Cumulative Social Impacts.

Soundscape Valuation

Grant holder: **Dr Like Jiang**
Investigators: **Dr John Nellthorp**
Funded by: **ESRC IAA & Defra**
Dates: **February 2020 to February 2021**
Collaborating partner: **UCL, Defra**

Abstract: The growing field of soundscape research has shown that noise-based measurements alone do not reflect the sound environment quality as experienced by people, especially in public urban spaces where the sound environments are usually more complex with both positive and negative sounds. However, cost benefit analysis in sound environment decision-making remains noise based. The limitations are that; only impacts of noise are considered whereas positive contributions of wanted sounds are omitted; limited receiver types are covered, in most cases only receptors in residential properties.

The project applies knowledge and methods developed in our noise valuation and soundscape evaluation research, to develop a framework for valuing soundscape in public urban spaces, engaging stakeholders from policy sectors, academia and citizens, through a series of workshops.

Impact: Our framework will help shape new national methodology of noise valuation integrating a soundscape approach and will achieve more holistic cost benefit analysis for sound environment decision-making.

Outputs: Jiang L & Nellthorp J (2020) Valuing transport noise impacts in public urban spaces in the UK: Gaps, opportunities and challenges. Applied Acoustics, 166: 107376.

Traffic Information during Covid lockdown.

SIMULATION

Driver Frustration

Grant holder: **Professor Oliver Carsten**
Investigator: **Dr Zahara Batool**
Funded by: **Highways England**
Dates: **October 2019 to May 2020**

Abstract: The aim of this project is to identify and facilitate the development of interventions that could minimise driver frustration, stress and aggression-related behaviours, hence improving safety and riding experiences on roads. Many interventions for road safety have unclear or unrealistic aims, are poorly piloted and weakly evaluated. Our research provides evidence based support for developing Behavioural Change Intervention, grounded in theories of health psychology.

Pedestrian-in-the-Loop Simulator (HIKER)

Grant holder: **Professor Richard Romano**
Investigator: **Professor Natasha Merat**
Funded by: **EPSRC**
Dates: **January 2018 to December 2021**
Website: **uolds.leeds.ac.uk/facility/hikerlab**

Abstract: This project has developed a new laboratory for Highly Immersive Kinematic Experimental Research (HIKER) to support safe experimental research in a repeatable fashion in which variables with respect to AV design, safety systems, and intersection configuration can be studied. The experiments can also look at the impacts of human factors including age, vision and mobility. Pedestrians represent roughly 24% of road fatalities (in 2015). In this context, the increased use of Autonomous Vehicles (AVs) and new systems such as automatic emergency braking have the potential to dramatically reduce road deaths. A major concern, however, is that the AVs and safety systems must be designed to take into account the capabilities and limitations of pedestrians. What makes the simulator unique in the world is its very high resolution displays combined with its large walkable environment (9 metres by 4 metres) and its integration with driving simulators to test interactions between pedestrians and drivers.

Impact: The simulator was used extensively to support the interACT, HumanDrive, and VeriCAV projects

Outputs: Sadraei E, Romano R, Merat N, Garcia de Pedro J, Lee YM, Madigan R, Uzondu C, Lyu W, Tomlinson A (2020) Vehicle-Pedestrian Interaction: A Distributed Simulation Study, Driving Simulation Conference Europe 2020.

VeriCAV

Grant holder: **Professor Richard Romano**
Investigators: **Dr Albert Solernou-Crusat, Dr Gustav Markkula, Professor Natasha Merat. Dr Ehsan Sadraei, Jorge Garcia de Pedro, Dr Evangelos Paschalidis, Dr He Wang (School of Computing)**
Funded by: **Innovate UK**
Coordinating partner: **HORIBA MIRA**
Collaborative partners: **Aimsun, CPC**
Dates: **September 2019 to December 2020**
Website: **https://vericav-project.co.uk/**

Abstract: The VeriCAV project is developing an integrated test framework to allow Automated Driving Systems (ADSs) to be validated in simulation, exposing them to large numbers of complex driving situations such that developers and regulators can have real confidence in their reliability and safety when deployed on the roads. The project goes beyond scenario-based testing to a paradigm where optimal test cases are generated from the space of all possible situations.

VeriCAV is improving the efficiency of testing by minimising human effort in supervising the huge number of tests. As part of this approach, a test oracle automates the evaluation of an ADS's performance during a test run and aggregates information on the simulation setup in order to automatically create test coverage statistics.

The research team at Leeds validates this approach by comparing the ADS's response between simulated and real environments and evaluates the ADS's performance on a number of metrics to ensure that the simulation performance is similar to that in the real world.

Smart actors are key to allowing a breadth of ADS test scenarios as well as to tune the simulation setup in the test oracle to find the most critical events for testing the ADS. In addition machine learning based approaches will be compared against the cognitive models to understand the value of both approaches and their applicability to a range of scenarios.

AUTOMATION

COMMOTIONS

Grant holder: **Professor Gustav Markkula**
Investigators: **Dr Yi-Shin Lin, Dr Aravinda Srinivasan, Dr Jac Billington (School of Psychology), Dr Matteo Leonetti (School of Computing)**
Funded by: **EPSRC**
Collaborative partners: **FiveAI, Aimsun**
Dates: **July 2019 – December 2023**

Abstract: COMMOTIONS is an acronym for Computational Models of Traffic Interactions for Testing of Automated Vehicles. If automated vehicles (AVs) cannot interact well with human road users, they risk causing frustration or even casualties. This

EPSRC fellowship project is researching mathematical models of how humans interact in road traffic, with the objective of using these models to test and optimise the interactive behaviour of AVs. The interaction models are being developed based on knowledge and methods from cognitive neuroscience, using behavioural data from naturalistic and controlled environments (e.g., the new ITS HIKER lab), as well as neurophysiological data collected in collaboration with Leeds School of Psychology. The project will also investigate how the developed cognitive models compare to and can be complemented with purely data-driven, machine-learned models of interactive behaviour, in a collaboration with the School of Computing. The project partners FiveAI and Aimsun provide direct links to intended industrial applications of the models, in AV software and traffic modelling tools, respectively.

Impact: Provided input on human behaviour modelling to an ISO Technical Specification on virtual testing of vehicle safety.

Papers: Markkula G, Madigan R, Nathanael D, Portouli E, Lee YM, Dietrich A, Billington J, Schieben A, Merat N. 2020. Defining interactions: a conceptual framework for understanding interactive behaviour in human and automated road traffic. Theoretical Issues in Ergonomics Science. http://dx.doi.org/10.1080/146392 2X.2020.1736686

Responsible Automation for Inclusive Mobility (RAIM)

Grant holder: **Professor Ed Manley, School of Geography**
Investigator: **Professor Susan Grant-Muller**
Funded by: **ESRC**
Dates: **February 2020 to January 2023**
Coordinating partner: **School of Geography, University of Leeds**
Collaborative partners: University College London, University of Manitoba, Canadian Urban Transit Research & Innovation Consortium (CUTRIC)

Abstract: To capture the full social and economic benefits of AI, new technologies must be sensitive to the diverse needs of the whole population. This means understanding and reflecting the complexity of individual needs, the variety of perceptions, and the constraints that might guide interaction with AI. RAIM will address how on-demand, electric autonomous vehicles might be integrated within public transport systems in the UK and Canada to meet the complex needs of older populations, resulting in improved social, economic, and health outcomes. The research uses a multidisciplinary methodology - integrating qualitative perspectives and quantitative data analysis into AI-generated population simulations and supply optimisation.

Inclusive mobility – new technologies must be sensitive to the diverse needs of the whole population - understanding and reflecting the complexity of individual needs.

Effects of Automation on Road User Behaviour (SEARUB)

Grant holder: **Professor Samantha Jamson**
Investigators: **Professor Oliver Carsten**
Funded by: **EU**
Coordinating partner: **TNO**
Dates: **March 2019 – March 2020**

Abstract: The aim of this study is to provide strategic and practical advice to the European Commission General Directorate DG MOVE on the policy-related actions required to address disruptive digital developments, particularly the transition to automated driving and its effects on driver behaviour and performance. Automated driving brings a number of changes to the traffic system. The topics addressed include the expected evolution of automated driving, changes in human-machine interfaces (in the vehicle and in interactions with road infrastructure), traffic rules, driving licences, and the training of professional drivers. It includes also a reflection on these topics towards the development of a code of conduct for the transition to automated mobility. Based on a broad literature review and the views of experts, different issues are discussed, and a number of policy-oriented recommendations are put forward.
Final Report: Study on the effects of automation on road user behaviour and performance https://op.europa.eu/en/publication-detail/-/publication/6d947c46-140d-11eb-b57e-01aa75ed71a1

Trustonomy

Grant holder: **Professor Samantha Jamson**
Investigators: **Dr Foroogh Hajiseyedjavadi**
Funded by: **EU H2020**
Dates: **May 2019 – April 2022**

Abstract: Trustonomy will investigate, setup, test and comparatively assess, in terms of performance, ethics and acceptability, different relevant technologies and approaches in a variety of autonomous driving scenarios, covering different types of users (in terms of age, gender, driving experience, etc.), road transport modes (private cars, trucks, buses), levels of automation (L3 – L5) and driving conditions. ITS is responsible for one of the four pillars – Trust – and is carrying out a simulator study to investigate how trust in automation is formed and affected by characteristics of the automation design.

Papers: Rodak A, Jamson S, Kruszewski M, Pędzierska M (2020) User Requirements for Autonomous Vehicles - a Comparative Analysis of Expert and Non-expert-based Approach. Presented at International Conference of Electrical and Electronic Technologies for Automotive (AEIT AUTOMOTIVE), Italy. ISBN 978-8-8872-3749-8 https://ieeexplore.ieee.org/document/9307415

L3Pilot tests the viability of automated driving as a safe and efficient means of transportation on public roads.

Interaction of Humans and Automated Vehicles (SHAPE IT)

Grant Holder: **Professor Natasha Merat**
Co-Investigator: **Professor Gustav Markkula**
Funded by: **EU H2020**
Dates: **October 2019 to September 2023**

Abstract: Supporting the interaction of Humans and Automated vehicles: Preparing for the Environment of Tomorrow (SHAPE-IT) is an Innovative Training Network project under the EU Marie Skłodowska-Curie grant agreement. Fifteen PhD-students (including three at ITS) will perform research in the project, together with their academic and industrial supervisors. The overall goal of SHAPE-IT is to enable rapid and reliable development of safe and user-centred automated vehicles (AVs) for urban environments. Vehicle automation has been identified as a game-changer in transport, promising substantial reductions in road-traffic fatalities while improving mobility. However, the processes to integrate automation in transport have been primarily focused on technology with insufficient consideration given to how users will interact with AVs.
The three PhD researchers, based at the Institute for Transport Studies, and their study topics are: Chen Peng - Developing more acceptable, pleasant and transparent AV-kinematic cues for drivers; Yue Yang - Long Term Effects of AV Exposure on AV/VRU Interactions; Amir Hossein Kalantari -Computational AV/Pedestrian Interaction Models.

L3PILOT

Grant holder: **Professor Natasha Merat**
Investigators: **Dr Tyron Louw, Dr Guilhermina Antas-Torrao, Michael Daly, Dr Andrew Tomlinson, Dr Ruth Madigan, Dr Yee Mun Lee**
Funded by: **EU H2020**
Dates: **September 2017 to August 2021**
Coordinating partner: **VW**
Collaborative partners: **See website**
Website: **l3pilot.eu/index.php?id=26**

Abstract: Automated driving technology has matured to a level motivating a final phase of road tests which can answer key questions before market introduction of the systems. L3Pilot tests the viability of automated driving as a safe and efficient means of transportation on public roads. It focuses on large-scale piloting of SAE Level 3 functions, with additional assessment of some Level 4 functions. The functionality of the systems will be exposed to variable conditions with 1,000 drivers and 100 cars across ten European countries, including cross-border routes. The technologies being tested cover a wide range of driving situations, including parking, overtaking on highways and driving through urban intersections. The tests will provide data for evaluating technical aspects, user acceptance, driving and travel behaviour, as well as impact on traffic and safety. In this multi-partner consortium our role at Leeds has been the development of detailed pilot site questionnaires and design and analysis of an annual global survey to assess user understanding and acceptance of these systems. We also lead the user-evaluation work package.

L3PILOT Papers:

1. Lyu W, Gonçalves R, Guo F, Torrão G, Radhakrishnan V, Puente Guillen P, ... & Merat N (2021) Applying Entropy to Understand Drivers' Uncertainty during Car-following. In Proceedings of the joint meeting of the 12th International Conference on Measuring Behavior and the 6th Seminar on Behavioral Methods. Krakow, Poland.
2. Gonçalves R, Lyu W, Torrão G, Puente Guillen P, Louw T & Merat N (2021) Development of an algorithm to identify stabilisation time for car-following after transitions of control from vehicle automation. In Proceedings of the joint meeting of the 12th International Conference on Measuring Behavior and the 6th Seminar on Behavioral Methods. Krakow, Poland.
3. Bellotti F, Osman N, Arnold EH, Mozaffari S, Innamaa S, Louw T, ... & Berta R (2020) Managing Big Data for Addressing Research Questions in a Collaborative Project on Automated Driving Impact Assessment. Sensors, 20(23), 6773.
4. Louw T, Goncalves R, Torrao G, Radhakrishnan V, Lyu W, Puente Guillen P & Merat N (2020) Do drivers change their manual car-following behaviour after automated car-following? Cognition, Technology & Work, 1-15.
5. Nordhoff S, Louw T, Innamaa S, Lehtonen E, Beuster A, Torrao G ... & Merat N (2020) Using the UTAUT2 model to explain public acceptance of conditionally automated (L3) cars: A questionnaire study among 9,118 car drivers from eight European countries. Transportation Research Part F: Traffic Psychology and Behaviour, 74, 280-297.
6. Innamaa, S., Aittoniemi, E., Bjorvatn, A., Fahrenkrog, F., Gwehenberger, J., Lehtonen, E., Louw, T. ... & Sintonen, H. (2020). L3Pilot Deliverable D3.4: Evaluation Plan. European Commission.
7. Louw, T., Merat, N., Metz, B., Wörle, J., Torrao, G., & Satu, I. (2020). Assessing user behaviour and acceptance in real-world automated driving: The L3Pilot project approach. In Proceedings of 8th Transport Research Arena TRA 2020. Conference cancelled.
8. Innamaa S, Louw T, Merat N, Torrao G & Aittoniemi E (2020) Applying the FESTA methodology to automated driving pilots. In Proceedings of 8th Transport Research Arena TRA 2020. Conference cancelled.
9. Goncalves R, Louw T, Quaresma M, Madigan R & Merat N (2020) The effect of motor control requirements on drivers' eye-gaze pattern during automated driving. Accident Analysis & Prevention, 148, 105788.

InterACT

Grant holder: **Professor Natasha Merat**
Investigators: **Professor Rich Romano, Dr Gustav Markkula, Dr Yee Mun Lee, Dr Ruth Madigan, Dr Jami Pekkanen, Jorge Garcia de Pedro, Dr Foroogh Hajiseyedjavadi**
Funded by: **EU H2020**
Dates: **May 2017 to April 2020**
Coordinating partner: **DLR German Aerospace**
Website: **www.interact-roadautomation.eu**

Abstract: InterACT will enable the safe integration of Automated Vehicles (AVs) into mixed traffic environments by designing, implementing, and evaluating solutions for safe, cooperative, and expectation-conforming interactions between the AV and its driver as well as other traffic participants.

In more detail the project will: Develop psychological models of interaction between road users; Improve methods for assessing the intentions, and predicting the behaviour of other traffic participants; Develop a novel Cooperation and Communication Planning Unit to enable the integrated planning and control of automated vehicles; Provide fail-safe trajectory planning to ensure safety in mixed traffic environments; Develop novel human-vehicle interaction designs; Establish new evaluation methods for studying the interactions of road users with AVs, and user acceptance of these vehicles.

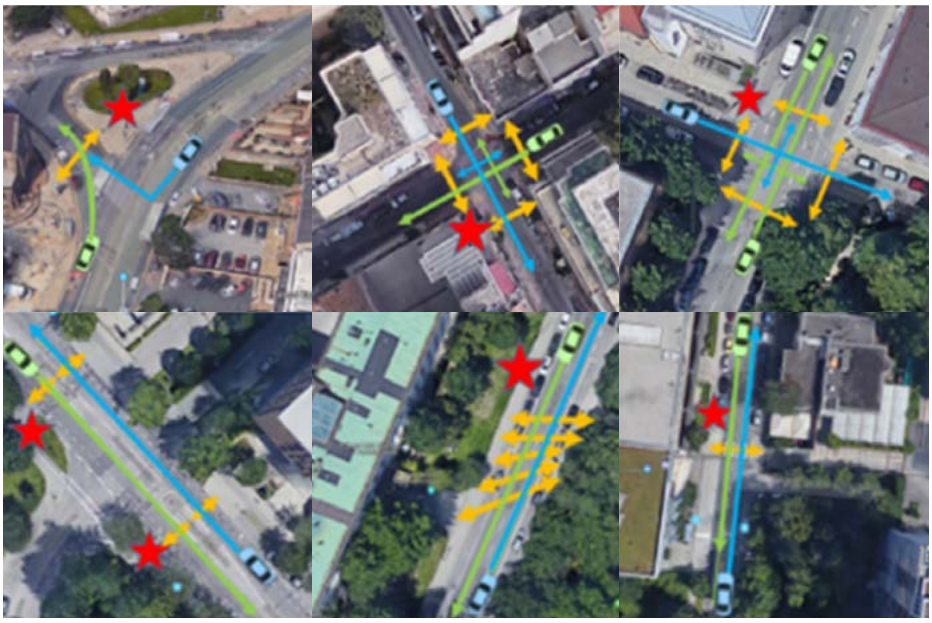
Impact: The team are contributing to an ISO working group on this topic

InterACT Deliverables:

1. Dietrich A, Lee YM, Madigan R, Merat N et al (2020) interACT D6.2 Evaluation report on on-board user and road users interaction with AVs equipped with the interACT technologies.
2. Madigan R, Lee YM, Markkula G, Merat N et al (2020) interACT D6.3 Impact assessment of the new interaction strategies on traffic cooperation, traffic flow, infrastructure design and road safety.

InterACT Conference Papers:

1. Camara F, Cosar S, Bellotto N, Merat N, Fox C (2020) Continuous Game Theory Pedestrian Modelling Method for Autonomous Vehicles. In: Olaverri-Monreal C; García-Fernández F; Rossetti RJF (eds.) Human Factors in Intelligent Vehicles. 1. River Publishers.
2. Camara F, Dickinson P, Merat N & Fox C (2020) Examining Pedestrian-Autonomous Vehicle Interactions. Proceedings of 8th Transport Research Arena TRA 2020, April 27-30, 2020, Helsinki.



InterACT graphics from the project's webpage: https://tinyurl.com/ezw7uzoc

3. Camara F & Fox C (2020) Game Theory For Self-Driving Cars. 3rd UK-RAS Conference.
4. Schieben A, Wilbrink M, Dietrich A, Portouli E, Kaup M, Tango F, Lee YM, Weber F, Ruenz J, Althoff M, Amditis A & Merat N (2020) Designing cooperative interaction of automated vehicles in mixed traffic environments: Results from the interACT project. Proceedings of 8th Transport Research Arena TRA 2020, April 27-30, 2020, Helsinki.

InterACT Journal Articles:

1. Camara F, Bellotto N, Cosar S, Nathanael D, Althoff M, Wu J, Ruenz J, Dietrich A, Fox C (2020) Pedestrian Models for Autonomous Driving Part I: Low-Level Models, from Sensing to Tracking. IEEE Transactions on Intelligent Transportation Systems. DOI:10.1016/j.trf.2020.05.004
2. Camara F, Bellotto N, Cosar S, Weber F, Nathanael D, Althoff M, Wu J, Ruenz J, Dietrich A, Markkula G, Schieben A, Tango F, Merat N, Fox C (2020) Pedestrian Models for Autonomous Driving Part II: High-Level Models of Human Behavior. IEEE Transactions on Intelligent Transportation Systems. DOI: 10.1016/j.trf.2020.05.004
3. Kaleefathullah A, Merat N, Lee YM, Eisma YB, Madigan R, Garcia J & Winter J (2020) External Human-Machine Interfaces can be Misleading: An examination of trust development and misuse in a CAVE-based pedestrian simulation environment. Human Factors: The Journal of the Human Factors and Ergonomics Society. DOI: 10.1177/0018720820970751
4. Lee YM, Madigan R, Giles O, Garach-Morcillo L, Markkula G, Fox C, Camara F, Rothmueller M, Vendelbo-Larsen SA, Rasmussen PH, Dietrich A, Nathanael D, Portouli V, Schieben A & Merat N (2020) Road users rarely use explicit communication techniques when interacting in today's traffic: Implication for Automated Vehicles. Cognition, Technology and Work, 1-14. DOI: 10.1007/s10111-020-00635-y
5. Markkula G, Madigan R, Nathanael D, Portouli E, Lee YM, Dietrich A, Billington J, Schieben A & Merat N (2020) Defining interactions: A conceptual framework for understanding interactive behaviour in human and automated road traffic. Theoretical Issues in Ergonomics Science (TTIE) DOI: 10.1016/j.trf.2020.05.004
6. Uttley J, Lee YM, Madigan R & Merat N (2020) Investigating Road user interactions in a shared space setting: understanding what means of communication are needed for future automated vehicles. Transportation Research Part F, 72, 32-46. DOI:10.1016/j.trf.2020.05.004
7. Lee YM, Madigan R, Uzondu C, Garcia J, Romano R, Markkula G & Merat N (2020) Learning to interpret novel eHMI: The effect of communicative indications and vehicle kinematics on pedestrians' crossing behaviour. https://psyarxiv.com/2xub4

HumanDrive: The Grand Drive in a self-driving car was successfully completed.

Human Drive

Grant holder: **Professor Natasha Merat**
Investigators: **Dr Chongfeng Wei, Dr Foroogh Hajiseyedjavadi, Dr Evangelos Paschalidis, Dr Zahara Batool, Michael Daly, Dr Andrew Tomlinson**
Funded by: **Innovate UK**
Dates: **July 2017 to March 2020**
Collaborative partners: **Nissan, TSC, Hitachi, Horiba Mira, Highways England, Aimsun, Cranfield University, Atkins**
Website: **humandrive.co.uk**

Abstract: The HumanDrive project has developed a prototype autonomous vehicle and demonstrated an automated journey in live traffic and under different environmental conditions. The Grand Drive from Nissan Cranfield to Sunderland was achieved as part of an investigation into how autonomous driving can emulate a natural, human-like driving style. On its journey, the Nissan LEAF test vehicle experienced a range of driving scenarios from country lanes with no or minimal road markings, to junctions, roundabouts and motorways. Autonomous technology was activated along the route to change lanes, merge and stop and start when necessary. The system has undergone a robust testing process including simulation, hardware in the loop, private test track and small sections of public roads. The Leeds team developed and tested a series of vehicle control models. Can more human-like behaviour from an automated vehicle affect user behaviour and acceptance? In our state of the art motion-based driving simulator, the experiences of drivers were monitored to ensure the vehicle control models are acceptable to a wide range of users.

Human Drive Conference Papers:

1. Hajiseyedjavadi F, Merat N, Romano R, Jamson H, Louw T, Li P & Boer E (2020) The Effect of Road Environments on Driving Behavior. In International Conference on Traffic and Transport Psychology.
2. Forster D & Batool Z (2020) Systematic Use of Subjective Reflections on AV. Measuring Behaviour.
3. Solernou A, Romano R, Souflas I, Hajiseyedjavadi F, Paschalidis E and Merat N. (2020) Integration and training of a ROS autonomous driver for human-like driving style in a complex multi-component driving simulator In: Proceedings of the Driving Simulation Conference

Human Drive Journal Papers:

1. Paschalidis E, Hajiseyedjavadi F, Wei C, Solernou A, Jamson AH, Merat N. . . Boer E. (2020) Deriving metrics of driving comfort for autonomous vehicles: A dynamic latent variable model of speed choice. Analytic Methods in Accident Research, 28, 100133.
2. Radhakrishnan V, Merat N, Louw T, Lenné MG, Romano R, Paschalidis E. . . Boer ER (2020) Measuring Drivers' Physiological Response to Different Vehicle Controllers in Highly Automated Driving (HAD): Opportunities for Establishing Real-Time Values of Driver Discomfort. Information, 11(8), 390.

Making full use of Automation for National Transport and Road Authorities (MANTRA)

Grant holder: **Professor Oliver Carsten**
Investigator: **Dr Zia Wadud**
Funded by: **Conference of European Directors of Roads (CEDR)**
Dates: **September 2018 to September 2020**
Coordinating partner: Traficon Ltd
Collaborative partners: Arndt IDC, HITEC, VTT Technical Research Centre of Finland, TU Delft.

Abstract: At a time of quick development of connected and automated driving, automation will affect the core business of National Road Authorities (NRAs). The MANTRA project aimed to answer the following questions: What are the influences of automation on the core business of NRAs in relation to road safety, traffic efficiency, the environment, customer service, maintenance and construction processes?; How will the current core business, on operations & services, planning & building and ICT, change in the future? MANTRA applied a European transnational approach to facilitate the utilization of the results for all CEDR members.

TRANSITION

Grant holder: **Professor Richard Wilkie, (University of Leeds, School of Psychology)**
Investigators: **Professor Natasha Merat, Professor Rich Romano, Dr Gustav Markkula**
Funded by: **EPSRC**
Dates: **September 2017 to August 2020**
Coordinating partner: **University of Leeds**
Collaborative partners: **Volvo Cars**

Abstract: Whilst there has been widespread coverage of the development of fully automated vehicles, it is unlikely that full-automation will quickly become the norm. Indeed 'driverless' vehicles are already technologically possible, but there are significant barriers to adoption, and the prevalent view is that the human driver will remain the primary controller of the vehicle for some time. There are a number of reasons for this such as; regions where automation is not possible (e.g. poor GPS coverage, inaccurate mapping or poor road demarcation), needing human control of the vehicle when automatic systems fail; some drivers will continue to desire vehicles that allow them to be in control. In this context, understanding the best way to ensure safe interactions between humans and automation remains a high priority. Human error is a major contributor to road

accidents. Automated Vehicles (AVs) have the potential to dramatically reduce road death. A major concern, however, is that many AVs require human supervision, and despite our lack of understanding how human drivers interact with AVs there are already AV systems purchased and being used on the roads (e.g. Tesla). We used sophisticated vehicle simulators to examine how drivers re-engage with the vehicle after a period of AV control. Impact: Our findings identify situations where drivers are particularly vulnerable to making steering errors. We developed the TRANSITION model to improve the design and implementation of AV systems.

RAIL

In partnership with RSSB, ITS is working on rail accessibility, safety, technology, the development of appraisal methods and big data in railways.

ASSETS4RAIL

Grant holder: **Dr Manuel Ojeda-Cabral**
Investigators: **Professor Andrew Smith, Dr Xiaoxiao Ma**
Funded by: **EU H2020**
Coordinating partner: **Eurecat / Eurenex**
Collaborative partners: **See full list on http://www.assets4rail.eu/**
Dates: **December 2018 to May 2021**
Website: **http://www.assets4rail.eu/**

Abstract: The European railway infrastructure is ageing and needs to cope with an expected increase in traffic in the near future. Reliable rolling stock will be required to crystallize the desired modal shift to rail. A proactive and cost-effective maintenance and intervention system is also required. Assets4Rail aims to contribute to this modal shift by exploring, adapting and testing cutting-edge technologies for railway asset monitoring and maintenance. The main objective for the project is to develop a set of cost efficient and cutting-edge asset-specific measuring and monitoring devices. These devices will collect and deliver the status data of the railway system (infrastructure and rolling stock). The data will be processed to support asset management decisions. To achieve that, Assets4Rail follows a twofold approach, including infrastructure (tunnel, bridges, track geometry, and safety systems) and rolling stock. The project benefits from a strong multidisciplinary consortium. As a key member of the team ITS are providing the economic appraisal of a wide range of railway innovations developed by Assets4Rails.

RSSB-ITS Research Partnership in Rail Economics

Grant holder: **Dr Manuel Ojeda-Cabral**
Investigators: **Professor Richard Batley, Professor Andrew Smith, Dr Phill Wheat, Dr Chiara Calastri, Dan Johnson, Dr Thijs Dekker, Dr Bryan Matthews**
Funded by: **RSSB**
Dates: **July 2020 to March 2021**

Abstract: Railways are complex systems with multiple interfaces delivered by many different organisations. RSSB have formed a strategic partnership with the University of Leeds which has been extended for a third year. Dr Ojeda Cabral is seconded to RSSB to support the development of a novel transport/rail economics research programme.

Impact: Cross-industry research and innovation play key roles in developing the knowledge, technologies and operational solutions that individual players in the rail system could not pursue in isolation. Research, analysis and insight help industry to tackle the issues of today and enable the railway of the future to be better, safer and more sustainable. Through this partnership, ITS is continuously working closely with the rail industry on multiple jointly developed research projects around topics such as rail accessibility, safety, technology, the development of appraisal methods and big data in railways.

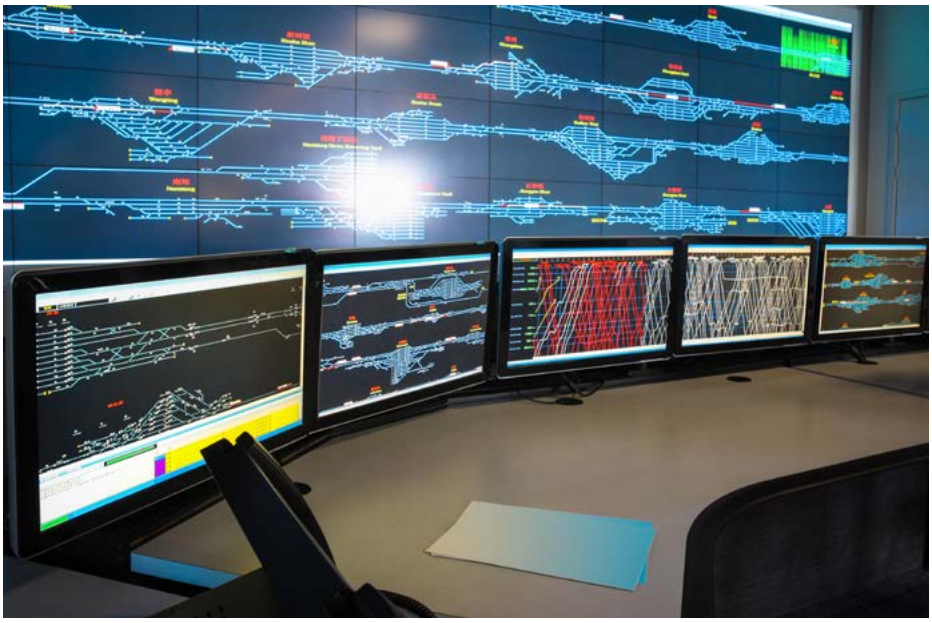
Outputs:

1. Ojeda-Cabral, M., Matthews, B., Dekker, T. and Batley, R. (2020). Valuation and Appraisal of Accessibility in Rail: an appraisal framework for improvements in accessibility for all – Final Report. https://www.sparkrail.org/Lists/Records/DispForm.aspx?ID=26839
2. Ojeda-Cabral, M., Ma, X. and Smith, A. (2020). The economic case for removing the gap and step between trains and platforms: the case of Kneeling Trains. https://www.sparkrail.org/Lists/Records/DispForm.aspx?ID=26911

Adaptive and Intelligent Automatic Train Operations (AI – ATO)

Grant holder: **Professor Ronghui Liu**
Funded by: **Royal Academy of Engineering**
Coordinating partner: **Beijing Jiaotong University, TCT Ltd**
Dates: **April 2020 to March 2022**

Abstract: Rail transit is an effective and sustainable mass public transport system for cities but the energy consumption from running train services is significant. Beijing Metro is the city's biggest electricity user, and 50% of its energy consumption is used by train traction force. Following on from an earlier collaboration with BJTU and TCT on the development of energy-efficient train speed controls for Beijing Metro Line 7 (ATO project reported in the 2018 ITS Annual Research Report), the current project is to exploit state-of-the-art control technologies and machine learning. It will develop energy-efficient optimal train speed control



Dynamic Timetabling explores advanced Artificial Intelligence to automate the train timetable planning processes.

that is dynamic, responding to real-time operation conditions.

Impact: An intelligent self-learning process will automatically adjust railway control parameters and functions to achieve optimal performances in terms of energy efficiency, tracking precision and safety.

Dynamic Timetabling

Grant holder: **Professor Ronghui Liu**
Investigators: **Dr Zhiyuan Lin**
Funded by: **RSSB**
Coordinating partner: **Bellvedi Ltd**
Dates: **April 2020 to March 2022**

Abstract: Very Short Term Planning (VSTP) is a railway operation process by which the need to change one or more train services at very short notice can be made. Working closely with the relevant rail industry, this project aims to create a digital platform that can process VSTP requests, create and validate the proposed schedules, and transfer the VSTP schedule to the Network Rail control team. The team at ITS Leeds will develop dynamic timetabling capability that allows the automatic adjustment of schedules and/or train routes around problem areas. We will explore advanced Artificial Intelligence to automate the train timetable planning processes.
Impact: The improvements in a digital VSTP process will provide the foundation for more flexible and dynamic timetables, where available capacity can be adjusted to meet the changes in demand.

Roadmaps for AI Integration in the Rail Sector (RAILS)

Grant holder: **Professor Ronghui Liu**
Investigators: **Dr Ziyuan Lin, Dr He Wang (Computing)**
Funded by: **EU Shift2Rail**
Coordinating partner: **CINI**
Dates: **December 2019 to November 2022**

Abstract: RAILS is to investigate the potential of Artificial Intelligence (AI) approaches in the rail sector and contribute to the definition of roadmaps for future research in next generation signalling systems, operational intelligence, and network management. A unique task of the project is to address the training of PhD students to support the research capacity in AI within the rail sector across Europe by involving research institutions in four different countries with a combined background in both computer science and transportation systems. To this end, RAILS supports a full scholarship for a PhD based at University of Leeds, supervised by Prof Ronghui Liu and Dr Zhiyuan Lin, with support from AI specialist Dr He Wang of the School of Computing.

Reducing Energy Demand (TransEnergy)

Grant holder: **Professor Andrew Smith**
Funded by: **EPSRC**
Dates: **July 2017 to July 2021**
Collaborative partner: **Mark Wardman (SYSTRA)**
Website: **www.sheffield.ac.uk/creesa/projects/transenergy**

Abstract: The TransEnergy Road to Rail Energy Exchange is an innovative technical and socio-economic research collaboration. It aims to provide energy buffering services between rail and electric vehicles to enable a step-change reduction in energy demand. Our contribution to this project is a socio-economic study providing financial models and frameworks to support adoption and implementation of the technology.

NEXTGEAR

Grant holder: **Professor Andrew Smith**
Investigators: **Dr Phill Wheat, Dr Kristofer Odolinski**
Funded by: **EU H2020**
Coordinating partner: **Unife**
Collaborative partners: **see project website**
Dates: **December 2019 to November 2021**
Website: **https://nextgear-project.eu/**

Abstract: NEXT generation of methods, concepts and solutions for the design of robust and sustainable running GEAR (NEXTGEAR) will implement a coordinated set of research activities to develop Running Gear Innovations and the Wheel Set of the Future. The project is part of the Shift2Rail programme.

Land Value and Transport – Phase 3

Grant holder: **Dr John Nellthorp**
Investigators: **Dr Han Lin, Dr Manuel Ojeda-Cabral, Dr Like Jiang**
Funded by: T**ransport for the North**
Dates: **October 2020 to March 2021**

Abstract: This study builds on two previous phases of the project which have increased knowledge about, and developed practical tools to quantify the value of locational characteristics as seen in the property market. An important omission from the previous studies was a large-sample model of commercial property for the complete TfN area. The main objectives of this study are therefore: 1.To develop a model of commercial property value for the whole TfN area, at a fine level of spatial detail in order to allow for a detailed analysis of the role of accessibility by multiple modes. 2. To include in the model business-to-business accessibility, as well as the home-to-business accessibility that was a key variable in the residential model. 3. To provide a spreadsheet tool with which TfN can apply the model results to analyse the value associated with particular schemes or policy changes.

West Coast Main Line Property Impacts

Grant holder: **Dr John Nellthorp**
Investigators: **Dan Johnson, Dr Manuel Ojeda-Cabral, Dr Like Jiang, Dr Han Lin, John Dixon**
Funded by: **HS2**
Dates: **November 2019 to May 2020**

Abstract: What is the likely impact of HS2 on local/regional property markets? In 1998 to 2009 modernisation of the West Coast Main Line (WCML) was a £9bn investment programme which led to substantial improvements in journey time and frequency between stations on the West Coast route. This created an opportunity to investigate the pattern of property value uplifts which resulted from these rail service improvements – and which are relatively recent and relate to a large part of the same geography as HS2. Moreover, we were able to conduct a cross-sectional analysis in the same study area.

CONNECTED AND SHARED MOBILITY

ARCADE

Grant holder: **Dr Yvonne Barnard**
Investigator: **Jo-Ann Pattinson**
Funded by: **EU H2020**
Dates: **October 2018 to September 2021**
Coordinating partner: **ERTICO – ITS Europe**
Collaborative partners: **24 European partners (see website for details)**
Website: **connectedautomateddriving.eu/arcade-project**

Abstract: ARCADE (Aligning Research & Innovation for Connected and Automated Driving in Europe) is a coordination and support action for consensus-building among stakeholders for sound and harmonised deployment of Connected, Cooperative and Automated Driving (CAD). Stakeholders include industry, automotive clubs, professional drivers associations, researchers and public sectors. ARCADE supports the commitment of the European Commission, the European Member States and the industry to develop a common approach to development, testing, validation and deployment of connected and automated driving in Europe and beyond.

Impact: ARCADE has established a joint stakeholders forum to coordinate and harmonise automated road transport approaches at European (e.g. strategic alignment of national action plans for automated driving) and international level (in particular with the US and Japan). Towards this objective, ARCADE organised the Second European CAD conference.

Mobility as a Service platforms enable people to make more sustainable travel choices.

HI TRANS MaaS

Grant holder: **Dr Kate Pangbourne**
Investigators: **Dr Zahara Batool**
Funded by: **Transport Scotland**
Co-ordinating partner HITRANS
Collaborative partners: **Shotl, Fleetondemand, Enterprise Car Club and Car Hire, Bewegen, Stagecoach Bus, West Coast Motors, Inverness Taxis, ScotRail, Loganair and SkedGo**
Dates: **April 2020 to June 2022**
Website: **https://tinyurl.com/2sxkm4uw**

Abstract: HITRANS are developing a Mobility as a Service (MaaS) platform to enhance mobility services by integrating travel modes. The HI TRANS MaaS app will allow users to find, book and pay for journeys using any iPhone or Android mobile device. It relies on bringing together all participating transport modes and will provide integrated ticketing for e-bike hire, ferries, buses, trains, car clubs, Logan Air and taxis. At Leeds we are leading the evaluation of user experience, behavioural and transport impacts.

Impact: This pioneering project is an ambitious region-wide solution that has the potential to make a significant contribution to improve accessibility for residents and visitors. It also addresses Government ambitions to reduce carbon emissions by encouraging a modal shift from sole occupancy cars to shared cars and public transport alternatives. It will also help to create healthier lifestyles by improving the sustainable travel choices people can make in the Scottish Highlands region including active travel opportunities.

Shift2MaaS

Grant holder: **Professor Andrew Smith**
Investigators: **Dan Johnson, Dr Manuel Ojeda-Cabral, Dr Xiaoxiao Ma**
Funded by: **EU H2020**
Coordinating partner: **UIP**
Collaborative partners: **See full list on http://shift2maas.eu/**
Dates: **December 2018 to December 2020**

Abstract: Shift2Maas is one of five innovation programmes of Shift2Rail. The main goal of Shift2Maas is to support the uptake of new and integrated Mobility-as-a-Service platforms to enable seamless passenger experience throughout Europe. Our role at Leeds is the economic assessment of the MaaS platform.

Impact: Shift2Maas adopts a traveller-centred approach in order to allow a full seamless multimodal travel experience: customers will be able to easily plan and purchase door-to-door journeys, as well as being assisted before, during and after their journey. Improved information technology, management and exploitation, and cross-industry collaboration will help to provide passengers with smart and personalised services for journey information and ticket purchase, together with entertainment and communication services.

PASCAL: research on user acceptance of highly automated transport systems and driver awareness in a range of complex urban environments.

SUITCEYES

Grant holder: **University of Borås, Sweden**
Investigator: **Bryan Matthews**
Funded by: **EU H2020**
Dates: **January 2018 to December 2020**
Website: **suitceyes.eu**

Abstract: SUITCEYES is an acronym for Smart, User-friendly, Interactive, Tactual, Cognition-Enhancer, Yielding Extended Sensosphere. There are an estimated 2.5M deafblind persons in the EU. Limited communication and mobility are major problems for this group. SUITCEYES proposes a new, intelligent, flexible and expandable mode of haptic communication via soft interfaces. Based on user needs and informed by disability studies, the project combines smart textiles, sensors, semantic technologies, image processing, face and object recognition, machine learning, and gamification. Perception of the environment is one of the challenges this project will address. This, among other wider benefits, will help to enhance a deafblind person's ability to travel safely in their community.

Valuing Accessibility in Transport

Grant holder: **Dr Manuel Ojeda-Cabral**
Investigators: **Dr Thijs Dekker, Professor Richard Batley, Dr Chiara Calastri, Bryan Matthews, Dr Phill Wheat**
Funded by: **DfT and Transport Scotland**
Coordinating partner: **ARUP**
Dates: **June 2019 to October 2021**

Abstract: Accessibility is here defined as the degree to which all members of society can access transport systems in an inclusive way. This study, for DfT and Transport for Scotland, aims to develop and test a robust methodology for estimating the benefits of accessibility interventions. These benefits can be used for transport appraisal.

Impact: Our research inputs will contribute towards WebTAG, the guidelines for socio-economic appraisal of transport projects and policies in the UK.

AUTOPILOT

Grant holder: **Dr Haibo Chen**
Investigators: **Dr Kaushali Dave, Dr Gillian Harrison, Dr Jianbing Gao, Dr Jo-Ann Pattinson, Dr Ye Liu, Dr Yvonne Barnard, Junyan Chen, Professor Simon Shepherd**
Funded by: **EU H2020**
Dates: **January 2017 to February 2020**
Coordinating partner: **ERTICO**
Collaborative partners: **46 partners in industry and academia (see website for details)**
Website: **autopilot-project.eu**

Abstract: 'Automated driving Progressed by Internet Of Things' (AUTOPILOT) brings the Internet of Things (IoT) into the automotive world. IoT enables connections between objects or 'Things'. The IoT connects anything, anytime, anyplace, using any service over any network. The project aims to transform connected vehicles (i.e. moving 'things' within the IoT ecosystem) into highly and fully automated vehicles. While using the IoT potential for automated driving, AUTOPILOT also returns data from autonomous cars to the IoT. AUTOPILOT will involve vehicles, road infrastructure and surrounding objects in the IoT ecosystem, with particular attention to the safety-critical aspects of automated driving. The IoT-enabled AUTOPILOT cars are being tested in real conditions at six permanent large-scale pilot sites in Finland, France, Italy, the Netherlands, South Korea and Spain. The project aims to bring automated driving towards a new dimension.

AUTOPILOT Papers:

1. Harrison G, Shepherd S & Chen H (2021), Modelling Uptake Sensitivities of Connected and Automated Vehicle Technologies, International Journal of System Dynamics Applications (IJSDA), Volume 10, Issue 2.
2. Pattinson J & Chen H (2020), A barrier to innovation: Europe's ad-hoc cross-border framework for testing prototype autonomous vehicles, International Review of Law, Computers & Technology, 34(1), pp.108-122, doi: 10.1080/13600869.2019. 1696651.
3. Chen J & Chen H, Gao J, Pattinson J & Quaranta R (2020), A business model and cost analysis of automated platoon vehicles assisted by the Internet of things, Proceedings of the Institution of Mechanical Engineers Part D: Journal of Automobile Engineering. 235 (2-3), doi: 10.1177/0954407020949726.
4. Liu B, Jia D, Lu K, Chen H, Yang R, Wang J, Barnard Y & Wu L (2017), Infrastructure-Assisted Message Dissemination for Supporting Heterogeneous Driving Patterns, IEEE Transactions on Intelligent Transportation Systems, 18(10), pp.2865-2876. doi: 10.1109/TITS.2017.2661962

AUTOPILOT Impact: Further research funding was won for the PAsCAL project (described below)

PASCAL

Grant holder: **Dr Haibo Chen**
Investigators: **Dr Kaushali Dave, Dr Evangelos Paschalidis, Dr Like Jiang, Professor David Watling, Bryan Matthews**
Funded by: **EU H2020**
Coordinating partner: **LIST**
Collaborative partners: **13 partners in industry and academia (see website for details)**
Dates: **June 2019 to May 2022**
Website: **https://www.pascal-project.eu/**

Abstract: PASCAL proposes an awareness-driven and large-scale penetration approach to address issues raised by the majority of the general public - issues that hinder the

wide market uptake of Connected and Autonomous Vehicles (CAV). Using an interdisciplinary mix of innovative tools from both human science and technology to capture public acceptance and attitude we will analyse and assess the concerns raised by people, model and simulate realistic scenarios for hands-on practice, and validate the research innovation in several real-world trials.

Impact: This project will contribute to: Improved levels of safety and security in all modes of transport, in line with the Transport White Paper 2011 (e.g. Vision Zero); The possible reduction of cost for industry and public authorities through an improved understanding of requirements and needs of different types of 'drivers'/ users in the context of connectivity and automation in all modes of transport; A better user acceptance of innovative, cooperative, connected and highly automated transport systems; Enhanced driver awareness and behaviour in a range of complex / urban operating environments.

PASCAL Papers:

1. Pattinson J, Chen H & Basu S (2020) Legal issues in automated vehicles: critically considering the potential role of consent and interactive digital interfaces, Humanities and Social Sciences Communications (published by Springer Nature).
2. Chen J, Dave K, Chen H, Gao J & Liu Y (2020) Societal impacts and gap analysis of connected and autonomous vehicles, presented at ITS European Congress, Lisbon

AIR QUALITY AND HEALTH

COVID-19 Emergency Data Collaboration

Grant holder: **Professor Greg Marsden**
Investigators: **Professor Jillian Anable, Dr Llinos Brown**
Funded by: **UKRI, DfT, Transport Scotland, Climate Exchange, Liverpool City Region Combined Authority, Strathclyde Partnership for Transport and the University of Leeds**
Co-ordinating partner: **University of Leeds**
Collaborative partners: **University of Stirling**
Dates: **01/05/2020 - ongoing**
Website: **https://covid19transas.org/**

Abstract: This is an emergency COVID-19 rapid response grant. The research is unique in conducting an in-depth three wave longitudinal panel data collection survey in 10 sites across the UK (N=9000+ in wave 1). This is accompanied by two waves of more in-depth qualitative panel interviews with over 100 citizens. There are also a series of policy translation and impact assessment strands to the work programme. These include a three wave longitudinal panel of expert policy maker interviews across the public and private sector and national, sub-national and local government and NGOs; research in the impacts of the pandemic on business workplace strategy and city centres and individual adaptations to home working. The project holds monthly behavioural insight data exchange meetings which attract speakers and attendees from across local and national government as well as industry. The project aims to deliver timely insights which can influence the policy responses of our funders and other decision-makers whilst also creating a unique set of data assets to allow us to understand how behaviour changes over time and how that relates to the expectations of individuals and the actions of policy makers, transport providers and businesses.

Impact: The work is on-going with monthly sharing of findings.

Papers: https://covid19transas.org/outputs/

Covid Traffic Light sign.

COVID-19 Exposure Risk Trade-offs in Transport

Grant holder: **Dr Zia Wadud**
Investigators: **Dr Zahara Batool, colleagues from School of Engineering**
Funded by: **EPSRC**
Dates: **October 2020 to October 2021**
Coordinating partner: University of Leeds
Collaborating partners: **Bangladesh University of Engineering and Technology, University of Asia Pacific, Makerere University, Federal University of Technology Owerri**

Abstract: In developing countries, which transport mode is safest in terms of COVID exposure risk? This project aims to provide a science-based answer for transport policymakers. By developing Computational Fluid Dynamics (CFD)-based models of droplet dispersion in different types of public transport, vehicles with different geometry, seating configuration, ventilation properties, occupancy and protection (e.g. helmet in motorcycles), the project will provide a world-first insight into passenger risks of exposure to COVID. The CFD models will also be used to design barriers or shields for motorcycle and autorickshaw rides to make these modes safer than they currently are. The objective risk measures will be complemented by a survey to understand passengers' travel behaviour and reveal their preferences regarding different transport modes and the droplet dispersion shields.

Dr Zia Wadud - modelling the links between transport, air quality and Covid-19 spread in Bangladesh.

Modelling the links between transport, air quality and COVID-19 spread

Grant holder: **Dr Zia Wadud**
Funded by: **UKAID**
Dates: **October 2020 to April 2021**
Coordinating partner: **University of Leeds**
Collaborating partners: **Bangladesh University of Engineering and Technology**
Website: **Modelling COVID spread in transport / https://tinyurl.com/h2znkbck**

Abstract: The aim of this project is to investigate the effects of COVID-19 related policy interventions on the transport outcome and correlating these with potential changes in air quality, traffic fatality and spread of the disease. The study is using naturalistic data from Dhaka, Bangladesh.

Papers:

1. Bhaduri E, Manoj BS, Wadud Z, Goswami A and Choudhury C (2020) Modelling the effects of COVID19 on mode choice behaviour in India. Transportation Research Interdisciplinary Perspective, Vol. 8, 100273
2. Cohen T, Stilgoe J, Akyelken N, Cavoli C, Day J, Dickinson J, Fors V, Hopkins D, Lyons G, Marres N, Newman J, Reardon L, Seipe N, Stares S, Tennant C, Wadud Z and Wigley (2020) A constructive role for social science in the development of automated vehicles. Transportation Research Interdisciplinary Perspective, Vol. 6, 100133
3. Wadud Z (2020) The effects of ride-hailing apps on motorcycle ownership in an emerging-country megacity. Transportation Research Part A, Vol. 137, pp. 301-312
4. Wadud Z (2020) An investigation into the effects of ridehailing services on airport parking demand. Journal of Air Transport Management, Vol. 84
5. Andreou A, Barrett J, Taylor PG and Wadud Z 2020, Decomposing drivers of residential space cooling energy consumption in EU-28 countries using a panel data approach. Energy and Built Environment.

Transport Risk Assessment for COVID-19 Knowledge (TRACK)

Grant holder: **Professor Cath Noakes, School of Engineering, University of Leeds (PI)**
Investigators: **Professor Susan Grant-Muller, Dr Martin Lopez-Garcia, Dr Marco-Felipe King Frances Hodgson, Professor Simon Shepherd, Professor David Watling, Dr Andrew Tomlinson**
Funded by: **EPSRC, DfT**
Dates: **Sept 2020 to Feb 2022**
Coordinating partner: **University of Leeds**
Collaborative partners: **DfT, University of Manchester, DSTL, Public Health England, Newcastle University, University of Cambridge, Imperial College, Industry partners**

Abstract: TRACK is a multidisciplinary project designed to address knowledge gaps around COVID-19 transmission on public transport. TRACK will develop a novel risk model that can simulate infection risk through three transmission mechanisms (droplet, aerosol, surface contact) within different transport vehicles and operating scenarios. New data will be collected on public transport in Leeds, Newcastle and London: Air and surface samples will be collected to measure SARS-Cov-2 prevalence together with other human biomarkers as a proxy measure for pathogens. User and staff travel behaviour and demographics will be characterised through surveys and passive data collection to relate public transport use to geographic and population sub-group disease prevalence. The proximity of people and their surface contacts will be quantified through analysis of transport operator CCTV data to enable simulation of micro-behaviour in the transport system. The dispersion of infectious droplets and aerosols with different environmental infection control strategies will be evaluated using physical and computational models. Data sources will be combined to develop probability distributions for SARS-CoV-2 exposure and simulate transmission risk through a Quantitative Microbial Risk Assessment (QMRA) framework.

Impact: Working closely with Department for Transport (DfT) and transport stakeholders, TRACK will provide microbial and user data, targeted guidance and risk planning tools that will directly enable better assessment of infection risks for passengers and staff using surface public transport networks, and help policy teams design effective interventions to mitigate transmission.

uCARe

Grant holder: **Professor Samantha Jamson**
Investigators: **Dr James Tate, Dr Zahara Batool, Dr Chris Rushton**
Funded by: **EU H2020**
Coordinating partner: **TNO**
Collaborative partners: **14 partners - see project website**
Dates: **May 2019 – April 2022**
Website: **https://www.project-ucare.eu/**

Abstract: The aim of uCARe is to reduce the overall pollutant emissions of the existing vehicle fleet by providing vehicle users with simple and effective tools to decrease their individual emissions and to support stakeholders with an interest in local air quality in selecting feasible intervention strategies that lead to the desired user behaviour. The project will assess the emission reduction potential of certain driving behaviours and vehicle components. Then, a toolbox of containing intervention strategies will be developed to roll-out to policy makers and other stakeholders with an interest in air quality. These strategies will be evaluated and an impact assessment performed. Interviews with forty participants have taken place to uncover their existing

knowledge with regards vehicle pollutants and how they can adopt certain behaviours to reduce these. We found that whilst drivers were aware of the effects of CO2, most had little understanding about NOx and particulates. These results will help guide the development of teaching materials in the final phase of the project.

Targeting the Bad Emitting Vehicles

Grant holder: **Dr Karl Ropkins**
Funded by: **EPSRC**
Collaborative partners: **Dr Joe Zietsman, Texas A&M University Transportation Institution; US Department of Transport Center for Advanced Research in Transport, Emissions, Energy and Health**
Dates: **May 2019 to November 2020**

Abstract: We know some vehicles are bad emitters, i.e., they are continuous or intermittent high emitters of one or more priority pollutant. We do not know exact numbers, but we suspect some are poorly engineered vehicles, some are deliberately tampered vehicles and some are incorrectly or unmaintained vehicles. The objectives within this study are two-fold: 1) To explore options to enhance our understanding of these vehicles, through the focused analysis of existing datasets; and 2) To repurpose and redeploy conventional in-vehicle emissions measurement systems for car-chaser work focused on the characterisation of followed-vehicle emissions as good or bad.

Impact: Ropkins K, Ibarra-Espinosa S, Bernard Y (2020) Chapter 4. Vehicle Emissions Measurement and Modeling. In: Khreis H, Nieuwenhuijsen M, Zietsman J, Ramani T. eds. Traffic-Related Air Pollution: Emissions, Human Exposures, and Health. Elsevier. ISBN: 9780128181225. https://www.elsevier.com/books/traffic-related-air-pollution/khreis/978-0-12-818122-5

City Air Remote Emission Sensing (CARES)

Grant holder: **Dr James Tate**
Investigators: **Dr Karl Ropkins**
Funded by: **EU H2020**
Dates: **May 2019 to April 2022**
Website: **https://cares-project.eu/**

Abstract: CARES aims to investigate contactless measurement of vehicle exhaust emissions such that it becomes a widespread means for the monitoring and enforcement of real-world vehicle emissions.

uCARe, Targeting the Bad Emitting Vehicles, CARES and Evaluate Local NO2 Plans – research aimed at reducing road pollution.

We develop plume chasing instruments to detect high-emitters in free flowing traffic. We turn fast-response air quality sensors into roadside point samplers, adding particle mass, number and size to the remote sensing capabilities. Furthermore, we speed up the data handling towards a real-time analysis of vehicle emission data; merging the emissions data with technical data from national vehicle registers and relevant data from traffic and air quality management systems. Third, we eliminate today's often very time consuming data analysis by providing a suite of open-source functions. All our innovations will improve the user friendliness, bring down costs by automated operations and achieve a broader deployment potential of remote emission sensing. CARES aims to demonstrate these developments in three major, heavily air polluted cities in Europe.
Impact: CARES will bring together researchers, remote emission sensing technology providers, local, regional and national authorities and many other stakeholders from Europe, China and the rest of the world, to maximize the project's exploitation potential.

Evaluate Local NO2 plans

Grant holder: **Dr James Tate**
Investigators: **Professor Jillian Anable, Dr Karl Ropkins**
Funded by: **DEFRA/ IPSOS**
Dates: **November 2018 to April 2022**

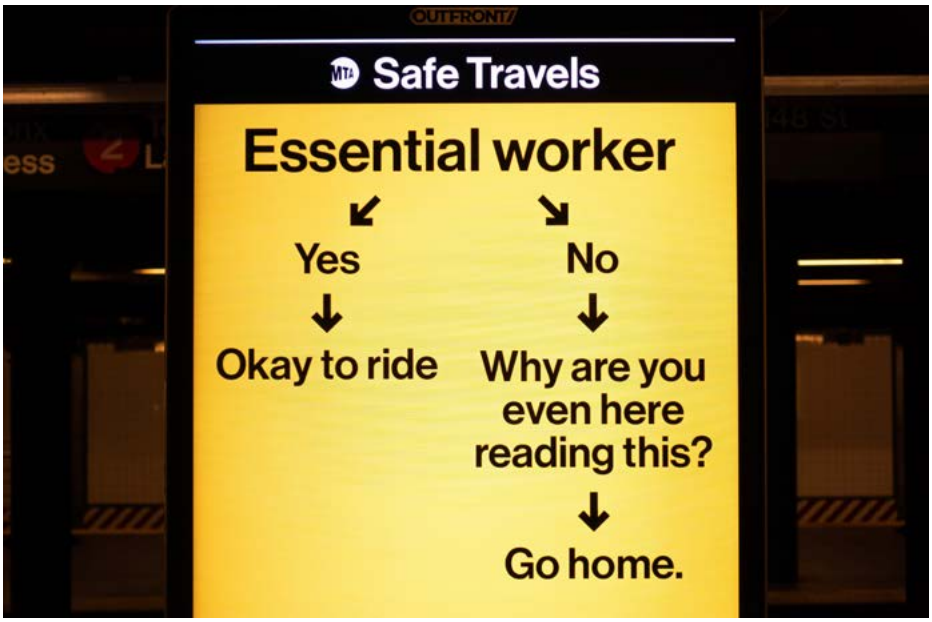
Abstract: DEFRA have invested over £1 billion into Clean Air Zones including Leeds and 32 other Local Authorities. The aim of this project is to detect and measure the impact of air quality plans across the UK. A network of data collection points is in place. We will analyse that data.

Impact: The UK policy on air quality is world leading. If we can detect improvement in health within clean air zones this would be hugely significant. This large project can be extended in scope. We are in a stage 2 proposal with NIHR & the Born in Bradford research group.

MODALES

Grant holder: **Dr Haibo Chen**
Investigators: **Dr Jianbing Gao, Dr Ye Liu, Professor David Watling**
Funded by: **EU H2020**
Coordinating partner: **ERTICO**
Collaborative partners: **16 European partners in industry and academia and 3 Chinese Partners (see website for details)**
Dates: **September 2019 to August 2022**
Website: **http://modales-project.eu/**

Abstract: MODALES is aimed at contributing to a substantial global reduction in air pollution from all types of motorised road vehicles by encouraging the adoption of eco-driving behaviour and maintenance. The main goal of MODALES is to understand and influence user behaviour via dedicated training, including a driver assistance app and awareness campaigns, in order to support effective air quality plans and enforcement strategies of local and national authorities.



Decisions made easy during the Covid pandemic.

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2. Tu R, Li T, Meng C, Xie Y, Xie F, Yang F, Chen H, Li Y, Gao J & Liu Y et al (2021), Real-world Emissions of Construction Mobile Machines and Comparison to a Non-road Emission Model, Science of the Total Environment, 10.1016/j.scitotenv.2021.145365
3. Gao J, Chen H, Dave K, Chen J & Jia D (2020), Fuel economy and exhaust emissions of diesel vehicle under real traffic conditions, Energy Science & Engineering, 2020(8), pp. 1781-1792, DOI: 10.1002/ese3.632.
4. Gao J, Chen H, Dave K, Chen J, Li Y, Li T & Liang B (2020), Driving behaviours analysis of truck drivers using motorway tests, Proc. IMechE, Part D: Journal of Automobile Engineering, ISSN 0954-4070, 10.1177/0954407020925568.
5. Gao J, Chen H, Chen J & Dave K (2020), A New Simulation Approach of Estimating the Real-World Vehicle Performance, In: SAE Technical Papers. WCX SAE World Congress Experience, 21-23 Apr 2020, Detroit, MI, USA. SAE International, doi.org/10.4271/2020-01-0370.

CHOICE MODELLING

ADAPT

Grant holder: **Dr Kate Pangbourne**
Investigators: **Dr Foroogh Hajiseyedjavadi**
Funded by: **EPSRC**
Dates: **June 2016 to May 2021**
Collaborative partners: **See project website**
Website: **adapt.leeds.ac.uk**

Abstract: ADAPT is funded by the 'Living with Environmental Change Challenge' Fellowship programme. The over-arching vision is to develop more effective methods of influencing people to choose sustainable travel modes. A dataset of travel behaviour-change communications has been created. These have been tagged with useful metadata and have argument diagrams completed in AML format. We used this dataset to derive messages for stated preference experiments styled as online surveys. The surveys focus on arguments and framings for persuasive messages for walking or cycling. We explored persuasive arguments that highlight time-use during journeys. Initial research has been supplemented with focus groups to trial the behavioural impacts of targeted messaging. Follow us on Twitter: @ADAPT_travel

Papers: Pangbourne K, Bennett S & Baker A (2020). Persuasion profiles to promote pedestrianism: effective targeting of active travel messages. Travel Behaviour and Society, 20, 300-312.

DECISIONS

Grant holder: **Professor Stephane Hess**
Investigators: **Dr Charisma Choudhury, Dr David Palma, Dr Chiara Calastri, Dr Thomas Hancock**
Funded by: **ERC**
Dates: **July 2014 – December 2020**
Website: **https://cmc.leeds.ac.uk/research/decisions/**

Abstract: Mathematical models of choice are used to understand and forecast behaviour, or valuate intangibles such as time. These outputs are key in many decision-making contexts. While current modelling techniques are faithful to economic theory, their behavioural and psychological soundness have been questioned. The Decisions project is developing choice models that more accurately represent the human decision-making process and the context of real-life choices.
This requires introducing behavioural and psychological elements in mathematical choice models and implies moving away from the 'homo economicus' framework to a more complex representation, where 'soft' factors such as social influence affect decisions.

We also consider context and temporality (long term vs short term) when modelling human choices which are generally not made in isolation. For example, the decision to commute by car is affected by the decision to live in a given area, which in turn is influenced by longer term decisions such as having a large family or not. Moreover, many choices are not restricted to a simple selection, but to a choice of quantity and quality, for example what to buy at the supermarket, and how much of each product. Our models seek to better represent these complex choices.

Papers:

1. Daly AJ & Hess S (2020) VTT or VTTS: a note on terminology for value of travel time work. Transportation.
2. Calastri C, Crastes dit Sourd R (2020) We want it all: experiences from a survey seeking to capture social network structures, lifetime events and short-term travel and activity planning. Transportation.

Next generation activity and travel behaviour models (NEXUS)

Grant holder: **Dr Charisma Choudhury**
CO-Investigators: **H Wang (School of Computing), F Mushtaq (School of Psychology)**
Funded by: **UKRI Future Leaders Fellowship**
Dates: **October 2020 to October 2024**
Coordinating partner: **UoL**
Collaborating partners: **Alan Turing Institute, University of California Berkeley, Department for Transport (DfT), Asian Development Bank (ADB), Citi Logik, PTV**
Website: **NEXUS/ tinyurl.com/vf5v68tv**

Abstract: Technological advances such as self-driving cars, flying taxis and the other new modes of travel, while societal changes are leading to a more diverse and multi-ethnic set of travelers, and disruptive changes like the COVID-19 pandemic are leading to fundamental changes in the way we work, move and think. Traditional travel behaviour models are unable to deal with such increased complexities and radical changes. This motivates our research which will focus on developing next-generation mathematical models of travel behaviour that can better predict the decisions made by travellers in the changing landscape. This will be achieved by developing new frameworks that bring together Choice Modelling, Ubiquitous Computing and Machine Learning techniques. The developed methodologies will enable better utilization of passively generated mobility traces (from GPS, mobile phones, etc.), neurophysiological signals and virtual reality to capture decision making in a wide range of future scenarios. The developed models will be implemented in an agent-based microsimulation tool to test alternative policy scenarios in a more robust manner.

Alternative forms of transport and staycations - popular during the Covid pandemic.

University of Leeds - The Great Hall - silent and empty during Covid lockdown.

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Journal papers

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Institute for Transport Studies
Leeds, United Kingdom
LS2 9JT
Tel: 0113 343 5325
www.its.leeds.ac.uk

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University of Leeds
Leeds, United Kingdom
LS2 9JT
www.leeds.ac.uk