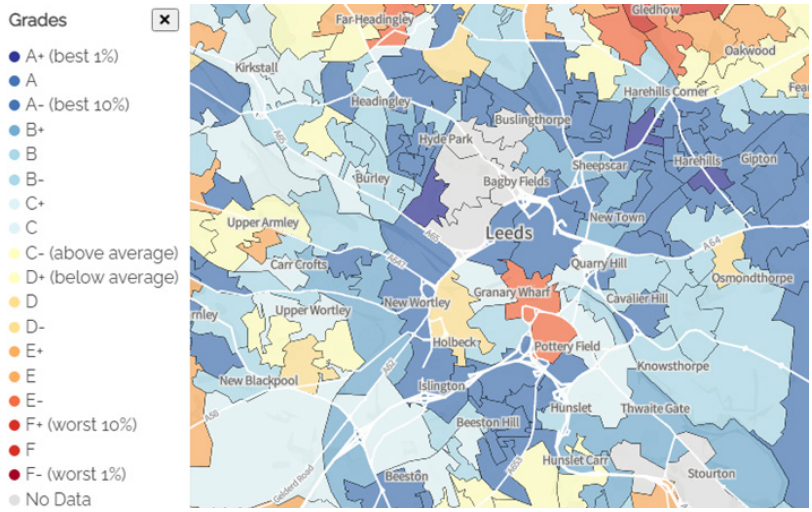
ITS RESEARCH REPORT 2021

Data science expert, **Dr Robin Lovelace**, has been awarded a prestigious Fellowship, working in the heart of government. Robin will work with 10 Downing Street's data science team and the Office for National Statistics on issues ranging from decarbonisation to the Government's levelling-up agenda. Robin will co-design research and produce analysis using new and existing data to inform national policy. Dr Lovelace said, "Translating high level policies such as full decarbonisation into local interventions is a major political and technical challenge and data science can help identify effective interventions and ensure investment goes where it is most needed."



Dr Malcolm Morgan launched a free online tool that maps the carbon footprint of every neighbourhood in England. A number of media outlets highlighted the **Place Based Carbon Calculator** in their news articles. Dr Morgan presented the tool to a cross party climate group at Whitehall and to Local Authorities and said:

"We hope this tool will help communities target their highest carbon-emitting activities and motivate those with the largest footprints to do more."

A study led by **Dr Zia Wadud** found that affordable plastic shields reduce the risk of COVID-19 infection for passengers on motorcycle taxis. This offered an economic lifeline for drivers during the pandemic. Motorcycle taxi drivers in countries such as Bangladesh, Uganda, Nigeria, Vietnam, Indonesia and Rwanda were banned from working for many months due to the risk of COVID spread to passengers. That plunged many drivers into poverty. Dr Wadud's research team used simulations to demonstrate that a shield placed behind the rider pushes droplets away from the passenger reducing airborne exposure. Shields made from recycled plastic are a cost-effective solution.

In a further study led by Dr Wadud, researchers warned that Governments need to be careful about the messaging around compulsory mask wearing to ensure the policy is fully effective. When officials in Bangladesh announced a legal requirement for masks to be worn outside the home, there was an associated increase in mobility linked with a rise in COVID-19 cases. People needed to be constantly reminded that mask wearing was an additional measure alongside limiting travel and close interactions. The study shines a light on what is known as 'risk compensation', where people adopt riskier behaviour if they feel an intervention is making them safer – for example, motorcyclists feeling they can go faster if they are wearing a crash helmet. Dr Wadud's study – Face mask mandates and risk compensation: an analysis of mobility data during the COVID-19 pandemic in Bangladesh – is published in BMJ Global Health.

CONTENTS

HIGHLIGHTS OF 2021

The Institute for Transport Studies (ITS) is one of the world's leading departments for transport teaching and research. We deliver internationally excellent research outputs, which impact upon transport policy and practice, and contribute to the wider economy and society. Our research feeds directly into our teaching. Students learn about the latest developments in their field from world-leading researchers. With over 90 staff, headed by Professor Simon Shepherd, ITS is the largest transport research body in the UK.

Influencing transport policy

Professor Oliver Carsten is chair of Human Factors in International Regulations for Automated Driving Systems (HF-IRADS) which brings together human factors experts from around the world and operates under the auspices of the International Ergonomics Association. Prof Carsten also represents the European Transport Safety Council in the World Forum for Harmonization of Vehicle Regulations, the Global Forum for Traffic Safety and the EU Motor Vehicles Working Group which is the final arbiter of EU vehicle technical regulations.

Leeds at COP26

Leeds researchers working to tackle the climate crisis and help the world achieve net zero carbon emissions addressed world leaders at COP26. **Professor Jillian Anable, Dr Robin Lovelace** and **Dr Ian Phillips** contributed to a series of videos for the event. In this video they discuss some transport solutions

'EVs are not Net Zero'

Dr Karl Ropkins is signatory to the TRANSITION Clean Air Networks' response to COP26. Their 'Declaration on Accelerating the Transition to 100% Zero Emission Cars and Vans' expresses concerns about the UK Government's focus on the shift to EVs, to the near-exclusion of still cleaner and more sustainable modes of transport, namely public transport and active travel, and the misleading description of EVs as 'zero emission vehicles' that neglects their non-exhaust emissions.

Professor Jillian Anable sits on a number of Advisory Boards including the ESRC Environmental Social Science Strategic Advisory Group, the Campaign for Better Transport, the National Transport Strategy Review for Scotland, the Electric Vehicle and Energy Taskforce, the Northern Ireland Energy Strategy Advisory Panel and the Essex Climate Commission. Prof Anable has presented policy advice to 16 climate panels and assemblies across the UK. Prof Anable has also presented to the House of Lords and to the House of Commons Transport Committee inquiry on zero emissions vehicles and road pricing

Extract from Professors Marsden and Anable's **COVID-19 TRANSAS report**.

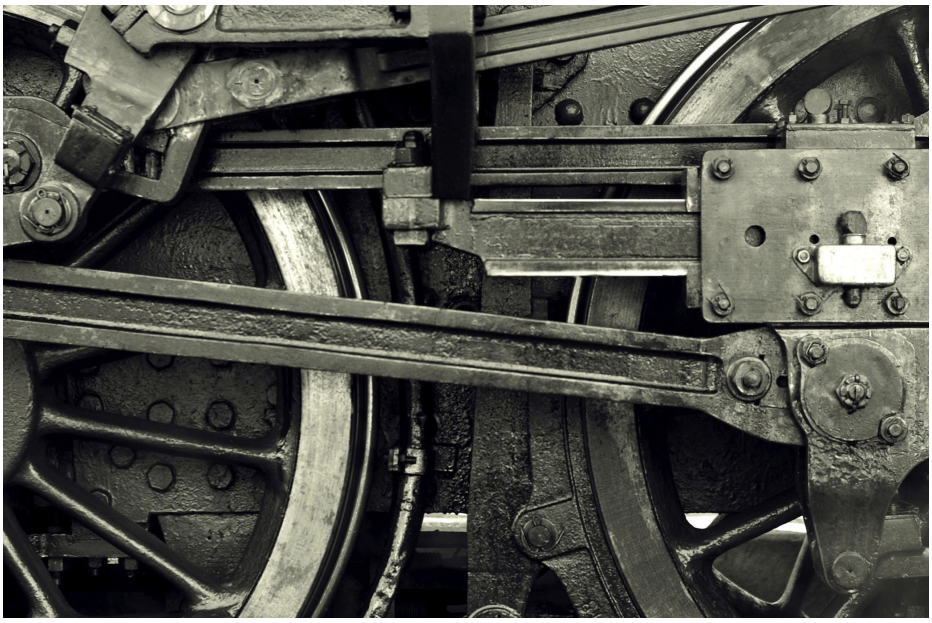
Professors Greg Marsden and **Jillian Anable** were invited to speak to the Department for Transport's Strategy Executive about their work on Covid-19. Their research is described in the PROJECTS section under 'COVID-19 Emergency Data Collaboration (TRANSAS)' and in the following report: House of Lords Covid Committee: inquiry into the long-term impact of the pandemic on the UK's towns and cities. CREDS consultation response some of which is quoted here: 'our evidence has … reinforced the lack of options for those living on the edges of cities, on low incomes who are having to commute by car to their jobs which public transport already does not serve. Some might argue that taking on a car is a sign of social progress. This is not always the case. It has been demonstrated that around 7% of the UK population has a car despite being classified as at risk of poverty (e.g. not able to afford basics such as heating). This is a distress purchase not a choice. The messaging from central government to "Avoid Public Transport" has been hugely damaging to public transport. Prior to the pandemic the costs of public transport were rising in real terms well above inflation… socially necessary bus services were being reduced. One thing which the pandemic revealed was some of the real social value of public transport in relation to its support for key workers. It has also revealed the extent to which our town and city centre economies have grown up depending on large numbers of people working there. […] Whilst it is far from clear that this will happen, it appears that the changes to rail franchising provide one example of the way forward. The UK has attempted to run public transport with market logics. There is no entirely commercial local public transport or rail – subsidy is channelled into this either directly or indirectly and then commercial enterprises decide how best to use that to deliver the pseudo-commercial market outcomes.'

Professors Greg Marsden and **Jillian Anable** are members of Greener Transport Solutions. This group of leading professionals in the transport and planning sectors has published a **Manifesto for Decarbonising Transport** stating that achieving our carbon targets will require: 1) Traffic reduction in addition to the roll out of zero emissions vehicles, 2) A complete reform of motoring taxation as we transition from petrol and diesel vehicles and 3) A credible national programme for delivering behaviour change.

Professor Greg Marsden gave a keynote speech at Westminster Energy and Environment Forum Transport on decarbonisation in the UK, low-carbon fuels, infrastructure, sector-specific targets and next steps for policy. Video and slides are available at **decarbon8.org.uk/videos/**

Dr Jo-Ann Pattinson took part on Drones Roundtable hosted by the Geospatial Commission and the Cabinet Office.

Dr Kate Pangbourne is a Director of Act Travelwise whose mission is to make



'Slavery and Steam' Collaborative and multidisciplinary project explores the links between railways and the slave trade.

transport in the UK more sustainable, helping people and organisations meet their travel needs in ways that support community well-being, protect and enhance the environment and improve public health.

Professor Andrew Smith spoke at 'The future of rail infrastructure in the UK - CP6' on the Integrated Rail Plan, and delivering modernisation - Westminster Energy, Environment & Transport Forum policy conference.

Professor Natasha Merat attended Research and Innovation Advisory Board meetings for National Highways and is an advisor (attending board meetings) of Veoneer, Zenzic Interoperable Simulation, Centre for Connected and Automated Vehicles (CCAV) and CDEI AI Barometer.

In the media

Professor Jillian Anable contributed expert opinion in a number of BBC interviews on how we can collectively adapt behaviour towards a zero-carbon environment. In one interview Prof Anable comments on the environmental impact of sports utility vehicles (SUVs). In three other BBC interviews Prof Anable advised that the move away from petrol and diesel vehicles and simply introducing more battery and hydrogen powered cars doesn't lead to zero carbon. creds.ac.uk/publications/dft-consultation-ending-the-sale-of-new-petrol-diesel-and-hybrid-cars-and-vans/

Understanding the 'Traffic Brain'. New research by **Professor Gustav Markkula** helps reveal how our brains make critical decisions when driving. This is important both since it demonstrates that theories developed in cognitive neuroscience labs hold also in real-world contexts, and since it improves our understanding of human behaviour in road traffic, which is needed not least to develop automated vehicles that can coexist safely and acceptably with human road users. Prof Markkula's paper generated media interest. His research is described in the PROJECTS section under 'Commotions'.

Universities and museums across Yorkshire and the North of England explore the links between railways and the global slave trade, as part of a new networking project 'Slavery and Steam: steam power, railways and colonialism'. **Dr Kate Pangbourne** who is leading the UoL contribution to the project said there is a *"visible legacy that is revealed in the geography of our ports, rail infrastructure, and industrial landscapes that deserves closer examination."* Funded by the White Rose Collaboration Fund, the project also involves the University of Leeds Schools of History and Law. Click here for further information.

HS2

Professor Jillian Anable said scrapping Northern Powerhouse Rail, in particular, left Leeds and Bradford far behind Manchester in terms of connectivity. **Professor Greg Marsden** said the revised HS2 plan offers *"nothing to Leeds, while Manchester, Nottingham and Sheffield stand to benefit"*. **Professor Chris Nash** also said in The Conversation that the new HS2 plan *"leaves Yorkshire without a high-speed connection to the rest of the country. It also fails to solve the ongoing problems of limited capacity."*

Staff Awards

A paper led by **Dr Thomas Hancock**, co-authored with **Professor Stephane Hess** and **Dr Charisma Choudhury**, has been awarded the 'David Hensher Best Transport Demand Modelling Paper Prize' at the Australasian Transport Research Forum 2021. The paper titled 'Decision field theory: an extension for real-world settings' presents theoretical extensions of the decision field theory model from mathematical psychology to make them better suited for real-world travel behaviour modelling.

Faculty Partnership awards 2021 - A Mentor Award went to Professor Stephane Hess whose guidance and support has encouraged and nurtured others to develop their skills and prospects for the future, helping them to grow and progress, either personally or in their learning.

Five ITS academics have been selected as fellows of the Alan Turing Institute: **Dr Charisma, Dr Robin Lovelace, Professor Ronghui Liu, Professor Susan Grant-Muller** and **Professor Stephane Hess**.

Professor Stephane Hess has been awarded a prestigious ERC Advanced Grant. The ERC scheme is for ground-breaking high-risk projects assessed solely on the basis of excellence. Prof Hess's project, SYNERGY will, over 5 years, develop new behavioural models at the intersection of psychology, econometrics and machine learning.

Alumni Awards

ITS alumnus **Dr Bashirul Haque** received the Dean's Award for Research Excellence from Shahjalal University of Science Technology, Bangladesh for his paper 'Understanding differences in residential location preferences between ownership and renting: A case study of London'. The paper is co-authored with his PhD supervisors, Dr Charisma Choudhury and Professor Stephane Hess.

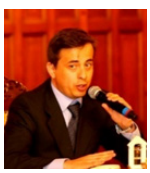
Alumnus Dr Jeroen Bastiaanssen won best paper of the year in Transport Reviews for his article 'Does transport help people to gain employment? A systematic review and meta-analysis of the empirical evidence' (co-authored by supervisors Daniel Johnson and Professor

Karen Lucas). Jeroen said *"It is a real honour to receive this prize and particularly nice because it is the first paper of my PhD-thesis. I believe that the multidisciplinary research approach, in which we combined the social and economic perspectives on transport, is what truly made it become a good quality paper. That is what makes research at ITS a unique opportunity for any PGR. I currently work as a transport researcher at the Netherlands Environmental Assessment Agency (PBL), where I'm conducting follow-up research into the role of new public transport infrastructure on individual labour market outcomes. Our review paper identified only a few empirical studies that have examined this before, while various Dutch cities want to invest in new (light)rail connections, so this research comes in a very timely moment. I would encourage other PGR's to leverage on the knowledge and experience of the multidisciplinary research group at ITS and disseminate their work in the wider research community."*

ITS alumna wins Voorhees-Large Prize

Alumna **Miaw Ling Chor** won the 2020 Voorhees-Large Prize for her Transport Planning Masters dissertation 'Residential Price Impacts due to London Overground & Potential Inference for Metroisation'

Alumnus Dr Andrew Naimanye became Executive Director at Uganda Road Fund. This follows his previous appointment by the Minister of Finance in 2019 as Acting Executive Director of Uganda Road Fund. Andrew undertook multiple studies at UoL: PhD Transport Economics (ITS 2016), MSc Transport Planning and Engineering (ITS 1996), BEng Civil Engineering (Leeds Uni 1995). Andrew has 20 years' professional experience on a wide range of civil, transport planning, road safety, railway and highway engineering projects in the UK and East Africa, including eleven years of experience in the Uganda road sector.



Alumnus Dr Alvaro Guzman was appointed as Secretary for Transport in Quito, Ecuador. Alvaro studied both his masters and his PhD at ITS. Since graduating in 2018, he has been developing and implementing impactful transport projects in Ecuador. His priority as Secretary for Transport is for a clean, safe and accessible transport system. In his new role Alvaro will also have voice and vote on the Board of Directors of the Metropolitan company of Quito.

Alumna Flavia Anyiko, MSc Transport planning and Engineering 2015 was featured as a woman who has shown exemplary leadership. These women come from diverse backgrounds and roles, and they bring with them a unique perspective to gender equality within the energy sector. *"The #womeninenergy platform has been a source of inspiration for me and I sincerely hope that my story inspires another. I am excited for what lies ahead."*

Alumnus **Prof Dr M. Shafiq-Ur Rahman** was awarded the 2021 prize for his article 'Public bike-sharing schemes (PBSS): Prospects in Bangladesh'.

Alumnus Mark Harrison was awarded the 2021 Chartered Institution of Highways and Transportation (CIHT) Young Professional of the year. Sue Percy CBE, Chief Executive CIHT said: *"Mark has been awarded the CIHT Young Professional of the Year 2021 award after really impressing our panel of judges. He not only demonstrated a breadth of knowledge and expertise in his role as a Transport Planner but also by his work in developing a carbon assessment toolkit."*

Alumnus Charles Wain (and two other colleagues) recently received a Highly Commended Award as part of the Future Transport Visions Group initiative funded by the Rees Jeffrey Road Fund for their research into the views of the transport sector on the long term implications of Covid-19 on transport planning and policy. Charles graduated from ITS in 2019 with MSc Transport Planning and currently works as a Network Strategy Manager for National Highways.

Alumnus Dr Thiago Guimaraes Rodrigues was unanimously recommended for 'Best PhD Thesis Written in the English Language on Urban Mobility in Cities of Developing Countries' and awarded his prize at CODATU XVIII. His thesis entitled 'Bridging the accessibility gap to healthcare: The role of urban transport for low-income communities in São Paulo, Brasil' was awarded a PhD in 2020. *"Thanks to my supervisors Prof Karen Lucas and Dr Paul Timms who made this achievement possible."*

Thiago currently works as an independent consultant to foster a culture of research excellence and ensure high quality of WRI Brazil's knowledge products across the programmes Cities (Urban Development and Transport), Climate and Forests. His expertise lies in assessing the social impacts of urban transport policies.

Postgraduate Researcher **Rafael Cirino Gonçalves** has been awarded a pioneering fellowship by Seeing Machines, a leading supplier of Driver Monitoring systems. The 18-month postdoctoral fellowship will support Rafael's investigation of safety in self-driving cars. Advanced technology and infotainment systems in vehicles increase the concern that drivers' attention is moved away from the roadway and the driving task. This safety concern will only be amplified when the development of autonomous cars gives drivers permission to engage in other activities, taking their attention further away from the road.

The partnership with Seeing Machines has allowed Rafael and colleagues to use a range of Occupant Monitoring Systems in the University of Leeds Driving Simulator. This technology tracks the location of drivers' head, eyes, hands and other body parts, to understand user behaviour. The research will help to develop technologies that support the driver to remain safely engaged in driving.

Understanding how such systems can be used effectively, especially at higher levels of automation, and ensuring that they are accurate and inclusive for all driver types, is part of a long-term research programme at ITS.

More news about our Alumni can be found on: environment.leeds.ac.uk/transport-alumni

Staff changes

Dr Haibo Chen was promoted to Chair of Intelligent Transport Systems with a special focus on machine learning to improve traffic network performance and to reduce vehicle emissions and air pollution. **Professor Chen's** research is described in the PROJECTS section under 'MODALES, PASCAL, nPETS and HETMAR'.

In memory of Dr Jeremy Toner (centre in yellow rain jacket) leading a student field trip in Yorkshire, courtesy: **Tribute to Jeremy Toner, 1964 - 2021 (muchloved.com)**

Dr Kate Pangbourne and **Dan Johnson** were promoted to Associate Professor. In addition, **Dr Pangbourne** became Deputy director of the Leeds Social Sciences Institute. Early Career Researchers **Dr Alex Stead, Dr Ruth Madigan** and **Dr Yee Mun** Lee also gained their promotions. **Dr Albert Solernou-Crusat** took on the management of Virtuocity following Rich Romano's retirement.

New staff welcomed to ITS during 2021: **Dr Yanis Boussad, Dr Arash Kalatian, Dr İbrahim Öztürk, Keiran Suchak, Dr Vo Huyen Tran, Yuanxuan Yang,** teaching fellow **Dr Angelica Salas Jones**, and five of our former PhD students **Dr Zihao An, Rafael Cirino-Gonçalves, Dr Said Munir, Dr David Pierce,** and **Dr Fangqing Song**.

We bade farewell to Dr Kaushali Dave, Dr Kadambari Lokesh, Dr Jianbing Gao, Dr Xiaoxiao Ma, Dr Foroogh Hadjiseyedjavadi, Dr Han Lin, Professor Richard Romano and, sadly, Dr Jeremy Toner who passed away due to cancer.

After much thought and reflection, **Professor Richard Romano** decided to retire early from his position as Chair in Driving Simulation. Prof Romano joined ITS in November 2015 and has been instrumental in the continued success of the Driving Simulator and Virtuocity proposition. He has overseen a doubling in the use of the Virtuocity simulators and has been involved personally in over £10M worth of research. Several projects were in the area of automated vehicles funded by Innovate UK and the European Commission in which new human vehicle interfaces were developed. Rich was the PI of the VeriCAV project which focused on the development of new simulation-based testing frameworks for automated vehicles.

Rich has also been the key driver behind the design and development of HIKER, the most advanced immersive pedestrian simulator in the world which, integrated with the enhanced driving and truck simulators, provides an unmatched distributed simulation environment. He leaves the team and simulators in a strong position and we thank him for his great work over the last six years.

Rich would like to pass on his gratitude to the members of ITS and the University. His work has been *'stimulating, challenging and rewarding. This is primarily because of great co-workers, students and collaborators as well as incredible support from the University … looking forward to continuing involvement at Leeds as visiting professor'*.

PhD Students and Awards

During 2021, ITS had 84 research students: Khaled Abdullah, Ilyas Alhassan, Abdullah Almtairi, Lawrence Alongu, Maryam Alwari, Zihao An, Jeroen Bastiaansen, Pinar Bilgin, Jawaher Binsuwadan, Isam Bitar, Martyna Bogacz, Fanta Camara, Juan Castellanos-Vanegas, Celic Matea, Jina Cheon, David Chikwendu, Philip Churchman, Rafael Cirino-Gonçalves, Hngshin (Edward) Daramy-Williams, Patrick Dichabeng, Lawrence Duncan, Umoh Edemeka, Ian Greenwood, Thalia Hernandez-Amezcua, Lydia Hidayati, Christopher Holmes, Stefanie Horn, Yiming Hou, Ejiro Ikoko, Rashed Ismaeel, Shujuan Ji, Amir Kalantari, Rizal Kamaruddin, Naphat Ketphat, Salma Khuky, Edward Lambert, Prasetyaning Letsari, Gengze Li, Shuwei Lin, Siyi Lin, Xian Liu, Maximiliano Lizana-Maldonado, Henry Lo, Wei Lyu, Davide Maggi, Tahera Mayat, Ioanna Moscholidou, Haruko Nakao, Winny Novalina, Lamprini Papafoti, Chen Peng, Michael Perrier, David Pierce, Amelia Pyper, Vishnu Radhakrishnan, Kacper Rossa, Jiang Ruisen, Teekanya Rujinarong, Yeni Sagala, Rosie Samuel, Mohammad Sarker, Abdul Sazali, Stephanie Scott, John Stuart, Sidi Sun, Agung Surono, Tianli Tang, Ruifan Tang, Yvonne Taylor, Oguz Tengilimoglu, Vanessa Ternes, Jack Thompson, Kai Tian, Panagiotis Tsoleridis, Athanasios Tzigerias, Alexandra-Elena Vitel, Yu Wang, Sijin Wu, Zhuoqian Yang, Yue Yang, Jose-Angel Zabala-Garcia, Khatun Zannat and Chenzhao Zhai.

In addition, ITS staff supervised the following eight students on behalf of other schools: Ahmed Alali and Nura Kabuga (Engineering) Eran Livne, Caroline Tait and Eugeni Vidal-Tortosa (Geography), Padma Satagopam (visitor), Azam Ali and Lin Zhang (Earth & Environment).

Congratulations to fifteen PhD students who graduated in 2021: **Ilyas Alhassan** 'Five empirical essays on the user perspective of the public transport ticketing system: understanding effects, attitudes and behavioural response to ticketing improvements'; **Zihao An** 'Correlates of multimodal travel behaviour: The role of age-period-cohort, trip purposes, and attitudes'; **Jeroen Bastiaansen** 'Youth mobility and access to economic opportunities'; **Jawaher Binsuwadan** 'The application of meta-analysis to enhance the appraisal of transport projects'; **Martyna Bogacz** 'Neural processing of context and information: Implications for behavioural modelling'; **David Chikwendu** 'A novel approach to combining scenario specification, visioning and optimisation methods; a study from the Nigerian Petroleum Industry'; **Lawrence Duncan** 'Development and application of consistent path size route choice models'; **Probo Hardini** 'Creating city growth narratives from different disciplinary perspectives: An application to land use and transport development in an Indonesian City'; **Alexandros Kontotasios** 'Fatigue in pilots who commute by driving: identification of the problem and investigation with driving and flying simulation'; **Haruko Nakao** 'Stochastic process model of the evolution of providers and users in a shared on-demand ride service system'; **Lamprini Papafoti** 'Automated vehicles and future transport inequalities in the UK. Exploring the potential accessibility implications for

older people'; **David Pierce** 'Modelling the economic impacts of inter-city connectivity'; **Ismaeel Rashed** 'Prevalence and self-regulation of drivers' secondary task engagement: An investigation of behaviour at intersections based on naturalistic driving data'; **Tianli Tang** 'Predicting boarding and alighting behaviour of bus passengers with smart card data using machine learning techniques'; **Yvonne Taylor** 'Shift workers, fatigued driving and the impact on road safety - an investigation involving police service employees'.

RESEARCH PROJECTS

Research at the Institute for Transport Studies (ITS) is international, multidisciplinary and cross cutting. Projects are grouped under thematic headings in an attempt to bring similar subjects together, but there is much crossover between themes where researcher skills may apply. Over 70 research projects, ranging from seed-corn funds for early career researchers to five-year grants involving multidisciplinary teams, are described in the following pages. Research outcomes are listed under PUBLICATIONS. For the first time in our annual report we have included metric analysis of our publications and a section listing the SOFTWARE created and used at ITS.

TRANSPORT AND SOCIETY

Although the benefits and problems of mobility are shared by everyone, they are not shared equally. Mobility systems shape our social and economic opportunities and activities and have profound implications for environment and health. We investigate transport and mobility from perspectives of social and political sciences with the aim of delivering effective, fair and environmentally sustainable mobility systems locally, nationally and globally.

InExiTI

Grant holder: **Dr Gillian Harrison**
Funder: **University of Leeds Crucible Scheme**
Dates: **September 2021 – September 2022**
Collaborative partners: **Dr Stefania Romano, Leeds University Business School**

Abstract: This research investigates individuals' perceptions of their transport behaviours. Using an interdisciplinary methodology, we explore individual transport identities and innovation in transport choice and consider how these have been affected by COVID-19 disruptions in mobility behaviour. Individuals can change their decision-making process over time as they obtain new information from reliable sources that could contradict the historical imprint. The researchers will design and convene two half-day workshops where participants will explore the research questions through Lego© Serious Play and Causal Loop Diagram group model building, which will also lead to the development of a new methodological framework.

Morgan Campbell (Researcher) with a young participant of the Active Travel Neighbourhoods scheme in Beeston, Leeds. Photo courtesy of Connecting Leeds.

Sustaining Active Travel Neighbourhoods

Grant holders: **Dr Robin Lovelace and Dr Morgan Campbell**
Funder: **ESRC Impact Acceleration Account**
Dates: **February to October 2021**

Abstract: In response to COVID-19, the UK government launched a £250m Emergency Active Travel Fund (EATF) to support the adoption of active travel. Leeds City Council (LCC) used a significant proportion of their fund to develop new Active Travel Neighbourhoods (ATNs) to prevent post-lockdown traffic gridlock, to help Leeds become a 'city where you don't need a car', to support a 'green restart' and bolster the Council's commitment for Leeds to be carbon neutral by 2030. Community support for the re-allocation of road space was high during the spring and summer when people spent more time outside and fewer cars were on the road. However, ATNs were framed by some critics as an example of top-down Council initiatives with limited community engagement, representing a threat to individual choices and freedoms. This research collaboration with Leeds City Council assisted in the analysis of the initial commonplace survey data. Residents affected by the ATN scheme were encouraged to share their feedback online. The second stage of this collaboration was to use an 'engage-deliberate-decide' approach to neighbourhood participation and support for ATNs in Beeston, Hyde Park, and Chapel Allerton.

Impact: As the EATF enters tranche 2, we are continuing our collaboration with Connecting Leeds, Leeds involving people and members of Walk it Ride it. In Chapeltown, Beeston and Armley we are asking residents how best to implement neighbourhood designs that promote traffic calming and active travel.

COVID-19 Emergency Data Collaboration (TRANSAS)

Grant holder: **Professor Greg Marsden**
Investigators: **Professor Jillian Anable, Dr Llinos Brown, Dr Kadambari Lokesh**
Funders: **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 partner: **University of Stirling**
Dates: **01/05/2020 – 31/03/2021**
Website: **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

One of the Active Travel Neighbourhoods (also known as Low Traffic Neighbourhoods) created by Leeds City Council during Covid lockdown. Photo courtesy of Joanna Carder.

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 five-wave longitudinal panel of expert policy maker interviews across the public and private sector; national, sub-national, local government and Non-Government Organisations (NGOs); researching the impacts of the pandemic on business workplace strategies, city centres and individual adaptations to home working. Monthly behavioural insight data exchange meetings which attract speakers and attendees from across local and national government as well as industry. The project delivers timely insights which can influence the policy responses of decision-makers whilst also creating a unique set of data assets 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 team has presented to the Department for Transport (DfT), Public Health Scotland, Rail Delivery Group and a range of professional seminars. Its work was incorporated in the Committee on Climate Change 2021 review of progress on climate change to Parliament. The TRANSAS team has contributed to the All Party Parliamentary Group for Cycling & Walking Report Reaching Our Active Travel Potential.

Reports: The project has produced several user-friendly reports tracking behavioural adaptations in response to the pandemic: covid19transas.org

E-DRONE

Grant holder: **Professor Greg Marsden**
Investigators: **Dr Morgan Campbell**
Funder: **EPSRC**
Dates: **January 2021 to December 2024**
Collaborative partners: **University of Southampton, Bournemouth University, University College London**
Website: **e-drone.org/**

Abstract: The research vision for the E-Drone project is to examine the energy reduction potential of integrated logistics solutions involving Un-crewed Aerial Vehicles (UAVs, commonly known as drones) operating alongside traditional and sustainable last-mile delivery solutions (e.g. vans, cargo cycles, walking porters). This involves generating fundamental new understanding of how drone operations will function in shared airspace in harmony with traditional, crewed aircraft under various regulations. The project uses a case study approach based around NHS patient diagnostic sample transportation involving simulated and live trials across the Solent region. The ITS team is responsible for undertaking an analysis of the governance issues surrounding the introduction of commercial drone logistics into the UK. The research approach is a mix of Q-SORT and deliberative methods.
Papers: e-drone.org/project-outputs

Responsible Automation for Inclusive Mobility (RAIM)

Grant holder: **Professor Ed Manley, School of Geography**
Investigator: **Professor Susan Grant-Muller, Frances Hodgson**
Funder: **ESRC**
Dates: **February 2020 to January 2023**
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.

ADAPT

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

Abstract: The vision of ADAPT 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 messages encouraging walking or cycling. We explored persuasive arguments that highlight time-use during journeys. Initial research was supplemented with focus groups to trial the behavioural impacts of targeted messaging.

Impact: The research has revealed new knowledge about how to construct travel behaviour-change messages which people find persuasive. In the final experiment for example, the Betterpoints App tracked travel behaviour of three experimental groups: The first was the control group who received no messages. The second group got untargeted motivational messages such as Einstein's "I get my best ideas while cycling". The third

group were sent intervention messages backed by scientific evidence on health, environment and cost. Dr Pangbourne has provided advice on travel behaviour change messaging to 2CV and Transport for the West Midlands. Dr Pangbourne is also working with Mobilityways on messaging to promote lift-sharing. The ADAPT project has underpinned the award of a Michael Beverley Innovation Fellowship to Dr Pangbourne who will be working with Fleetondemand to explore MaaS platform end-user value through messaging and other user-facing enhancements.

Inclusive Public Space

Grant holder: **Professor Anna Lawson** (School of Law)
Investigators: **Professor Richard Romano, Dr Ehsan Sadraei**
Funder: **British Academy**
Dates: **October 2020 to September 2021**
Collaborative partners:
Website: inclusivepublicspace.leeds.ac.uk/

Abstract: The Inclusive Public Space project investigates the social justice problems caused by city streets which exclude some pedestrians – particularly pedestrians whose circumstances mean that they do not meet general expectations about mobility or ability. The Project aims to deepen understanding of what aspects of streets are experienced as exclusionary and by whom, how these problems affect the lives of the people concerned, and how effectively law and politics are responding to problems caused by inaccessible or difficult streets. It also aims to increase shared concern about these social justice problems and to raise awareness of how law and politics can be used to challenge them.

GIGWORK

Grant holder: **Dr Robin Lovelace**
Funder: **Manchester Metropolitan University**
Dates: **October to November 2021**
Website: **gigwork.bike/**

Abstract: Understanding delivery riding as a precarious occupation, this project studies the management, solidarity and resistance of platform food couriers in Manchester (UK), Cluj-Napoca (Romania) and Lyon (France). Dr Robin Lovelace provides the mapping software.

Gigwork – a study of food delivery in three European cities.

TRANSPORT AND ENERGY

Transport consumes a fifth of global energy and is overwhelmingly dependent on petroleum. The provision of sustainable, low carbon and secure sources of energy to fuel the transport system is a formidable challenge - and an exciting opportunity.

Cut Carbon Network

Grant holder: **Professor Greg Marsden**
Funder: **EPSRC**
Coordinating partner: **University of Leeds**
Dates: **September 2019 to August 2023**
Website: **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.

DecarboN8

Grant holder: **Professor Greg Marsden**
Investigators: **Dr Kadambari Lokesh**
Funder: **EPSRC**
Coordinating partner: **University of Leeds**
Collaborative partners: **Universities of Manchester, Liverpool, Newcastle, Sheffield, Durham, Lancaster and York and the Connected Places Catapult**
Dates: **September 2019 to August 2023**
Website: **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 be the same everywhere in the UK. DecarboN8 has developed an innovative place-based approach to decarbonisation. We pay attention to the major societal implications of any of the changes

VITALISE - Walking to school in Bradford – Photo courtesy of Zahara Batool.

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 road-space reallocation measures. Two examples of these seedcorn projects ('Vitalise' and 'Serious Games' are shown below).

Impact: DecarboN8 was a key contributor to the development of the Place-based theme in the Department for Transport's Decarbonisation Plan. Decarbon8 has shaped the development of the Transport for the North's decarbonisation strategy and has completed a major series of decarbonisation briefing notes and webinars for local authorities.

Papers: decarbon8.org.uk/publications/

Serious Games for Serious Energy Solutions

Grant holder: **Dr Morgan Campbell**
Funder: **EPSRC seed-corn fund via the Decarbon8 network**
Dates: **August to September 2021**
Website: **decarbon8.org.uk/decarbon8-research-projects/**

Abstract: Achieving net zero by 2050 will require serious planning and collaboration across the whole of UK society. Decision-making around how, when, and where to reduce emissions must be inclusive, fair, and creative, which is in contrast to the more traditional, top-down, expert-driven approach to policy formation and implementation. The project is a collaboration between UK universities and The Equal Group investigating how diversity impacts decision-making. More specifically, in the context of how to rapidly decarbonize our society, we are investigating, via serious play, whether a more diverse group of decision-makers leads to a more heterogenous set of solutions.

COVID restrictions forced a radical rethink of the project and the result was an online, serious game called New Shores designed to emulate the climate and resource challenges of the present and future. We hosted the game twice, first with a heterogenous group and second with a homogenous group of people (based on diversity criteria tools developed by the Equal Group). Players in a group were unknown to one another during the game. Participant questionnaires were administered before and after the game to gauge how they felt the group played together and if certain assumptions were made about other players. Serious Games for Serious Energy Solutions was an opportunity to pilot both the game and the approach. It is expected to be scaled up in two ways. First, as a potential tool for organisations wishing to assess how the diversity of team members impacts collective decision making. Second, to further refine the tool to learn about attitudes toward climate change and decarbonisation.

Visualising Active Travel with Pakistani Families in Bradford (VITALISE)

Grant holder: **Dr Zahara Batool**
Funder: **EPSRC seed-corn fund via the Decarbon8 network**
Dates: **October 2021 to May 2022**
Website: **decarbon8.org.uk/decarbon8-research-projects/**
Collaborative Partners: **DfT, TfN, Bradford Metropolitan District Council, Capital of Cycling**

Abstract: The role of societal and behaviour change in meeting the UK's Net Zero emissions target by 2050 is fundamental. To achieve this, millions more journeys need to be walked or cycled. However, across the UK, we do not yet walk or cycle sufficient short trips to make a difference. Many people find it difficult to get out of the habit of using a car for every journey, there are not enough safe routes for walking or cycling and, within some communities, participation in active travel is low. The aim of VITALISE is to encourage critical consciousness of active travel by using the Photovoice method thereby facilitating change. The plan is to co-engage with Pakistani origin families in Bradford. Participants will be asked to reflect on everyday journeys by discussing photos they take of what matters to them in the travel environment, good or bad. Hence, encouraging them to voice opinions about the challenges they perceive and to identify solutions which they consider best match their social and cultural needs. The results will be shared at a community exhibition of the pictures and engaging invited decision-makers in policy-dialogue with participants.

Operation and Performance of Transport Infrastructure Chargepoints (OPTIC)

Grant holder: **Dr Craig Morton, Loughborough University**
Investigator: **Dr Malcolm Morgan**
Funder: **EPSRC**
Dates: **October 2021 to January2022**
Collaborative partners: **Transport for Greater Manchester**
Website: **decarbon8.org.uk/decarbon8-research-projects/**

Abstract: The rapid adoption of Electric Vehicles (EVs) requires an equally rapid installation of chargepoints yet relatively little is known about the best places to locate them and what types are appropriate in different locations. As chargepoints are expensive to install, especially the high

power rapid and super rapid variants, it is important that they are located where they are most needed. The OPTIC project is studying the logs from chargepoints across Greater Manchester to find how, when, and where people charge their EVs.
Impact: The project aims to inform the rollout of chargepoints across the UK, allowing planners to estimate future demand, by identifying locations where chargepoints for EVs are most useful.

Understanding Change in Car Use over Time (UNCCUT)

Grant holder: **Dr Malcolm Morgan**
Investigators: **Dr Robin Lovelace**
Funder: **EPSRC - Decarbon8 seedcorn fund**
Dates: **October 2021 to May 2022**
Website: **decarbon8.org.uk/decarbon8-research-projects/**

Abstract: For the UK to meet its climate change targets we need to reduce the total number of miles driven per year yet, historically, annual mileage has tended to increase. Many people are dependent on their cars. The best predictor of miles driven per person is car ownership - which is also increasing. The UNCCUT project will investigate how and why car ownership has changed over time, with a particular focus on areas where car ownership has declined. We are mapping car ownership over small geographical areas between 2002 and 2018.

Impact: The project will help reveal what factors enable people to relinquish their cars, in the hope that these factors could be replicated elsewhere.

Shared Digital Carbon Architecture Programme

Grant holder: **Dr Malcolm Morgan**
Investigators: **Dr Kadambari Lokesh, Dr Ian Philips**
Funder: **DfT**
Dates: **November 2021 to June 2022**
Collaborative partners: **DfT, Network Rail, National Highways, HM Treasury, Infrastructure Projects Authority, Transport for London**

Abstract: The whole life carbon emissions of transport infrastructure are currently hard to estimate early in the planning process and therefore are often ignored or only considered when it is too late to make significant changes. This project is gathering data on whole life carbon emissions from previous infrastructure projects to build a tool to estimate the impact of future projects.

Impact: Once completed our tool will help transport planners and policymakers consider the whole life impacts of transport infrastructure early in the planning process potentially allowing a significant reduction in carbon emissions being designed into transport infrastructure projects.

ARE YOU STILL SWEATING WHILST PUTTING PETROL IN YOUR CAR FEELING SICK WHEN PAYING FOR IT, YOU YOU HAVE GOT THE CAROWNERVIRUS

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

Grant holder: **Professor Jillian Anable**
Investigators: **Professor Greg Marsden, Dr Zia Wadud, Dr Malcolm Morgan, Dr Noel Cass, Dr Thomas Haines-Doran**
Funder: **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 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.

STEP (Electric Vehicle Charging)

Grant holder: **Professor Jillian Anable**
Investigators: **Dr Noel Cass**
Funder: **Innovate UK/ OZEV**
Dates: **September 2019 to December 2021**
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).**
Website: **trojanenergyltd.com/step**

Abstract: Subsurface Technology for Electric Pathways (STEP) 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. The trial deployed between 150 to 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 issues with on-street EV charging such as trailing cables and clutter. The research involved before-and-after surveys on three groups of participants: observers; prospective EV drivers and current EV drivers. Participants were surveyed on

Digital Futures - harnessing the potential of new forms of digital data to generate policy relevant insights for transport.

their attitudes and opinions on EVs and the charging infrastructure and technology, street amenity, parking and about their current EV driving and charging behaviours. Impact: Commercialisation plans will target UK local authorities 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 and public space. A follow-on project – SmartSTEP has been funded by the Department for Business, Energy & Industrial Strategy (BEIS)

DIGITAL FUTURES

Many of the problems facing global societies are complex, requiring a multidisciplinary research approach and cross sectoral boundaries. Traditional data sources prove inadequate in the search for solutions. Research under the Digital Futures theme aims to harness the potential of new forms of digital data to generate policy relevant insights for transport and related sectors such as energy, health, safety, security, society and more.

Data Science Fellowship with 10 Downing Street

Grant holder: **Dr Robin Lovelace**
Funder: **ESRC and Administrative Data Research UK**
Dates: **November 2021 to April 2023**

Abstract: New forms of data are increasingly important in understanding travel behaviours and in improving our methods for modelling transport systems. Working closely with 10 Downing Street and the Office for National Statistics this fellowship will formulate research projects and help champion data science across central government, strengthening the engagement between government and academia in the UK.

Propensity to Cycle Tool (PCT)

Grant holder: **Dr Robin Lovelace**
Investigator: **Dr Joey Talbot**
Funder: **DfT/ Luton Borough Council/ Welsh Government**
Coordinating partner: **University of Cambridge**
Collaborative partners: **CycleStreets.net**
Dates: November 2017 to December 2021
Website: **www.pct.bike**

Abstract: Now in its fourth phase of funding, 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 and encourage cycling during the COVID-19 pandemic. PCT has generated many spin-off projects funded, among others, by Local Authorities, Sustrans, Welsh Government and Irish Government. PCT was used by local authorities across England to support their COVID-19 emergency responses on the transport network to ensure key workers' safe travel while public transport options were down, see: cyipt.bike/rapid/

Papers: Morgan M & Lovelace R. 2021. Travel Flow Aggregation: Nationally Scalable Methods for Interactive and Online Visualisation of Transport Behaviour at the Road Network Level. Environment & Planning B: Planning & Design. 48(6) 1684-1696.

Lovelace R. 2021. Open Source Tools for Geographic Analysis in Transport Planning. Journal of Geographical Systems, 23:547-578

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 and Caroline Tait (School of Geography)**
Funder and co-ordinating 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 improving cycle safety on UK roads. 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 is published in an R package, with the working title of trafficcalmr. This brings a step-change on how to access and process historic road calming intervention data, filling an important knowledge gap, and providing a robust evidence base on which future interventions can be prioritised and monitored.

Papers: Gilardi A, Mateu J, Borgoni R, and Lovelace R. 2021. Multivariate hierarchical analysis of car crashes data considering a spatial network lattice. Arxiv 2011.12595

Active travel in new developments

Grant holder: **Dr Robin Lovelace**
Investigators: **Dr Joseph Talbot**
Funder: **UKRI Impact Acceleration Account**
Dates: **December 2020 to March 2021**
Collaborative Partners: **CycleStreets Ltd, PlanIt, University of the West of England, A/B Street**
Website: **actdev.cyipt.bike/**

Abstract: Active travel in new developments. A range of factors influence ease of access by walking and cycling. Distance to key destinations such as workplaces is relevant, but equally important is the type of roads that must be followed and the presence or absence of good quality walking and cycling infrastructure. For case study sites, we have investigated measures affecting modal choice. These include the ratio of journey times/distances to local destinations by car as compared to by bicycle, the busyness of the roads, and the circuity of the routes. We have also studied access to public transport nodes such as rail stations.

Papers: Talbot J, … Lovelace R. 2021. Active Travel Oriented Development Assessing the Suitability of Sites for New Homes. Preprints.

Report: actdev.cyipt.bike/report/

AFRIMAPR

Grant holder: **Liverpool School of Tropical Medicine**
Investigators: **Dr Robin Lovelace, Martyna Bogacz**
Funder: **Wellcome**
Dates: **February to June 2021**
Website: **afrimapr.github.io/afrimapr.website/**

Abstract: This project creates R building blocks and learning resources to help create data-driven maps in Africa. The resources are promoted in Africa and beyond to grow a community of users and developers. Components are designed for ease of use to target new users of R. The R building blocks will make it easier to perform spatial data management tasks that should be straightforward, but seldom are, including: summarising data by administrative regions of different levels; joining and displaying data referenced by administrative region names; access to environmental, socio-economic and health data and displaying data in static maps and interactive web applications. Afrimapr also develops tutorials and runs online workshops. We hope to facilitate in-person workshops in the future.

Impact: See afrimapr.github.io/afrimapr.website/blog/

Provision for walking and cycling in new housing developments. Map shows desire lines for commuter journeys from Leeds Rail Station. Courtesy of Robin Lovelace.

CYCLEMON

Grant holder: **Dr Robin Lovelace**
Investigator: **Crispin Cooper**
Funder: **Sustrans**
Dates: **October 2020 to May 2021**

Abstract: This project developed new methods to estimate cycling potential to comprehensive schools in Monmouth and Caldicot. The new methods combine spatial network analysis with origin-destination modelling.

Impact: Improved cycle network design in Monmouthshire.

TIICYCLING

Grant holder: **Dr Robin Lovelace**
Investigator: **Dr Joey Talbot**
Funder: **Transport Infrastructure Ireland (TII)**
Dates: **November 2021 to September 2022**
Collaborative partners: **see website**
Website: tii.ie/

Abstract: This project supports TIIs objectives to enable cycling uptake while improving road safety outcomes, measured in the number of casualties per billion km cycled. It builds on Robin's work as lead developer of the Propensity to Cycle Tool.

KARMA

Grant holder: **Professor Susan Grant-Muller**
Investigators: **Dr Gillian Harrison, Frances Hodgson, Keiran Suchak**
Funder: **Alan Turing Institute Fellowship**
Dates: **October 2018 – November 2022**
Website: **KARMA**

Abstract: Full project title - New micro-location data analytics for improved cross-sectoral policies mitigating transport, environmental and inactivity related societal burdens. This project 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).

Making cycling safer - Transport Infrastructure Ireland tii.ie/

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.

CONNECTED AND SHARED MOBILITY

People and goods have become more connected than ever due to technologies such as the Internet of Things, cloud computing, and big data. This evolution has given rise to a substantial body of research towards improving the connectivity of transport infrastructure and services, developing new business models for shared mobility, and the policy around economic, environmental and social impacts of technological advances. Our research addresses the dynamic interaction between new technologies and the mobility of people and goods to help shape future sustainable transport systems.

COmpeting and COmplementary MObility solutions in urban contexts (COCOMO)

Grant holder: **Dr Eva Heinen**
Investigator: **Dr Caroline Mullen, Dr Zihao An**
Funder: **ESRC**
Dates: **April 2021 to March 2023**

Abstract: Shared micro-mobility (SMM) options are entering European cities, although at different rates. While the first insights about usage patterns, sustainability outcomes and equity effects start to accumulate, there is an emerging need for cities to develop a strategic view on the deployment of these new mobility options: How can shared micro mobility options best be combined with existing transport systems to increase accessibility for all and add to sustainable transportation solutions? COCOMO engages in co-creation with users and stakeholders to design and develop planning guidelines for sustainable and inclusive implementation of shared micro mobilities.

Innovative Light ELEctric Vehicles for Active and Digital TravEl: (ELEVATE)

Grant holder: **Dr Eva Heinen**
Investigator: **Professor Jillian Anable**
Funder: **EPSRC**
Dates: **June 2021 to May 2025**
Collaborating Partners: **University of Oxford, University of Brighton, Sustrans, 3 Local Authorities, WHO, Transport Systems Catapult, Clean Growth UK**

Abstract: In the UK, emissions from transport remain unchanged since the benchmark year of 1990. The Committee on Climate Change has been very critical of this failure and has identified electrically assisted scooters and bikes as one solution that needs to be urgently implemented. Indeed, the UK lags behind other countries in the uptake of a range of innovative light vehicles for both passenger and freight applications. Examples include electrically assisted bicycles, cargo bikes, push scooters, skateboards, trikes, quadricycles, hoverboards etc. Such vehicles involve energy expenditure by the user with some electrical assistance. Hence, we class these as Light Electric Vehicles for Active Travel (LEVATs). They enable people to travel more easily or enjoyably than conventional walking or cycling. Increased uptake of these vehicles has significant potential for reducing mobility-related energy demand and carbon emissions, especially when users switch from non-active modes such as cars or vans.

The aim of this project is to better understand the technological and business opportunities of LEVATs and some of the challenges that accompany them - such as overall energy usage, safety and regulatory issues, digital integration, physical environment design, battery standardisation and behavioural inertia.

After developing typologies and technology assessments based on multiple criteria, the empirical end-user research will consist of surveys (aiming for 1,200 responses), demonstration days (aiming to engage at least 300 people) and longer trials with at least 60 private individuals in 3 English cities. Quantitative surveys and in-depth interviews will be undertaken with participants before and after usage to understand changes in user perceptions and experience, triangulated with GPS tracking of the trial vehicles and contextual data such as the weather or hilliness. Freight applications in the logistics industry will be analysed through expert interviews and case studies.

Impact: We will develop new safety training resources for each mode, drawing on and adapting existing UK initiatives and international experience and working towards certified schemes. A number of technology and demand scenarios will assess the whole lifecycle health and environmental impacts of LEVATs.

HITRANS MaaS

Grant holder: **Dr Kate Pangbourne**
Investigators: **Dr Zahara Batool**
Funder: T**ransport 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 March 2022**
Website: **HITRANS MaaS**

Abstract: HITRANS are developing a Mobility as a Service (MaaS) platform to enhance mobility services by integrating travel modes. The HITRANS MaaS app (Go-Hi) allows users to find, book and pay for journeys using any iPhone or Android mobile device. It brings together all participating transport modes and provides integrated ticketing for e-bike hire, ferries, buses, trains, car clubs, Logan Air and taxis. Dr Pangbourne's team at ITS 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 Scottish residents and visitors. It also addresses Government ambitions to reduce carbon emissions by encouraging a modal shift from sole occupancy cars towards 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. Further funding has been secured for tranche 2 of the project in which Dr Pangbourne's team will explore unmet trip requests as well as seek to understand what initiatives might persuade more people to use the Go-Hi app.

Micromobility Behavior

Grant holder: **Professor Susan Grant-Muller**
Funder: **World Resources Institute**
Dates: **July 2021 to April 2022**
Coordinating partner: **New Urban Mobility Alliance (NUMO)**
Collaborative partners: **Dr Charalampos 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 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.

SUITCEYES – mobility-enabling technology for deafblind persons. Click on the image to view this impressive video.

SUITCEYES

Grant holder: **University of Borås, Sweden**
Investigator: **Bryan Matthews**
Funder: **EU H2020**
Dates: J**anuary 2018 to June 2021**
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 has addressed. This, among other wider benefits, will help to enhance a deafblind person's ability to travel safely in their community.

Impact: Watch this impressive documentary about mobility-enabling technology for deafblind persons.

Urban Public Administration and Services (U-PASS)

Grant holder: **Professor Simon Shepherd**
Investigators: **Dr Caroline Mullen, Dr Chandra Balijepalli, Dr Gillian Harrison, Dr Jo-Ann Pattinson**
Funder: **ESRC**
Dates: M**arch 2019 - October 2022**
Coordinating partner: **Vrije Universiteit Amsterdam**
Collaborative partners: **Beijing Jiaotong University, Zhejiang University, Beijing Transport Institute.**
Website: **vu.nl/en/about-vu/more-about/u-pass**

Abstract: Motivated by the world-wide shared desire and need for more efficient, reliable and environmentally sustainable urban transport, U-PASS 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, focussing on 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. Our work initially concentrated on governance issues and the development of a MARS model for Beijing along with how to represent tradeable permits and bike share schemes within that model.

Transport, Air Quality & Covid 19 – this video of Bangladesh data reveals complex interactions

Highways England Traffic Management Algorithm Review (HETMAR)

Grant holder: **Professor Haibo Chen**
Investigators: **Dr Ye Liu, Dr Jianbing Gao, Dr Said Munir**
Funder: **Highways England (now called National Highways)**
Dates: **May 2021 to April 2022**

Abstract: National Highways' Motorway Incident Detection and Automatic Signalling (MIDAS) system uses traffic detectors at fixed locations to monitor traffic conditions, and two traffic management algorithms to evaluate conditions and seek to change the traffic conditions on the network by setting appropriate signs and signals (e.g. variable mandatory speed limits). HETMAR aims to investigate new methods to improve the performance of the existing algorithms and thus to improve National Highways' traffic management capability.

GLOBAL SOUTH

Focusing on ways to transform the transport systems of Global South cities so that they can be socially sustainable, economically productive and environmentally benign. The theme is multi-disciplinary, viewing mobility and accessibility as a core component of the Sustainable Development Goals of struggling and emergent economies. We seek innovative ways to ensure that transport professionals and city planners can meet the highly challenging mobility, accessibility, safety, health and environmental needs of Global South cities.

SPARC-IIT Kharagpur

Grant holder: **Dr Charisma Choudhury**
Investigators: **Dr Zia Wadud**
Funder: **Ministry of HR Development India**
Dates: **March 2019 to September 2022**
Coordinating partner: **IIT Kharagpur**
Collaborating partners: **Dr Arkopal Goswami, IIT Kharagpur**
Website: **SPARC-Kharagpur**

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, especially in the new-normal after the Covid-19 pandemic.

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.

Papers: Zannat K, Bhaduri E, Goswami A & Choudhury C. 2021. The tale of two countries: modeling the effects of COVID-19 on shopping behavior in Bangladesh and India. Transportation Letters, 13(5-6), 421-433.

PT Electrification in Indian Cities

Grant holder: **Professor Ronghui Liu**
Investigator: **Professor Stephane Hess, Dr David Palma**
Funder: **UK PACK Green Recovery Challenge Fund**
Coordinating partner: **CEPT**
Dates: **February 2021 – August 2022**

Abstract: Full title: Strategy and action plan for electrification of public transport in Indian cities. Urban transport is one of the leading contributors to greenhouse gas emissions, and the Government of India is providing fiscal and non-fiscal incentives to city authorities to move towards electric mobility. A challenge however is the limited capacity of cities to translate national policy into implementable local-level strategies. This project seeks to address the lack of sustained action towards electric mobility, especially in Public Transport (PT) despite the significant policy and funding push by the national government. The project will adopt an 'Enable Avoid Shift Improve' (EASI) framework which suggests a wide range of measures for climate change mitigation. While Avoid and Shift measures have until now been the primary focus of Strategic Transport Plans in India, this project lays emphasis on Improve and Enable strategies that can strengthen the transition to electric mobility.

NOVA VIDA

Grant holder: **Associate Professor Ornella Iuorio**
Investigators: **Professor Richard Romano, Jorge Garcia de Pedro**
Funder: **British Academy**
Dates: **June to July 2021**
Website: **Novel Approach for Vital Infrastructure Post Disaster | The British Academy**

Abstract: This project evaluates post-disaster management cases in three cities in Ecuador, to create new bottom-up community-led frameworks for infrastructures development. It utilizes innovative virtual reality scenarios to capture non-technical people responses to different built environments, and evaluate their practical implementation, considering indigenous construction practices as well as

social and cultural preferences. The level of acceptance of such solutions is paramount for long-term vulnerability reduction and the well-being of survivors (UN Sustainable Development Goal 3). This research seeks to transform how post-disaster infrastructure is conceived, following a multi-disciplinary approach combining social and computer sciences with architecture and materials engineering.

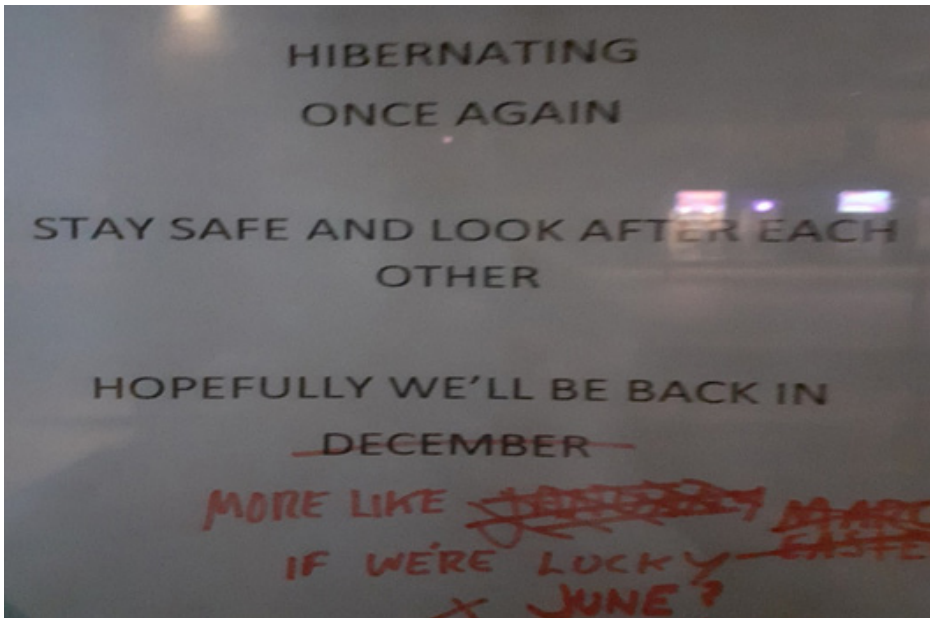
CHOICE MODELLING

The Choice Modelling Centre brings together expertise from all key disciplines creating an environment of collaboration by breaking down traditional barriers.

Next generation activity and travel behaviour models (NEXUS)

Grant holder: **Dr Charisma Choudhury**
Investigators: **H Wang (School of Computing), F Mushtaq (School of Psychology), Dr Thomas Hancock, Dr Arash Kalatian**
Funder: **UKRI Future Leaders Fellowship**
Dates: **October 2020 to October 2024**
Collaborating partners: **Alan Turing Institute, University of California Berkeley, DfT, Asian Development Bank (ADB), Citi Logik, PTV**
Website: **NEXUS**

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.



Lockdown in Headingley, Leeds – on the 'Otley run' route where groups of students traditionally visit each establishment on Otley Road for a drink, wearing fancy dress. Photo courtesy of Joanna Carder.

TOwards Zero Carbon Aviation (TOZCA)

Investigators: **Dr Charisma Choudhury, Dr Chiara Calastri, Fangqing Song**
Funder: **EPSRC**
Dates: **November 2021 to October 2024**
Coordinator: **University College London**
Collaborative partners: **see website**
Website: **TOZCA**

Abstract: The objective of the project is to develop a comprehensive tool suite to simulate the most cost-effective transition towards a net zero-carbon aviation system by 2050. It will identify the technological, economic and environmental synergies and trade-offs that result from drastic CO2 emissions reductions through changes in technology, fuels, operations, use of competing modes and change in consumer behaviour. ITS is responsible for one of the six Work Packages, namely WP2 - Modelling air passenger behaviour. WP2 focuses on developing models that better predict passenger behaviour by incorporating the effects of detailed demographic and 'softer' factors like changes in people's attitudes and perceptions, social norms, etc. Data will be collected from travellers in the UK, China and Sweden. The models will be implemented in the Aviation Integrated Model of UCL to forecast the effect of different policy scenarios.

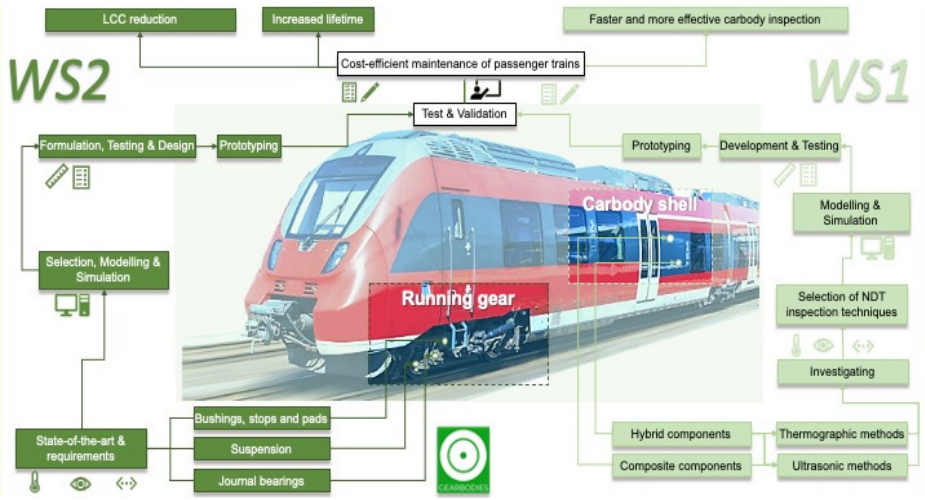
Impact: The academic partners of WP2 include Beijing Jiatong University (China), Indian Institute of Science (India), Queensland Institute of Technology (Australia), Universidad de Concepción (Chile), University of Capetown (South Africa), University of Ferrara (Italy) and University of Missouri (USA) and VTI - Swedish National Road and Transport Research Institute (Sweden). TOZCA is supported by key stakeholders from aircraft manufacturers, fuel suppliers, airlines, airports, the insurance industry (ADS-Group, Airbus, Arup, British Airways/IAG, GKN-Aerospace, Heathrow Airport, NATS, Shell, Sustainable Aviation, WillisTowersWatson), government departments/agencies (Aerospace Technology Institute, BEIS, DfT) and one NGO, the Aviation Environment Federation.

RAIL

To enhance the understanding of the economics of rail transport demand and supply, rail operation and control, and the economic value of rail technical innovation and investment, we use a multi-disciplinary approach combining rail engineering and technical research with economics, such that technical innovations that deliver social welfare gains can be identified.

Adaptive and Intelligent Automatic Train Operations (AI – ATO)

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



GEARBODIES – improving the efficiency of rolling stock maintenance.

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 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.

Assistant Very Short Term Planning (aVSTP)

Grant holder: **Professor Ronghui Liu**
Investigators: **Dr Zhiyuan Lin**
Funder: **RSSB**
Coordinating partner: **Bellvedi Ltd**
Dates: **July 2020 to October 2022**

Abstract: Assistant Very Short Term Planning (aVSTP) 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 (RAILSa)

Grant holder: **Professor Ronghui Liu**
Investigators: **Dr Ziyuan Lin, Dr He Wang (Computing)**
Funder: **EU Shift2Rail**
Coordinating partner: **CINI**
Dates: **January 2020 to June 2023**

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.

Impact: 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. Dr Lin organised the AI4RAILS2021 conference.

Reducing Energy Demand (TransEnergy)

Grant holder: **Professor Andrew Smith**
Funder: **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**
Funder: **EU H2020**
Coordinating partner: **Unife**
Collaborative partners: **see project website**
Dates: **December 2019 to February 2022**
Website: **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.

GEARBODIES

Grant holder: **Professor Andrew Smith**
Investigator: **Dr Kristofer Odolinski**
Funder: **EU H2020**
Coordinating partner: **EURNEX**
Collaborative partners: **see project website**
Dates: **December 2020 to December 2022**
Website: **gearbodies.eu/**

Abstract: The success of the European rail system to foster the modal shift towards rail requires cost-efficient and reliable long-lasting trains. GEARBODIES contributes to this effort by improving the efficiency of rolling stock maintenance.

IN2ZONE

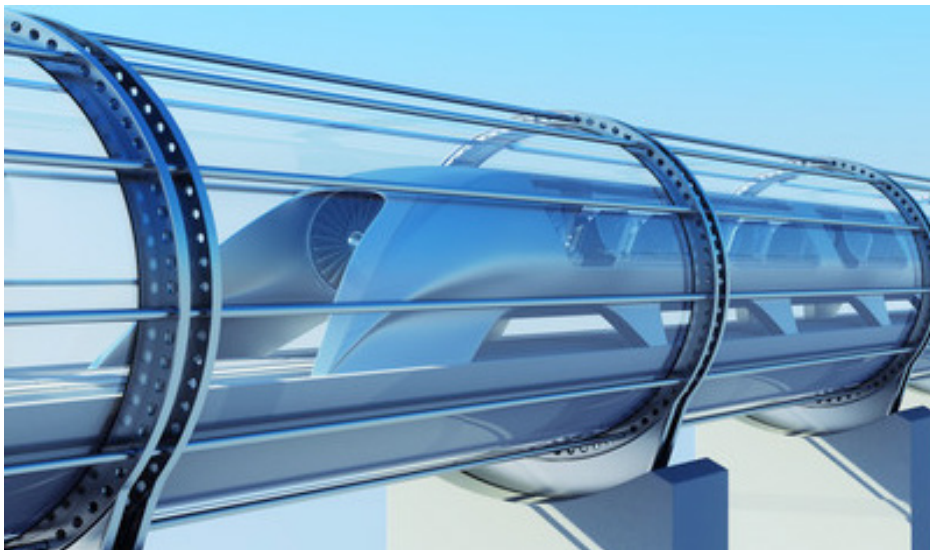
Grant holder: **Professor Andrew Smith**
Investigator: **Dr Kristofer Odolinski**
Funder: **EU H2020**
Coordinating partner: **University of Leeds**
Collaborative partners: **see project website**
Dates: **December 2020 to May 2023**
Website: **in2zone.eu/**

Abstract: The main aim of IN2ZONE is to develop the next generation of transition zone, which offers a step-change reduction in rail maintenance requirements, compared to existing solutions. High level objectives of the research include: Reduction in delays, lifecycle costs, noise and vibration; increased network capacity; optimum and sustained track support conditions.

HYPERNEX

Grant holders: **Professor Andrew Smith and the University of Leeds Institute for High Speed Rail**
Funder: **Shift2Rail**
Coordinating partner: **Universidad Politécnica de Madrid**
Collaborative partners: **see project website**
Dates: **December 2019 to November 2021**
Website: **hypernex.industriales.upm.es/**

Abstract: Since the modern hyperloop proof of concept was coined in a white paper in 2013, and with the creation of Shift2Rail in 2014, many activities touching innovation in guided transport have arisen in Europe and elsewhere in the world. Technologies including innovative control systems for vehicle to vehicle interaction, communication and positioning systems (including in-tunnel environments), advanced magnetic levitation, innovative light materials, energy storage and regeneration solutions have been investigated in a fragmented and competitive manner. The challenge is to channel these dispersed innovations and technical solutions into a coherent framework that would potentially support a possible European implementation or migration of concepts towards other innovations in guided transport modes and to support interoperability with the Single European Railway Area. HYPERNEX addresses the need for a catalyst to accelerate the development of the fifth means of transport - Hyperloop.



HYPERNEX addresses the need for a catalyst to accelerate the coherent development of Hyperloop.

ECONOMICS AND APPRAISAL

We research the economics of transport from a demand and supply perspective and individual travel decisions and assess the business case for transport investment.

Bus Demand and Real Journey Time

Grant holder: **Dr Alex Stead**
Investigators: **Dr Phill Wheat, Dr Han Lin**
Dates: **January 2021 to March 2022**
Funder: **Transport for West Midlands**

Abstract: Your bus is late. Your bus is stuck in traffic. How do bus passengers react to changes in service reliability? It is important to gather data to forecast the impact of bus reliability on ridership and the impact of investments aimed at improving reliability. This project combines smartcard data and real time information from buses gathered in 2019 and in 2020 to build a unique flow-level dataset on bus usage and journey time reliability. We conducted econometric analysis of that dataset in order to understand the impact of changes in journey time reliability on bus usage. The project considers various measures of journey time and assesses how well they explain variation in bus usage.

Impact: We analysed the extent to which bus passengers respond to changes in journey time reliability by travelling at different times and reported estimates of gross and net impacts on bus usage.

ASSETS4RAIL

Grant holder: **Dr Manuel Ojeda-Cabral**
Investigators: **Professor Andrew Smith, Dr Xiaoxiao Ma**
Funder: **EU H2020**
Coordinating partner: **Eurecat / Eurenex**
Collaborative partners: **See website**
Dates: **December 2018 to December 2021**
Website: **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.

Assets4Rail - ITS are providing the economic appraisal of a wide range of railway innovations.

RSSB-ITS Research Partnership in Rail Economics

Grant holder: **Dr Manuel Ojeda-Cabral**
Investigators: **Professor Richard Batley, Professor Andrew Smith, Dr Chiara Calastri, Dan Johnson, Dr Thijs Dekker, Dr Anthony Whiteing, Professor Chris Nash, Dr David Pierce, Dr Alex Stead**
Funder: **RSSB**
Dates: **From January 2019 (ongoing)**

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.

Report published by RSSB: Ojeda-Cabral M, Batley R and Johnson D. 2021. Rail Openings Appraisal: Ojeda-Cabral M, Batley R and Johnson D. 2021. Rail Openings Appraisal: Review and development of appraisal practice for new railway lines, stations and services. Project page (with non-technical-summary). Click here for Full technical report.

Rail Openings Appraisal

Grant holder: **Dr Manuel Ojeda-Cabral**
Investigators: **Professor Richard Batley, Dan Johnson**
Funder: **RSSB**
Dates: **July 2020 to October 2021**

Abstract: This project reviewed and developed solutions to strengthening the forecasting and appraisal methods that underpin benefit cost ratio (BCR) calculations for new rail openings and re-openings, covering new lines, stations and services. Given this overarching aim, the study addressed three objectives: i) Revisit the state-of-the-art forecasting and appraisal methods for BCR calculations for new rail openings and re-openings in the UK (new rail lines, stations and services); ii) Develop existing methods where appropriate and feasible; and iii) Provide recommendations for the development of better, clearer, more consistent and easier-to-apply appraisal methodology and guidance for rail schemes consisting of new rail openings and re-openings.

Impact: This work has been funded by RSSB and supported by the rail industry, with collaboration through the Steering Group of the Department for Transport, Network Rail and Jacobs. The methods developed are currently being used internally by the DfT to support their appraisal and decision-making processes, and a follow-up piece is currently underway to facilitate and support implementation in DfT's Transport Analysis Guidance (TAG). Our findings and recommendations are expected to contribute to developing more robust, comprehensive and consistent economic cases, in particular for contexts where mode shift is key.

Papers: Ojeda-Cabral M, Batley R and Johnson D. 2021. Rail Openings Appraisal: review and development of appraisal practice for new railway lines, stations and services. Report for RSSB.

Shift2MaaS

Grant holder: **Dan Johnson**
Investigators: **Professor Andrew Smith, Dr Anthony Whiteing, Dr Chiara Calastri, Dr Xiaoxiao Ma**
Funder: **EU H2020**
Coordinating partner: **UIP**
Collaborative partners: **See full list on shift2maas.eu/**
Dates: **December 2018 to February 2022**

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.

Land Value and Transport Phase 3

Grant holder: **Dan Johnson**
Investigators: **Dr Like Jiang, Dr John Nellthorp, Dr Han Lin, Dr Manuel Ojeda Cabral**
Funder: **Transport for the North (TfN)**
Dates: **October 2020 to January 2022**

Abstract: Described in the ITS Annual Research Report 2019 an earlier phase of Land Value and Transport focused on the uplift in residential land value in the vicinity of new rail stations. This third phase of the research is focused on commercial properties such as offices, retail outlets and warehouses. We look at how much such properties benefit from improved transport links and create numerical values to represent this. For

commercial sites there are different datasets, benefits and variables than for residential properties. We looked at most types of transport connectivity, our main focus was rail but road, freight, bus & tram as well as walking were included in our analysis.

Impact: The project provides 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**
Funder: **HS2**
Dates: **November 2019 to October 2021**

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 – 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.

Transport Infrastructure Efficiency Strategy (TIES)

Grant holder: **Dr Phill Wheat**
Investigators: **Professor Andrew Smith, Dr Alex Stead, Dr David Pierce, Dr Xiaoxiao Ma, Dr Vo Huyen Tran**
Funder: **Innovate UK**
Dates: **May 2020 to July 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 is shared.

Photo courtesy of Joanna Carder

CQC Efficiency Network

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

Impact: The CQC Efficiency Network provides a stimulus to realizing efficiency savings in road maintenance. The Network measures efficiency and evaluates the likely impact of changes to road maintenance practice and process. At ITS we provide state of the art benchmarking analysis for the Network. CQC is referenced in the DfT's Incentive Fund Self-Assessment Process and supports the case for local authorities to receive enhanced incentive funding.

AIR QUALITY AND HEALTH

Research under this theme spans the monitoring and measurement of transport generated pollution to transport related health and safety issues.

Transport, Air Quality & Covid19

Grant holder: **Dr Zia Wadud**
Funder: **FCDO/ UKAID**
Dates: **October 2020 to March 2021**
Collaborating partners: **Bangladesh University of Engineering and Technology**
Website: Transport, Air Quality & Covid19

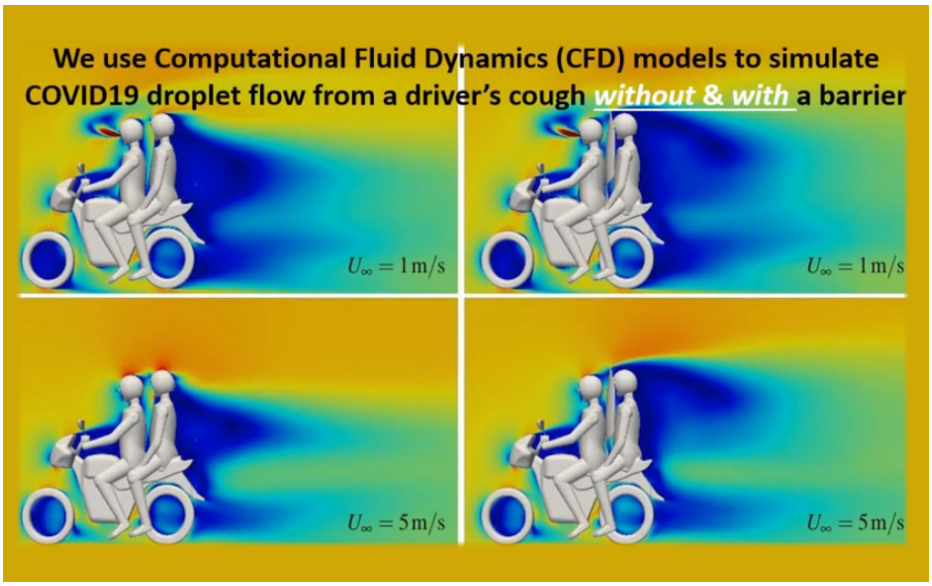
Abstract: This project investigated the effects of covid-19 related policy interventions on the transport outcome - correlating these with potential changes in air quality, traffic fatality and spread of the disease. The project quantified the relative role of different lockdown measures (e.g. closure of offices, schools, public transport, partial opening of public transport, festivals, etc.) on mobility and covid19 cases. The project revealed the 'risk compensation' effects of mask mandates, which resulted in higher mobility and reduced the intended benefits of the masks.

Impact: a high quality video summarises the research results: youtube.com/watch?v=mKfhIrGziWc

Papers: Wadud Z, Rahman SM, Enam A. 2021. Face mask mandates and risk compensation: an analysis of mobility data during the COVID-19 pandemic in Bangladesh. BMJ Global Health 2022;7:e006803.

Reports: Rahman SM, Enam A, Sohel Mahmud SM, **Wadud Z**. 2021. Links between Transport, Air Quality and COVID-19 Spread in Bangladesh

Wadud Z, Rahman SM and Enam A. 2021. Modelling the links between transport, air quality and COVID-19 spread using naturalistic data from Dhaka and Bangladesh.



Covid exposure risk on motorcycle taxis is reduced by plastic shield.

Transport Risk Assessment for COVID-19 Knowledge (TRACK)

Grant holder: **Professor Cath Noakes, School of Engineering, University of Leeds**
Investigators: **Professor Susan Grant-Muller, Dr Marco-Felipe King (Civil Eng), Frances Hodgson, Professor Simon Shepherd, Professor David Watling, Dr Andrew Tomlinson, Yuanxuan Yang, Yanis Boussad**
Funder: **EPSRC, DfT**
Dates: **October 2020 to March 2022**
Collaborative partners: **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 was collected on public transport in Leeds, Newcastle and London: Air and surface samples were 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 were 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 was 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 framework.

Impact: Working closely with 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 virus transmission.

Funding has been granted for the follow-on project - TRACK II.

COVID-19 Leeds Lifeband

Grant holders: **Professor Susan Grant-Muller**
Investigators: **Frances Hodgson, Dr Gillian Harrison, Yuanxuan Yang**
Funder: **EPSRC**
Dates: **August 2021 to December 2022**

Abstract: To develop new technology, a wearable device with an in-built sensor is developed to help people keep their social distance. The band sends a signal to warn users of their proximity and tracks the trajectories people take. It provides a measure of the level of exposure people are getting to potential viral infection.

Covid Exposure Risk Tradeoffs in Transport

Grant holder: **Dr Zia Wadud**
Investigators: **Dr Zahara Batool**
Funder: **EPSRC**
Dates: **October 2020 to February 2022**
Coordinating partner: **University of Leeds**
Collaborating partners: **Bangladesh University of Engineering and Technology, University of Asia Pacific, Makerere University, Federal University of Technology Owerri**
Website: **Covid Risk Tradeoffs**

Abstract: This project aims to provide a science-based answer for transport policymakers in developing countries to the question 'which is the safest publicly available transport mode (including paratransit modes such as motorcycle taxis and autorickshaws) to move people during an epidemic and how to make travelling in paratransit modes safer?' The objective risk measures using Computational Fluid Dynamic models will be complemented by a stated preference survey of transport users in the project countries to understand passengers' behaviour in terms of their perception of exposure risk to COVID-19 on motorbike taxis and reveal their current and future preferences for mitigation measures in various public transport and paratransit modes.

Impact: Watch the video: youtube.com/watch?v=QK6UrKaGqQs

Papers: Hetherington R, Toufique Hasan A, Khan A, Roy D, Salehin M and Wadud Z. 2021. Exposure risk analysis of COVID-19 for a ride-sharing motorbike taxi. Physics of Fluids 33, 113319

Modify Drivers' behaviour to Adapt for Lower Emissions (MODALES)

Grant holder: **Professor Haibo Chen**
Investigators: **Dr Jianbing Gao, Dr Ye Liu, Professor David Watling, Dr Zhiyuan Lin, Dr Said Munir**
Funder: **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: **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.

Impact: MODALES is a multi-disciplinary project including users, universities and R&D organisations specialising in vehicle emissions, industrial partners able to address the three types of emissions from exhaust gas, tyres and brakes and a legal network association to investigate tampering in Europe. It also includes several partners who provide the international dimension for MODALES solutions. Active collaboration within the MODALES consortium has led to the award of a grant for a new project, nPETS (see below), aimed at addressing the impact of nanoparticles from transport on the health of human beings and animals.

MODALES papers:

1. Gao J, Chen H, Liu Y, Li Y. 2021. Impacts of De-NOx system layouts of a diesel passenger car on exhaust emission factors and monetary penalty. Energy Science & Engineering, 9 (12), 2268-2280.
2. Gao J, Chen H, Liu Y, et. al. 2021. Comparison of NOx and PN emissions between Euro 6 petrol and diesel passenger cars under real-world driving conditions. Science of the Total Environment, 801,149789.
3. Liu Y, Fan C, Wang X, Liu F & Chen H. 2021. Thermally induced variations in the nanostructure and reactivity of soot particles emitted from a diesel engine. Chemosphere, Volume 286, Part 2. 131712.
4. Liu Y, Chen H, Gao J, Li Y, Dave K, Chen J, Federici M & Perricone G. 2021. Comparative analysis of non-exhaust airborne particles from electric and internal combustion engine vehicles. Journal of Hazardous Materials, 420, 126626.
5. Jia D, Chen H, Zheng Z, Watling D, Connors R, Gao J & Li Y. 2021. An Enhanced Predictive Cruise Control System Design with Data-driven Traffic Prediction. IEEE Transactions on ITS.
6. Liu Y, Song C, Lv G, Zhang W & Chen H. 2021. Evaluation of the oxidative reactivity and electrical properties of soot particles. Carbon, 178, 37-47.
7. Tu R, Li T, Meng C, Xie Y, Xie F, Yang F, Chen H, Li Y, Gao J & Liu Y. 2021. Real-world Emissions of Construction Mobile Machines and Comparison to a Non-road Emission Model, Science of the Total Environment, 771, 145365.
8. Gao J, Chen H, Liu Y, Li Y, Li T, Tu R, Liang B & Ma C. 2021. The effect of after-treatment techniques on the correlations between driving behaviours and NOx emissions of passenger cars. Journal of Cleaner Production 288, 125647.

Impacts of transport derived nanoparticle emissions are evaluated in the nPETS project.

Nanoparticle Emissions from the Transport

Sector: **Health and Policy Impacts (nPETS)**
Grant holder: **Professor Haibo Chen**
Investigators: **Dr Ye Liu, Dr Said Munir, Dr Evangelos Paschalidis, Dr Like Jiang, Dr John Nellthorp**
Funder: **EU H2020**
Coordinating partner: **KTH**
Collaborative partners: **13 European partners in industry and academia (see website for details)**
Dates: **June 2021 to May 2024**
Website: **npets-project.eu/**

Abstract: Adverse health effects of airborne particles are strongly linked to their size. A major fraction of outdoor ultrafine particles is traffic generated from road, rail, air, and sea transportation. nPETS aims to improve the knowledge of transport generated exhaust and non-exhaust nanoparticle emissions and their impacts on health and new public policies. It monitors and samples with state-of-the-art particle instruments the sub 100 nm particles emitted from various transport vehicles both in field and controlled laboratory environments. Living cells will be exposed to collected and real-world primary and aged aerosols as well as primary and aged aerosols generated in the laboratory. Furthermore, nPETS aims to evaluate the possible future impact of new policies on public health and linking the impacts with specific emission sources.

Papers: Liu Y, Chen H, Li Y, Gao J, Dave K, Chen J, Li T & Tu R. 2022. Exhaust and non-exhaust emissions from conventional and electric vehicles: A comparison of monetary impact values, Journal of Cleaner Production, Vol. 331, 129965.

Impact: The nPETS consortium consists of seven highly ranked universities (Stockholm University, KTH, KI, University of Leeds, Aristotle University of Thessaloniki, Lunds University and Tampere University) which combine excellence in aerosol science, toxicology, transport science and engineering science. The consortium also includes three world-leading European research institutes (CSIC, Mario Negri, and CERTH) in the field of aerosol monitoring, with a large experience in air quality issues including transport generated ones, and in transportation issues. The world-leading brake manufacturer BREMBO provides state-of-the-art techniques to measure vehicle brake emissions. Two European local administrations (Stockholm and Barcelona) are partners that have authority and excellent data on air quality, including long-term nanoparticle concentrations in ambient air, and dissemination channels for air quality worldwide.

TRANSITION Clean Air Network - developing practical solutions to tackle air quality issues.

Evaluate Local NO2 plans

Grant holder: **Dr James Tate**
Investigators: **Professor Jillian Anable, Dr Karl Ropkins, Dr Ian Philips, Dr Chris Rushton, Dr Robin Lovelace**
Funder: **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 currently evaluating the impacts of reducing motorway speed limits on emissions and air quality in Basildon.

uCARe

Grant holder: **Professor Samantha Jamson**
Investigators: **Dr James Tate**
Funder: **EU H2020**
Dates: **May 2019 to October 2022**
Website: **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.

City Air Remote Emission Sensing (CARES)

Grant holder: **Dr James Tate**
Investigators: **Dr Karl Ropkins, Dr Chris Rushton**
Funder: **EU H2020**
Dates: **May 2019 to April 2023**
Website: **cares-project.eu/**

Abstract: This project investigates contactless measurement of vehicle exhaust emissions with the aim that it becomes a widespread means for the monitoring and enforcement of real-world vehicle emissions. We develop plume chasing instruments to detect high-emitting vehicles 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 emissions, merging the emissions data with technical data from national vehicle registers and relevant data from traffic and air quality management systems. Third, we eliminate time-consuming data analysis by providing a suite of open-source functions. These innovations will improve the user friendliness, bring down costs by automated operations and achieve a broader deployment potential of remote emission sensing. The CARES project aims to demonstrate these developments in three major 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.

TRANSITION Clean Air Network

Investigator: **Dr Karl Ropkins**
Funder: **NERC**
Dates: **September 2020 to August 2023**
Coordinating partner/ grant holder: **University of Birmingham**
Collaborative partners: U**niversities of Coventry, Surrey, Ulster, Oxford, Sheffield, Bath and University College London.**
Website: **transition-air.org.uk/**

Abstract: The TRANSITION Clean Air Network is part of UK Research & Innovation Strategic Priorities Fund Clean Air Programme. The Programme aims to bring together the UK's world-class research base for high-quality, interdisciplinary research and innovation to develop practical solutions for today's air quality issues and equip the UK to proactively tackle future air quality issues. The TRANSITION Clean Air Network, which is one of several initiatives set up within the Programme, is focused on air quality and health impacts associated with the transport sector working on a broad range of activities including: Network summits, Challenges and Solutions workshops, Discovery and Innovation studies, Mobilisation and Exchange placements, Public Outreach Activities, Input to other networks and Clean Air activities across the SPF Programme.

Impact and Outputs: see website

ROAD SAFETY AND VEHICLE AUTOMATION

Human factors and safety are among the key challenges of automation in transport. Understanding the human factors implications and challenges of connected and automated vehicles is the main focus of research under this theme.

ARCADE

Grant holder: **Dr Yvonne Barnard**
Investigator: **Jo-Ann Pattinson, Professor Natasha Merat**
Funder: **EU H2020**
Dates: **October 2018 to September 2021**
Coordinating partner: **ERTICO – ITS Europe**
Collaborative partners: **24 European partners (see website for details)**
Website: **ARCADE**

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). The European Commission intends to establish a new European Partnership on Cooperative, Connected and Automated Mobility (CCAM) under Horizon Europe. The Partnership aims to align better public and private efforts through a common and long-term R&I agenda, and to accelerate the implementation of smart, innovative and sustainable mobility solutions for all.

The institute for Transport Studies with daffodils. Photo courtesy of Joanna Carder Spring 2021.

COMMOTIONS

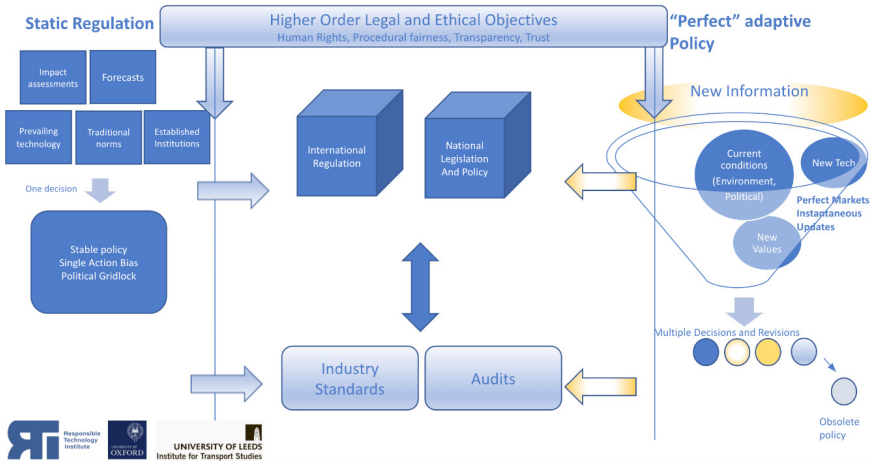
Grant holder: **Professor Gustav Markkula**
Investigators: **Dr Yi-Shin Lin, Dr Aravinda Srinivasan, Dr Jac Billington (School of Psychology), Dr Matteo Leonetti (School of Computing, King's College London), Jorge Garcia de Pedro**
Funder: **EPSRC**
Collaborative partners: **FiveAI, Aimsun**
Dates: **July 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, in both routine and safety critical circumstances, with the objective of using these models to test and optimise the interactive behaviour of AVs. The models are being developed based on knowledge and methods from cognitive neuroscience, using behavioural data from naturalistic and controlled environments, as well as neurophysiological data collected in collaboration with Leeds School of Psychology. The project also investigates 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, King's College London. 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. Advising automotive industry (e.g., Waymo) on road user interaction modelling.

Commotions papers:

1. Pekkanen J, Giles OT, Lee YM, Madigan R, Daimon T, Merat N and Markkula G. 2021. Variable-drift diffusion models of pedestrian road-crossing decisions. Computational Brain & Behavior.
2. Svärd M, Markkula G, Bärgman J and Victor T. 2021. Computational modeling of driver pre-crash brake response, with and without off-road glances: Parameterization using real-world crashes and near-crashes. Accident Analysis & Prevention, 163, 106433.
3. Markkula G, Uludağ Z, Wilkie RM and Billington J. 2021. Accumulation of continuously time-varying sensory evidence constrains neural and behavioral responses in human collision threat detection. PLoS Computational Biology, 17(7), e1009096.
4. Sarkar A, Hickman JS, McDonald AD, Huang W, Vogelpohl T and Markkula G. 2021. Steering or braking avoidance response in SHRP2 rear-end crashes and near-crashes: A decision tree approach. Accident Analysis & Prevention, 154, 106055.
5. Srinivasan AR, Hasan M, Lin YS, Leonetti M, Billington J, Romano R and Markkula G. 2021. Comparing merging behaviors observed in naturalistic data with behaviors generated by a machine learned model. 2021 IEEE International Intelligent Transportation Systems Conference (pp 3787-3792).



RAILS project – making systems trustworthy through adaptive and independent audits

Interaction of Humans and Automated Vehicles (SHAPE IT)

Grant Holder: **Professor Natasha Merat**
Co-Investigator: **Professor Gustav Markkula**
Funder: **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 under the EU Marie Skłodowska-Curie grant agreement. Fifteen Early Stage Researchers (ESRs) 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-centered 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.

Three ESRs are 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 (supervised by Professor Natasha Merat and Dr Chongfeng Wei); Yue Yang - Long Term Effects of AV Exposure on AV/VRU Interactions (supervised by Professor Natasha Merat and Dr Yee Mun Lee); Amir Hossein Kalantari -Computational AV/Pedestrian Interaction Models (supervised by Professors Gustav Markkula and Natasha Merat).

Impact: The ESRs work closely with industrial and academic partners via a series of placements. For example, Chen Peng spent 3 months with Bosch in Germany.

SHAPE IT papers:

1. Tabone W, Lee YM, Merat N, Happee R & De Winter J. 2021. Towards future pedestrian-vehicle interactions: Introducing theoretically supported AR prototypes. *13th International Conference on Automotive User Interfaces and Interactive Vehicular Applications (pp. 209-218)*
2. Figalová N, Nasser M, Jokhio S, Mbelekani N, Zang C, Yang Y, ... & Bärgman J. 2021. Methodological Framework for Modelling and Empirical Approaches *(Deliverable D1. 1 in the H2020 MSCA ITN project SHAPE-IT)*
3. Merat N, Yang Y, Lee YM ... & Nasser M. 2021. An Overview of Interfaces for Automated Vehicles (inside/outside) *(Deliverable D2.1)*
4. Tabone W, De Winter J ... & Stanton N. 2021. Vulnerable road users and the coming wave of automated vehicles: Expert perspectives. Transportation research interdisciplinary perspectives, 9, 100293

L3PILOT

Grant holder: **Professor Natasha Merat**
Investigators: **Dr Tyron Louw, Michael Daly, Tony Horrobin, Dr Andrew Tomlinson, Dr Ruth Madigan, Dr Yee Mun Lee, Dr Ehsan Sadraei, Dr Mahdi Rezaei, Dr Albert Solernou-Crusat, Professor Richard Romano, Jorge Garcia de Pedro**
Funder: **EU H2020**
Dates: **September 2017 to October 2021**
Coordinating partner: **Volkswagen AG**
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.

Impact: This 30-partner project includes all leading European vehicle manufacturers. The work conducted by the group is therefore immediately relevant to design of future in-vehicle systems. Understanding how users interact with and influence future automated vehicles is also important for design of more user-centric systems that will enhance user comfort and experience, as well as improving road safety.

L3PILOT papers:

1. Louw T, Madigan R, Lee YM, Nordhoff S, Lehtonen E, Innamaa S, Malin F, Bjorvatn A, Merat N. 2021. Drivers' Intentions to Use Different Functionalities of Conditionally Automated Cars: A Survey Study of 18,631 Drivers from 17 Countries. International Journal of Environmental Research and Public Health 18(22):12054.
2. Louw T, Gonçalves R, Torrao G et. al. 2021. Do drivers change their manual car-following behaviour after automated car-following? Cogn Tech Work 23, 669–683
3. Louw T, Madigan R, Lee YM, De Marco C, Mallada J & Merat N. 2021. Don't Worry, I'm in Control! Is Users' Trust in Automated Driving Different When Using a Continuous Ambient Light HMI Compared to an Auditory HMI? 13th *International* Conference on Automotive User Interfaces and Interactive Vehicular Applications (pp. 220-222)
4. Nordhoff S, Madigan R, Van Arem B, Merat N & Happee R. 2021.

Interrelationships among predictors of automated vehicle acceptance: a structural equation modelling approach. Theoretical issues in ergonomics science, 22(4), 383-408

5. Lehtonen E, Malin F, Innamaa S, Nordhoff S, Louw T, Bjorvatn A & Merat N. 2021. Are multimodal travellers going to abandon sustainable travel for L3 automated vehicles? Transportation research interdisciplinary perspectives, 10, 100380
6. Weber H, Hiller J, Eckstein L, Metz B, Landau A, Lee YM, Louw T, Madigan R, Merat N et.al. 2021. L3Pilot Deliverable D7.3: Pilot evaluation results.

Hi-Drive

Grant holder: **Professor Natasha Merat**
Investigators: **Dr Yee Mun Lee, Dr Tyron Louw, Dr Ruth Madigan, Dr Mahdi Rezaei**
Funder: EU H2020
Dates: **July 2021 to September 2025**
Co-ordinating partner: **Volkswagen AG**
Collaborative partners: **40 partners in 14 European countries, for details see Website**
Website: **www.hi-drive.eu/**

Abstract: Building on the results of the EU-funded project L3Pilot, Hi-Drive extends the data collection across EU borders in variable traffic, weather, and visibility conditions. The vast geographical coverage of Hi-Drive test sites across Europe will enable a more realistic scaling up of the results to an EU level. Hi-Drive addresses a number of key challenges which are currently hindering the progress of developments in vehicle automation.

Seeing Machines Fellowship

Grant holder: **Professor Natasha Merat**
Investigator: **Rafael Cirino-Gonçalves**
Funder: **Seeing Machines**
Dates: **November 2021 to November 2022**
Collaborative partners: **Seeing Machines**

Abstract: The aim of this fellowship is to define metrics and methods to measure driver readiness in the context of level 2/3 automation and provide tools to estimate readiness thresholds for the application in real-time Driver Monitoring Systems.

Responsible AV Data (RoAD)

Grant holder: **Dr Jo-Ann Pattinson**
Funder: **UKRI Trustworthy Autonomous Systems Hub**
Dates: **March 2021 to March 2022**

Professor Samantha Jamson in the University of Leeds Driving Simulator testing the performance of autonomous driving scenarios

Co-ordinating Partner: **University of Southampton**
Collaborating Partner: **University of Oxford**

Abstract: RoAD (Responsible AV Data: Ethical, Legal and Social challenges of using data from autonomous vehicles) investigates how the ability to access, explain and understand data related to system failure or accidents is a fundamental element for ensuring safety, liability and public trust. The legal frameworks relevant to the recording, storage and access to AV data are still being developed. RoAD explored what types of data should be recorded to ensure safety and trust in autonomous systems, how and who may access this data and under what circumstances, as well as the legal and technical issues which arise. We conducted expert interviews with stakeholders, and a survey of 800 drivers and road users, as well as simulations which included the recording of data parameters identified by stakeholders.

Impact: The outputs of RoAD helped shape a larger UKRI proposal called RAILS (Responsible AI for Life-Long Learning Autonomous Systems) – described below. The results of the RoaD survey and expert interviews will be used in the RAILS project as well as in discussions with regulators and policy makers.

Responsible AI for Life-Long Learning Autonomous Systems (RAILSb)

Grant holder: **Dr Jo-Ann Pattinson**
Funder: **UKRI**
Dates: **January 2022 to June 2024**
Collaborative partners: **University of Oxford, University of York, University College London, Amazon Web Services, Oxbotica, Addleshaw Goddard LLP, Society for Computers and Law, Autonomous Drivers Alliance**
Abstract: Developing trustworthy life-long learning systems, RAILS will explore independent long-term autonomy systems in different domains including AV and autonomous robot systems and drones, building upon the above described RoAD project. It is a multi-disciplinary project drawing upon law, engineering, social science and computer science to investigate regulations, standards and impacts around the long-term operation of autonomous systems from ethical, legal and social perspectives.

Impact: RAILS aims to develop a workable cloud-based model system for evaluating causal responsibility and accountability of autonomous systems, an assurance case for the safe operation of life-long learning and self-adaptive autonomous systems and an adaptive governance framework for the development and long-term deployment of autonomous systems.

Trustonomy

Grant holder: **Professor Samantha Jamson**
Investigators: **Dr Foroogh Hajiseyedjavadi, Michael Daly, Tony Horrobin**
Funder: **EU H2020**
Dates: **May 2019 – July 2022**
Collaborative partners: **see website**
Website: **h2020-trustonomy.eu/**

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.

An automated car and a pedestrian (research assistant Jorge Garcia de Pedro) interact in HIKER – the pedestrian simulator lab at Leeds University used in the Commotions, Human Drive and other research projects.

ITS is responsible for one of the four pillars of this collaborative research, namely Trust. At ITS we are carrying out a simulator study to investigate how trust in automation is formed and affected by characteristics of the automation design.

Papers: Library | Trustonomy (h2020-trustonomy.eu)

Enhance driver behaviour and Public Acceptance of Connected and Autonomous vehicLes (PAsCAL)

Grant holder: **Professor Haibo Chen**
Investigators: **Dr Kaushali Dave, Dr Evangelos Paschalidis, Dr Like Jiang, Bryan Matthews, Dr Yvonne Barnard, Professor David Watling**
Funder: **EU H2020**
Coordinating partner: **LIST**
Collaborative partners: **13 partners in industry and academia (see website for details)**
Dates: **June 2019 to November 2022**
Website: **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: PAsCAL's contributions include: improved levels of safety and security in all modes of transport, in line with the Transport White Paper 2011 (e.g., Vision Zero); 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; 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.

HumanDrive Extension

Grant holder: **Professor Natasha Merat**
Investigators: **Dr Andrew Tomlinson, Jorge Garcia de Pedro**
Funder: **Nissan**
Dates: **October 2019 to March 2022**
Collaborative partners: **Nissan**

Abstract: The aim of this project is to study the interaction of pedestrians with automated vehicles and understand if pedestrians can identify human-like driving of Automated Vehicles. What sorts of information do pedestrians seek from a vehicle when crossing the road? The information gained from our simulator studies helps with the design of more intuitive Automated Vehicles.The project extends the knowledge gained in the HumanDrive project which focused on the experience of drivers of automated vehicle – (HumanDrive was described in the ITS Annual Research Report 2020).

First Bus

Grant holder: **Professor Natasha Merat**
Investigator: **Dr Ruth Madigan**
Funder: **First Group plc**
Dates: **November 2020 to February 2021**

Abstract: The aim of the project was to understand the causes of a number of recent crashes of buses at low bridges, also providing a summary of what is known about these crashes from the literature. A small focus group with bus drivers identified a hierarchy of solutions for improving driver training and management, as well as how in-vehicle warning systems can be used to improve bus safety.

Impact: This project has received praise from the sponsor and related stake holders, such as Network Rail. In particular Ruth Madigan was thanked by Denise Harrison CFIOSH CMILT PIEMA, Head of Health & Safety, First Bus Division: "Your research has helped us to explore why a driver doesn't always heed the bridge warning signs and acknowledge vehicle height in relation to the bridge height. By conducting this new research, the study identifies the human factors at play and provides a deeper understanding around the drivers' mental workload, and how this can impact on concentration. This will certainly help First Bus, and the bus industry more widely, ensure the controls we introduce to prevent bridge strikes are aligned to the research, and thus more effective. The findings of this study will be shared with other key stakeholders in the prevention of bridge strikes and so the impact of this research has far wider reach. On a personal note, the way you came across at our Exec safety meeting was amazing. The presentation was well structured and clear. Your clear grasp and knowledge in the subject of human factors shone through and gave confidence to our business leaders that we now need to move to the next stage and act upon the report findings."

HAROLD

Grant holder: **Professor Natasha Merat**
Investigators: **Tony Horrobin, Dr İbrahim Öztürk, Dr Albert Solernou-Crusat, Jorge Garcia de Pedro**
Funder: **EPSRC**
Dates: **August 2021 to September 2023**
Collaborative partners: **University of Sheffield**

Abstract: The frequency and severity of road collisions are reduced if drivers are able to detect and recognize potential hazards in sufficient time to take evasive action such as braking and steering. An improvement in detection time measurable in hundreds of milliseconds could substantially increase the probability that a crash can be avoided. After dark, visual functions such as reaction time are significantly reduced, and road lighting is installed as a countermeasure to this visual impairment. Road lighting is of particular importance for revealing hazards beyond the reach of vehicle headlights such as pedestrians emerging from the side. The British Government recognize the need for significant reductions in road traffic collisions and committed to enhancing protection of vulnerable road users in the 2015 British Road Safety Statement. This project will investigate the way in which lighting can be used to enhance safety on main roads. Specifically, we seek lighting that increases the chance of drivers seeing a hazard and reduces the time taken to see the hazard. Pedestrians should use a pulsing or flashing LED band, worn on the wrist or ankle to take advantage of bio-motion. An LED band could provide a low-cost counter measure to reduce the risk of accident. Whilst drivers should be continuously scanning for potential hazards, there are many distractions which reduce our ability to detect hazards. We will investigate variations in the intensity and colour of lighting and ask whether optimal lighting can mitigate the driver distraction decrement. This research is of particular benefit to elderly drivers who tend to have poorer vision and perform worse than younger people when driving with distractions. We will identify the changes in lighting conditions likely to improve safety. We will validate our findings within a high-fidelity driving simulator. The simulator places the test participant in a more realistic setting while still maintaining control on road situation and ensuring participant safety.

Impact: Results from this study will help provide new guidance on road lighting.

VIRTUOCITY

A unique programme for city simulation and co-design, Virtuocity provides an immersive, 'human in the loop', simulation and visualisation facility. Our human-focused research has had impacts on the design of transport systems including Smart Motorways and driver safety systems and is now making a key contribution to simulating and evaluating highly automated driving systems. Virtuocity is comprised of three interconnected laboratories: the University of Leeds Driving Simulator, the Truck Simulator and the Highly Immersive Kinematic Experimental Research laboratory (HIKER) – the world's most advanced CAVE-based pedestrian simulator.

Virtuocity – A centre for city simulation.

Pedestrian-in-the-Loop Simulator (HIKER)

Grant holder: **Professor Richard Romano**
Investigators: **Professor Natasha Merat, Dr Albert Solernou-Crusat, Jorge Garcia de Pedro, Dr Ehsan Sadraei**
Funder: **EPSRC**
Dates: **January 2018 to December 2021**
Website: **uolds.leeds.ac.uk/facility/hikerlab**

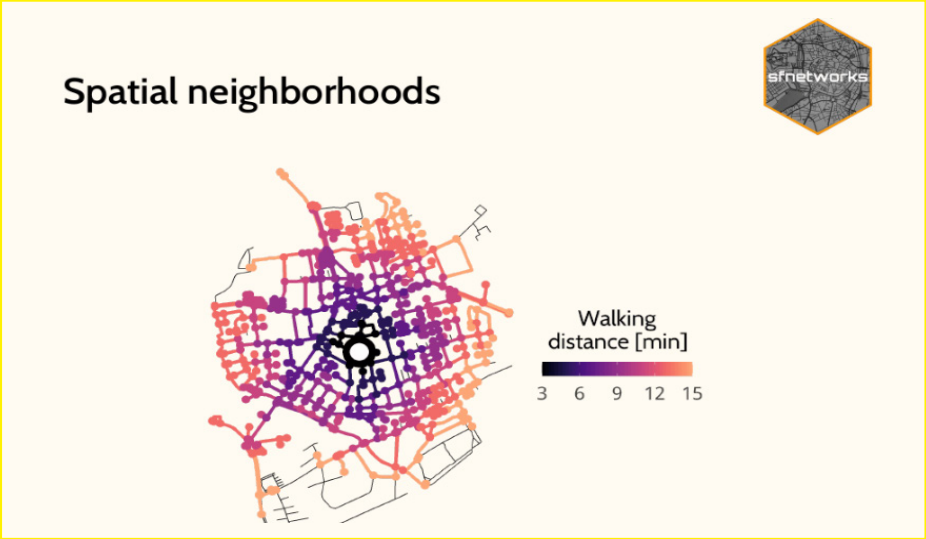
Abstract: This project has developed a new laboratory for Highly Immersive Kinematic Experimental Research (HIKER) to support safe experimental research in a repeatable fashion in which variables with respect to AV design, safety systems, and intersection configuration can be studied. The experiments 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 pedestrian simulator unique in the world is its very high-resolution displays combined with a large walkable environment (9 metres by 4 metres) and its integration with driving simulators to test interactions between pedestrians and drivers.

Impact: To date, the pedestrian simulator has been used extensively to support the interACT, HumanDrive, and VeriCAV projects.

Interoperable Simulator

Grant holder: **Dr Albert Solernou-Crusat**
Dates: **June 2021 to March 2022**
Funder: **EPSRC Impact Acceleration Account**
Coordinating partner: **Zenzic**
Website: **Virtuocity**

Abstract: Future vehicle testing is expected to take part largely on simulated environments as this will reduce the development costs, allow faster development and crucially, help assess autonomous vehicles. Together with the technical development, Arcadis and Reed Mobility have been commissioned by Zenzic to determine the extent of the opportunity presented by interoperable simulation and how such services can best meet the needs of the industry. The contribution from ITS was to link our HIKER lab to Ford's CAM Testbed network enabling a co-simulation experiment between a pedestrian participant in the HIKER and a driver in the UTAC Millbrook driving simulator. This enabled testing of a new Automated Emergency Brake system developed by Ford. The integration was done using SimulatorD, the software that underpins most of the projects in Virtuocity and developed at the University of Leeds



sfnetworks is designed as a general-purpose software package suitable for use across different application domains

during the past 25 years. Using this approach, we not only open the door to external access to the HIKER but to the rest of the Virtuocity simulators.

Impact: Following a detailed analysis of the interoperable simulator network and messaging system, we demonstrated that the system runs with a very low latency, which is essential for co-simulation experiments. This project has created an interoperable simulation platform that simultaneously brings together the physical and virtual capabilities of different simulators and enables collaboration between different partners by using common standards.

SOFTWARE

The Institute for Transport Studies develops and uses a number of software platforms:

Place Based Carbon Calculator

Developed by Dr Malcolm Morgan this free online tool maps the carbon footprint of every neighbourhood in England. The tool can help communities target their highest carbon-emitting activities.
Website: carbon.place/

APOLLO

Developed by Professor Stephane Hess and Dr David Palma with EU funding, Apollo is a highly flexible package for the specification and estimation of advanced choice models. It is completely free and does not rely on commercial statistical software as a host environment. Apollo relies on R, which is very widely used and works well across different operating systems.

Website: www.apollochoicemodelling.com

Reference: Hess S & Palma D (2019) Apollo: a flexible, powerful and customisable freeware package for choice model estimation and application. Journal of Choice Modelling, Volume 32, 100170

Impact: Apollo is now one of the most widely used software packages for choice modelling. It is used in teaching around the world, and the above paper has been cited over 125 times in the last 3 years.

Propensity to Cycle Tool (PCT)

Developed by Dr Robin Lovelace with colleagues in Cambridge and CycleStreets.net, the Propensity to Cycle Tool is a planning support system to improve cycling provision in regions or at specific points on the road network. PCT has generated many spin-off projects funded, among others, by Local Authorities, Sustrans, Welsh Government and the Irish Government.

Website: pct.bike

Cycling Infrastructure Prioritisation Toolkit

This Rapid Cycleway Prioritisation Tool has been used by many Local Authorities to inform their infrastructure investment.

Website: cyipt.bike/rapid/

Impact: This national tool helped Local Authorities encourage cycling and ensure safe travel for key workers while public transport options were down during the COVID-19 pandemic.

Outputs:

Morgan M & Lovelace R. 2021. Travel Flow Aggregation: Nationally Scalable Methods for Interactive and Online Visualisation of Transport Behaviour at the Road Network Level Environment & Planning B: Planning & Design.

Lovelace R. 2021. Open Source Tools for Geographic Analysis in Transport Planning. Journal of Geographical Systems.

sfnetworks

Developed by Dr Robin Lovelace and colleagues funded by R Consortium, Geospatial networks are graphs embedded in geographical space. Both the nodes and edges in the graph can be represented as geographic features: the nodes most commonly as points, and the edges as linestrings. Geospatial networks play an important role in many domains ranging from transportation planning and logistics to ecology and epidemiology. The structure and characteristics of geospatial networks go beyond standard graph topology, and therefore it is crucial to explicitly take space into account when analysing them. The team created sfnetworks to facilitate such an integrated workflow. Sfnetworks combines the forces of two popular R packages: sf for spatial data science and tidygraph for standard graph analysis. The core of the package is a dedicated data structure for geospatial networks, that can be provided as input to both the graph analytical functions of tidygraph as well as the spatial analytical functions of sf, without the need for conversion.

Additionally, we implemented a set of geospatial network specific functions, such as routines for shortest path calculation, network cleaning and topology modification. sfnetworks is designed as a general-purpose package suitable for use across different application domains, and

can be seamlessly integrated in tidyverse workflows.

Impact: Improved software for spatial network analysis.

Website: luukvdmeer.github.io/sfnetworks/

Portable Emissions (and Other Mobile)

Measurement System Utilities (pems.utils) Developed by Dr Karl Ropkins, this is an R package of utility functions for the handling, analysis and visualisation of data from portable emissions measurement systems (PEMS) and other similar mobile activity monitoring devices. The package includes a dedicated PEMS data class that manages many of the quality control, unit handling and data archiving issues that can hinder efforts to standardise PEMS research.

Website: pems.r-forge.r-project.org/

Lattice Options and Add-Ins (LOA)

Developed by Dr Karl Ropkins, this R package containing various plots and functions that make use of the lattice/trellis plotting framework. The main plots, which include loaPlot(), RgoogleMapsPlot() and trianglePlot(), use panelPal(), a function that extends 'lattice' and 'hexbin' package methods to automate plot subscript and panel-to-panel and panel-to-key synchronization/management.

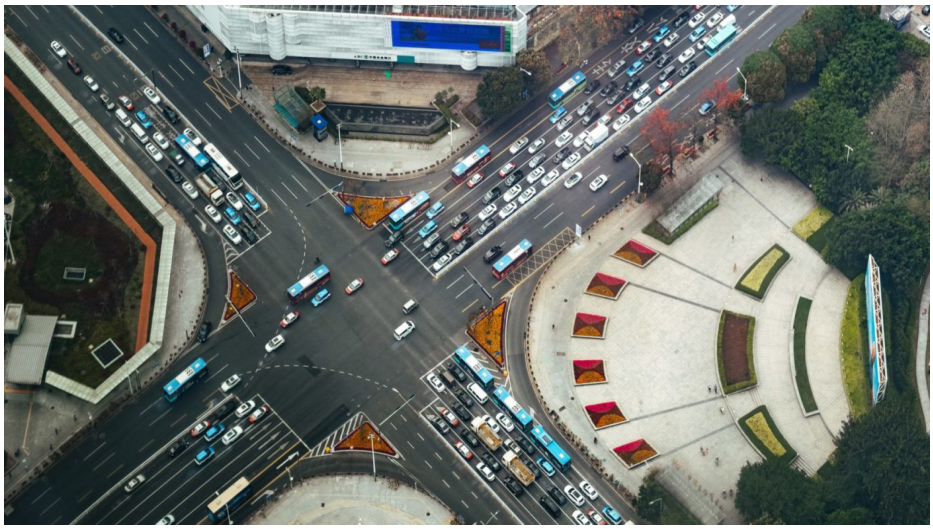
Website: loa.r-forge.r-project.org/loa.intro.html

Stable release version on CRAN: CRAN.R-project.org/package=loa

DRACULA

Developed by Professor Ronghui Liu, the DRACULA software provides detailed junction simulation, among other functionalities, to improve the management of traffic congestion.

Website: dracula-simulation.leeds.ac.uk/



DRACULA software provides detailed junction simulation, among other functionalities, to improve the management of traffic congestion.

SATURN

A powerful and flexible highway

assignment package to create both strategic and local traffic models SATURN has been continuously developed over the last 30 years by the combination of academic theoretical rigour through Dr Dirck Van Vliet and the Institute for Transport Studies, and the practical knowledge of Atkins Limited.

Website: saturnsoftware2.co.uk/

SimulatorD

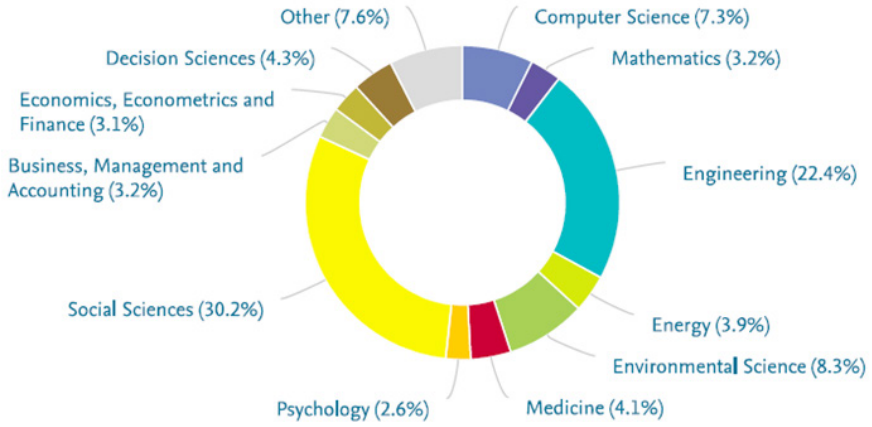
Launched in 2006, the University of Leeds Driving Simulator (UoLDS) continues to be one of the most technically advanced driving simulators in use within a research environment anywhere in the world today – and by far the most advanced in the UK. The facility is supported by SimulatorD software and is used to study the interaction of drivers with new technologies, typically before they are fully implemented on roads and in the vehicle. Realistic and repeatable scenarios allow studies on driver behaviour to be conducted in a safe and controllable environment, substantially reducing the costs associated with the development of real systems, infrastructures or prototypes. The biggest challenges currently being addressed using the UoLDS relate to the emergence of autonomous vehicles – and the need to simulate both the automated vehicle (as a virtual prototype) and to study driver behaviour at higher levels of vehicle automation. Together, this will contribute to the accelerated but safe introduction of AVs.

Universities and museums across Yorkshire and the North of England are to explore the links between railways and the global slave trade, as part of a new research project "Slavery

Publications

The University of Leeds uses peer review and expert judgment as the central component in the assessment of research outputs and wider research performance. It also recognises the value of quantitative metrics in supporting decision-making. The University is committed to responsible research metrics and has signed the San Francisco Declaration on Research Assessment.

In the citations of PUBLICATIONS listed below, authors (including research students) affiliated with the Institute for Transport Studies are highlighted in bold.



ITS publications by subject area - 2016-2020. Courtesy University of Leeds Library Research Support Team and SciVal.

Journal papers

Amaris G, Dawson R, Gironás J, **Hess S**, de Dios Ortúzar J. 2021. From mathematical models to policy design: Predicting greywater reuse scheme effectiveness and water reclamation benefits based on individuals' preferences. *Sustainable Cities and Society*. doi.org/10.1016/j.scs.2021.103132

Amaris G, Gironás J, **Hess S**, de Dios Ortúzar J. 2021. Capturing and analysing heterogeneity in residential greywater reuse preferences using a latent class model. *Journal of Environmental Management*. doi.org/10.1016/j.jenvman.2020.111673

Amaris G, **Hess S**, Gironás J, de Dios Ortúzar J. 2021. Using hybrid choice models to capture the impact of attitudes on residential greywater reuse preferences. *Resources, Conservation and Recycling*. doi.org/10.1016/j.resconrec.2020.105171

An Z, Heinen E, Watling D. 2021. The level and determinants of multimodal travel behavior: Does trip purpose make a difference? *International Journal of Sustainable Transportation*. doi.org/10.1080/15568318.2021.1985195

An Z, Heinen E, Watling D. 2021. When you are born matters: An age-period-cohort analysis of multimodality. *Travel Behaviour and Society*. doi.org/10.1016/j.tbs.2020.09.002

Balijepalli C, Alima D. 2021. Understanding the influence of a downstream-side bus stop on saturation flows at an isolated junction. *Transportation Planning and Technology*. doi.org/10.1080/03081060.2021.1956811

Bastiaanssen J, Johnson D, Lucas K. 2021. Does better job accessibility help people gain employment? The role of public transport in Great Britain. *Urban Studies*. doi.org/10.1177/00420980211012635

Batool Z, Younis M, Yasir A et. al. 2021. Effects of safety pattern, cabin ergonomics, and sleep on work-related stress and burnout of city and transit bus drivers in Lahore, Pakistan. *Ergonomics*. doi.org/10.1080/00140139.2021.1983029

Behrendt F, Cairns S, Raffo D, **Philips I**. 2021. Impact of E-Bikes on Cycling in Hilly Areas: Participants' Experience of Electrically-Assisted Cycling in a UK Study. *Sustainability*. doi.org/10.3390/su13168946

Bešinović N, De Donato L, Flammini F, Goverde R, **Lin Z, Liu R** et. al. 2021. Artificial Intelligence in Railway Transport: Taxonomy, Regulations and Applications. **IEEE Transactions on Intelligent Transportation Systems**. doi.org/10.1109/TITS.2021.3131637

=**Binsuwadan J, De Jong G, Batley R, Wheat P.** 2021. The value of travel time savings in freight transport: a meta-analysis. *Transportation*. doi.org/10.1007/s11116-021-10207-2

Bogacz M, Hess S, Calastri C, Choudhury C et. al. 2021. Modelling risk perception using a dynamic hybrid choice model and brain-imaging data: Application to virtual reality cycling. *Transportation Research Part C: Emerging Technologies*. doi.org/10.1016/j.trc.2021.103435

Calastri C, Pawlak J, Batley R. 2021. Participation in online activities while travelling: an application of the MDCEV model in the context of rail travel. *Transportation*. doi.org/10.1007/s11116-021-10166-8

Camara F, Dickinson P, Fox C. 2021. Evaluating pedestrian interaction preferences with a game theoretic autonomous vehicle in virtual reality. Transportation Research Part F: Traffic Psychology and Behaviour. 410-423 78.

Capurso M, Hess S, Dekker T. 2021. Stated consideration and attribute thresholds in mode choice models: a hierarchical ICLV approach. *European Journal of Transport and Infrastructure Research*. doi.org/10.18757/ejtir.2021.21.3.3982

Chen J, Chen H, Gao J, Dave K, Quaranta R. 2021. Business models and cost analysis of automated valet parking and shared autonomous vehicles assisted by internet of things. Proceedings of the Institution of Mechanical Engineers, *Part D: Journal of Automobile Engineering*. doi.org/10.1177/0954407021994445

Chen X, Li F, Jia B, Wu J, Gao Z, **Liu R**. 2021. Optimizing storage location assignment in an automotive Ro-Ro terminal. *Transportation Research Part B: Methodological*. doi.org/10.1016/j.trb.2020.10.009

Crawford F, **Watling D, Connors R**. 2021. Analysing Spatial Intrapersonal Variability of Road Users Using Point-to-Point Sensor Data. *Networks and Spatial Economics*. doi.org/10.1007/s11067-021-09539-4

de Bok M, **de Jong G**, Wesseling B et.al. 2021. An ex-ante analysis of transport impacts of a distance-based heavy goods vehicle charge in the Netherlands. *Research in Transportation Economics*. doi.org/10.1016/j.retrec.2021.101091

De Jong G, de Bok M, Thoen S. 2021. Seven fat years or seven lean years for freight transport modelling? Developments since 2013. Journal of Transport Economics and Policy.

de Souza F, Larranaga A, **Palma D**, Pitombo C. 2021. Modeling travel mode choice and

characterizing freight transport in a Brazilian context. *Transportation Letters*. doi.org/10.1080/19427867.2021.1976011

Dichabeng P, Merat N, Markkula G. 2021. Factors that influence the acceptance of future shared automated vehicles – A focus group study with United Kingdom drivers. *Transportation Research Part F: Traffic Psychology and Behaviour*. doi.org/10.1016/j.trf.2021.08.009

Distefano N, Leonardi S, Pulvirenti G, ***Romano R, Boer E***, Wooldridge E. 2021. Mining of the association rules between driver electrodermal activity and speed variation in different road intersections. *IATSS Research*. doi.org/10.1016/j.iatssr.2021.12.002

Dixon J, Koukoura S, Brand C, **Morgan M**, Bell K. 2021. Spatially Disaggregated Car Ownership Prediction Using Deep Neural Networks. *Future Transportation*. doi.org/10.3390/futuretransp1010008

Duncan L, Watling D, Connors R, Rasmussen T, Nielsen O. 2021. A bounded path size route choice model excluding unrealistic routes: Formulation and estimation from a large-scale GPS study. Transportmetrica A: *Transport Science*. doi.org/10.1080/23249935.2021.1872730

Etika A, Merat N, Carsten O. 2021. Identifying salient beliefs underlying speeding behaviour: An elicitation study of nigerian drivers. *Transportation Research Interdisciplinary Perspectives*. doi.org/10.1016/j.trip.2020.100279

Ezenwa A, **Whiteing A, Johnson D**, Oledinma A, Ejem E. 2021. Development of strategies to improve information communication technology diffusion in Nigeria's logistics and transport industry: adaptation of structure-process-outcome model. *International Journal of Integrated Supply Management*. doi.org/10.1504/IJISM.2021.118562

Fayyaz M, Bliemer M, Beck M, **Hess S**, van Lint J. 2021. Stated choices and simulated experiences: Differences in the value of travel time and reliability. *Transportation Research Part C: Emerging Technologies*. doi.org/10.1016/j.trc.2021.103145

Fernando M, **Heinen E, Johnson D**. 2021. Exposure, timing, and vulnerability: The role of public transport in inducing gentrification. *Journal of Transport and Land Use*. doi.org/10.5198/jtlu.2021.1897

Fu C, Zhu N, Ma S, **Liu R**. 2021. A two-stage robust approach to integrated station location and rebalancing vehicle service design in bike-sharing systems. *European Journal of Operational Research*. doi.org/10.1016/j.ejor.2021.06.014

Gao J, Chen H, Liu Y et. al. 2021. Comparison of NO and PN emissions between Euro 6 petrol and diesel passenger cars under real-world driving conditions. *Science of The Total Environment*. doi.org/10.1016/j.scitotenv.2021.149789

Gao J, Chen H, Liu Y, Li Y. 2021. Impacts of De-NO_x system layouts of a diesel passenger car on exhaust emission factors and monetary penalty. *Energy Science and Engineering*. doi.org/10.1002/ese3.1001

Gao J, Chen H, Liu Y et. al. 2021. The effect of after-treatment techniques on the correlations between driving behaviours and NOx emissions of passenger cars. *Journal of Cleaner Production*. doi.org/10.1016/j.jclepro.2020.125647

Giannoudis V, Guy S, **Romano R, Carsten O** et. al. 2021. Doctor when can I drive? Braking response after knee arthroplasty: A systematic review & meta-analysis of brake reaction time. *Knee*. doi.org/10.1016/j.knee.2021.03.013

Grote M, Pilko A, … **Marsden G**. 2021. Pathways to unsegregated sharing of airspace: views of the uncrewed aerial vehicle (UAV) industry. *Drones*. doi.org/10.3390/drones5040150

Hall S, **Anable J**, Hardy J et. al. 2021. Innovative energy business models appeal to specific consumer groups but may exacerbate existing inequalities for the disengaged. *Nature Energy*. doi.org/10.1038/s41560-021-00821-w

Hall S, **Anable J**, Hardy J et. al. 2021. Matching consumer segments to innovative utility business models (Author Correction). *Nature Energy*. doi.org/10.1038/s41560-021-00809-6

Hancock T, Hess S. 2021. What is really uncovered by mixing different model structures: Contrasts between latent class and model averaging. *European Journal of Transport and Infrastructure Research*. doi.org/10.18757/ejtir.2021.21.3.3949

Hancock T, Hess S, Marley A, **Choudhury C**. 2021. An accumulation of preference: Two alternative dynamic models for understanding transport choices. *Transportation Research Part B: Methodological*. doi.org/10.1016/j.trb.2021.04.001

Harrison G, Grant-Muller S, Hodgson F. 2021. A review of transport-health system dynamics models. *Journal of Transport & Health*. doi.org/10.1016/j.jth.2021.101138

Harrison G, Shepherd S, Chen H. 2021. Modelling Uptake Sensitivities of Connected and Automated Vehicle Technologies. International *Journal of System Dynamics Applications*. doi.org/10.4018/ijsda.2021040106

Hetherington R, Toufique Hasan A, Khan A, Roy D, Salehin M, **Wadud Z.** 2021. Exposure risk analysis of COVID-19 for a ride-sharing motorbike taxi. *Physics of Fluids*. doi.org/10.1063/5.0069454

Huan N, **Hess**, Yao E. 2021. Understanding the effects of travel demand management on metro commuters' behavioural loyalty: a hybrid choice modelling approach. *Transportation*. doi.org/10.1007/s11116-021-10179-3

Huan N, **Hess S,** Yao E, Liu W. 2021. Time-dependent pricing strategies for metro lines considering peak avoidance behaviour of commuters. *Transportmetrica A: Transport Science*. doi.org/10.1080/23249935.2021.1946203

Jia D, **Chen H**, Zheng Z, **Watling D, Connors R, Gao J**, Li Y. 2021. An Enhanced Predictive Cruise Control System Design with Data-Driven Traffic Prediction. *IEEE Transactions on Intelligent Transportation Systems*. doi.org/10.1109/TITS.2021.3076494

Jiang L, Hagen-Zanker A, Kumar P, Pritchard J. 2021. Equity in job accessibility and environmental quality in a segmented housing market: The case of Greater London. *Journal of Transport Geography*. doi.org/10.1016/j.jtrangeo.2020.102908

Jiang W, Yuan D, Sha A, **Huang Y**, Shan J, Li P. 2021. Design of a Novel Road Pavement Using Steel and Plastics to Enhance Performance, Durability and Construction Efficiency. *Materials*. doi.org/10.3390/ma14030482

Kalantari A, Monavar Yazdi S, Hill T, Moghaddam A, Ayati E, Sullman M. 2021. Psychosocial factors associated with the self-reported frequency of cell phone use while driving in Iran. *PLoS ONE*. doi.org/10.1371/journal.pone.0249827

Kalatian A, Farooq B. 2021. Decoding pedestrian and automated vehicle interactions using immersive virtual reality and interpretable deep learning. *Transportation Research Part C: Emerging Technologies*. doi.org/10.1016/j.trc.2020.102962

Kang Z, **Nash C, Smith A**, Wu J. 2021. Railway access charges in China: A comparison with Europe and Japan. *Transport Policy*. doi.org/10.1016/j.tranpol.2021.04.022

Ketphat N, Whiteing A, Liu R. 2021. State movement for controlling trains operating under the virtual coupling system. Proceedings of the Institution of Mechanical Engineers, Part F: *Journal of Rail and Rapid Transit*. doi.org/10.1177/09544097211043747

Lambert E, Romano R, Watling D. 2021. Optimal Smooth Paths Based on Clothoids for Car-like Vehicles in the Presence of Obstacles. *International Journal of Control, Automation and Systems*. doi.org/10.1007/s12555-020-0179-1

Lee YM, Madigan R, Uzondu C, **Garcia J, Romano R, Markkula G, Merat N**. 2021.

Learning to interpret novel eHMI: The effect of vehicle kinematics and eHMI familiarity on pedestrian' crossing behavior. *Journal of Safety Research*. doi.org/10.1016/j.jsr.2021.12.010

Lehtonen E, Malin F, Innamaa S, Nordhoff S, **Louw T,** Bjorvatn A, **Merat N**. 2021. Are multimodal travellers going to abandon sustainable travel for L3 automated vehicles? *Transportation Research Interdisciplinary Perspectives*. doi.org/10.1016/j.trip.2021.100380

Li S, **Liu R**, Gao Z, Yang L. 2021. Integrated train dwell time regulation and train speed profile generation for automatic train operations on high-density metro lines: A distributed optimal control method. *Transportation Research Part B: Methodological*. doi.org/10.1016/j.trb.2021.04.009

Liao P, Tang T-Q, **Liu R**, Huang H-J. 2021. An eco-driving strategy for electric vehicle based on the powertrain. *Applied Energy*. doi.org/10.1016/j.apenergy.2021.117583

Liu Q, **An Z**, Liu Y, Ying W, Zhao P. 2021. Smartphone-based services, perceived accessibility, and transport inequity during the COVID-19 pandemic: A cross-lagged panel study. *Transportation Research Part D: Transport and Environment*. doi.org/10.1016/j.trd.2021.102941

Liu Q, Liu Y, Zhang C, **An Z**, Zhao P. 2021. Elderly mobility during the COVID-19 pandemic: A qualitative exploration in Kunming, China. *Journal of Transport Geography*. doi.org/10.1016/j.jtrangeo.2021.103176

Liu Q, Lu D, Jiang R, Han X, **Liu R**, Gao Z. 2021. Departure time choice behavior in commute problem with stochastic bottleneck capacity: Experiments and modeling. *Transportmetrica A: Transport Science*. doi.org/10.1080/23249935.2021.1978590

Liu Y, Chen H, Gao J, Li Y, **Dave K, Chen J** et.al. 2021. Comparative analysis of non-exhaust airborne particles from electric and internal combustion engine vehicles. *Journal of Hazardous Materials*. doi.org/10.1016/j.jhazmat.2021.126626

Liu Y, Chen H, Li Y, **Gao J, Dave K** et. al. 2021. Exhaust and non-exhaust emissions from conventional and electric vehicles: A comparison of monetary impact values. *Journal of Cleaner Production*. doi.org/10.1016/j.jclepro.2021.129965

Liu Y, Fan C, Wang X, Liu F, **Chen H**. 2021. Thermally induced variations in the nanostructure and reactivity of soot particles emitted from a diesel engine. *Chemosphere*. doi.org/10.1016/j.chemosphere.2021.131712

Liu Y, **Liu R**, Wei C, Xun J, Tang T. 2021. Distributed model predictive control strategy for constrained high-speed virtually coupled train set. *IEEE Transactions on Vehicular Technology*. doi.org/10.1109/TVT.2021.3130715

Liu Y, Song C, Lv G, Zhang W, **Chen H**. 2021. Evaluation of the oxidative reactivity and electrical properties of soot particles. *Carbon*. doi.org/10.1016/j.carbon.2021.02.086

Lizana M, Carrasco J, Victoriano R. 2021. Daily activity-travel and fragmentation patterns in the weekly cycle: evidence of the role of ICT, time use, and personal networks. *Transportation Letters*. doi.org/10.1080/19427867.2021.1879623

Lizana M, Tudela A, Tapia A. 2021. Analysing the influence of attitude and habit on bicycle commuting. *Transportation Research Part F: Traffic Psychology and Behaviour*. doi.org/10.1016/j.trf.2021.07.015

Lokesh K, Marsden G. 2021. Estimates of the carbon impacts of commute travel restrictions due to Covid-19 in the UK. *Transport Findings*. doi.org/10.32866/001c.21574

Louw T, Madigan R, Lee YM, … **Merat N.** 2021. Drivers' Intentions to Use Different Functionalities of Conditionally Automated Cars: A Survey Study of 18,631 Drivers from 17 Countries. *International Journal of Environmental Research and Public Health*. doi.org/10.3390/ijerph182212054

Lovelace R. 2021. Open Source Tools for Geographic Analysis in Transport Planning. *Journal of Geographical Systems*. doi.org/10.1007/s10109-020-00342-2

Lu H, **Hess S**, Daly A, et. al. 2021. Using state-of-the-art models in applied work: Travellers willingness to pay for a toll tunnel in Copenhagen. *Transportation Research Part A: Policy and Practice*. doi.org/10.1016/j.tra.2021.06.021

Lucas K, **Philips I**, Verlinghieri E. 2021. A mixed methods approach to the social assessment of transport infrastructure projects. *Transportation*. doi.org/10.1007/s11116-021-10176-6

Ma F, Dong W, Fu Z, Wang R, **Huang Y**, Liu J. 2021. Life cycle assessment of greenhouse gas emissions from asphalt pavement maintenance: A case study in China. *Journal of Cleaner Production*. doi.org/10.1016/j.jclepro.2020.125595

Ma F, Li C, Fu Z, **Huang Y**, Dai J, Feng Q. 2021. Evaluation of high temperature rheological performance of polyphosphoric acid-SBS and polyphosphoric acid-crumb rubber modified asphalt. C*onstruction and Building Materials*. doi.org/10.1016/j.conbuildmat.2021.124926

Madigan R, Lee YM, Merat N. 2021. Validating a methodology for understanding pedestrian – vehicle interactions: A comparison of video and field observations. Transportation Research Part F: Traffic Psychology and Behaviour. doi.org/10.1016/j.trf.2021.05.006

Maggi D, Romano R, Carsten O. 2021. Handing control back to drivers: Exploring the effects of handover procedure during transitions from Highly Automated Driving. *Transportation Research Part F: Traffic Psychology and Behaviour*. doi.org/10.1016/j.trf.2021.11.008

Mao B, Lu X, Huang J, Ho T, **Chen H**. 2021. On Development Path of Hydrogen Energy Technology in China's Transportation System Under Carbon Neutrality Goal. *Jiaotong Yunshu Xitong Gongcheng Yu Xinxi/Journal of Transportation Systems Engineering and Information Technology*. doi.org/10.16097/j.cnki.1009-6744.2021.06.027

Markkula G, Uludağ Z, Wilkie R, Billington J. 2021. Accumulation of continuously time-varying sensory evidence constrains neural and behavioral responses in human collision threat detection. *PLoS Computational Biology*. doi.org/10.1371/journal.pcbi.1009096

Marsden G, Anable J. 2021. Behind the Targets? The Case for Coherence in a Multi-Scalar Approach to Carbon Action Plans in the Transport Sector. *Sustainability*. doi.org/10.3390/su13137122

Marsden G, Docherty I. 2021. Mega-disruptions and policy change: Lessons from the mobility sector in response to the Covid-19 pandemic in the UK. *Transport Policy*. doi.org/10.1016/j.tranpol.2021.05.015

Mole C, Pekkanen J, Sheppard W, **Markkula G**, Wilkie R. 2021. Drivers use active gaze to monitor waypoints during automated driving. *Scientific Reports*. doi.org/10.1038/s41598-020-80126-2

Mouter N, Koster P, **Dekker T**. 2021. Contrasting the recommendations of participatory value evaluation and cost-benefit analysis in the context of urban mobility investments. *Transportation Research Part A: Policy and Practice*. doi.org/10.1016/j.tra.2020.12.008

Mouter N, Koster P, **Dekker T**. 2021. Participatory value evaluation for the evaluation of flood protection schemes. *Water Resources and Economics*. doi.org/10.1016/j.wre.2021.100188

Mullen C. 2021. Fairness in transitions to low-carbon mobility. *One Earth*. doi.org/10.1016/j.oneear.2021.02.001

Mullen C. 2021. Why Mobility Justice Means Prioritising Accessible Walking Environments. *Active Travel Studies 1*. doi.org/10.16997/ats.1066

Nash C. Smith A. Fitzova H. 2021. Progress in implementing the Commission's targets for mode split. Network Industries Quarterly, Vol. 23, issue 4.

Ngoduy D, Hoang N, Vu H, **Watling D.** 2021. Multiclass dynamic system optimum solution for mixed traffic of human-driven and automated vehicles considering physical queues. *Transportation Research Part B: Methodological*. doi.org/10.1016/j.trb.2020.12.008

Nikiforiadis A. **Paschalidis E**, et. al. 2021. Analysis of attitudes and engagement of shared e-scooter users. *Transportation Research Part D: Transport and Environment*. doi.org/10.1016/j.trd.2021.102790

Nugroho T, **Balijepalli C, Whiteing A**. 2021. Independent Retailer Restocking Choices in Urban Goods Movement and Interaction Effects with Traditional Markets. *Networks and Spatial Economics*. doi.org/10.1007/s11067-021-09555-4

Nuñez Velasco J, **Lee YM**, Uttley J, **Solernou A, … Merat N**. 2021. Will pedestrians cross the road before an automated vehicle? The effect of drivers' attentiveness and presence on pedestrians' road crossing behavior. *Transportation Research Interdisciplinary Perspectives*. doi.org/10.1016/j.trip.2021.100466

Palma D, Enam A, **Hess S, Calastri C**, Crastes dit Sourd R. 2021. Modelling multiple occurrences of activities during a day: an extension of the MDCEV model. *Transportmetrica B: Transport Dynamics*. doi.org/10.1080/21680566.2021.1900755

Paschalidis E, Choudhury C, Hess S. 2021. From driving simulator experiments to field traffic application: Improving the transferability of car-following models. *Journal of Transportation Engineering, Part A: Systems*. doi.org/10.1061/JTEPBS.0000468

Pekkanen J, Giles O, **Lee YM**, Madigan R, Daimon T, **Merat N, Markkula G**. 2021. Variable-Drift Diffusion Models of Pedestrian Road-Crossing Decisions. *Computational Brain & Behavior*. doi.org/10.1007/s42113-021-00116-z

Perrier M, Louw T, Carsten O. 2021. User-centred design evaluation of symbols for adaptive cruise control (ACC) and lane-keeping assistance (LKA). *Cognition, Technology and Work*. doi.org/10.1007/s10111-021-00673-0

Philips I, Anable J, Chatterton T. 2021. E-bikes and their capability to reduce car CO2 emissions. *Transport Policy*. doi.org/10.1016/j.tranpol.2021.11.019

Philips I, Mattioli G, **Anable J**. 2021. Spatial Analysis of Dog Ownership and Car Use in the UK. *Transport Findings*. doi.org/10.32866/001c.29846

Romano R, Maggi D, Hirose T, Broadhead Z, **Carsten O**. 2021. Impact of lane keeping assist system camera misalignment on driver behavior. *Journal of Intelligent Transportation Systems*. doi.org/10.1080/15472450.2020.1822174

Sarkar A, Hickman J, McDonald A, Huang W, Vogelpohl T, **Markkula G**. 2021. Steering or braking avoidance response in SHRP2 rear-end crashes and near-crashes: A decision tree approach. *Accident Analysis and Prevention*. doi.org/10.1016/j.aap.2021.106055

Satsukawa K, Wada K, **Watling D**. 2021. Dynamic system optimal traffic assignment with atomic users: Convergence and stability. *Transportation Research Part B: Methodological*. doi.org/10.1016/j.trb.2021.11.001

Schindler **M, Wang J, Connors R**. 2021. A two-stage residential location and transport mode choice model with exposure to traffic-induced air pollution. *Journal of Transport Geography*. doi.org/10.1016/j.jtrangeo.2021.103044

Serpush F, **Rezaei M**. 2021. Complex Human Action Recognition Using a Hierarchical Feature Reduction and Deep Learning-Based Method. *SN Computer Science*. doi.org/10.1007/s42979-021-00484-0

Sharifi A, Zibaei A, **Rezaei M**. 2021. A deep learning based hazardous materials (HAZMAT) sign detection robot with restricted computational resources. *Machine Learning with Applications*. doi.org/10.1016/j.mlwa.2021.100104

Signori-Müller C, … **Talbot J**. 2021. Non-structural carbohydrates mediate seasonal water stress across Amazon forests. *Nature Communications*. doi.org/10.1038/s41467-021-22378-8

Smith A, Odolinski O, … Wheat P. 2021. Estimating the marginal maintenance cost of different vehicle types on rail infrastructure. *Proceedings of the Institution of Mechanical Engineers Part F: Journal of Rail and Rapid Transit*. doi.org/10.1177/0954409721991309

Song F, Hess S, Dekker T. 2021. A joint model for stated choice and best-worst scaling data using latent attribute importance: application to rail-air intermodality. *Transportmetrica A: Transport Science*. doi.org/10.1080/23249935.2020.1779384

Srinivasan A, Hasan M, **Lin Y-S** Leonetti M, Billington J, **Romano R, Markkula G**. 2021. Comparing merging behaviors observed in naturalistic data with behaviors generated by a machine learned model. *2021 IEEE International Intelligent Transportation Systems Conference (ITSC)*. doi.org/10.1109/itsc48978.2021.9564791

Starkey P, **Batool Z**, Younis E, Rehman A, Ali M. 2021. Motorcycle three-wheelers in Pakistan: Low-cost rural transport services, crucial for women's mobility. *Transportation Research Interdisciplinary Perspectives*. doi.org/10.1016/j.trip.2021.100479

Sudmant A, Viguié V, Lepetit Q, Oates L, Datey A, Gouldson G, **Watling D**. 2021. Fair Weather Forecasting? The Shortcomings of Big Data for Sustainable Development, a case study from Huballi-Dharwad, India. *Sustainable Development*. doi.org/10.1002/sd.2221

Svärd M, **Markkula G**, Bärgman J, Victor T. 2021. Computational modeling of driver pre-crash brake response, with and without off-road glances: Parameterization using real-world crashes and near-crashes. *Accident Analysis and Prevention*. doi.org/10.1016/j.aap.2021.106433

Tabone W, de Winter J, … **Merat N**. 2021. Vulnerable road users and the coming wave of automated vehicles: Expert perspectives. *Transportation Research Interdisciplinary Perspectives*. doi.org/10.1016/j.trip.2020.100293

Tang T, Fonzone A, **Liu R, Choudhury C**. 2021. Multi-stage deep learning approaches to predict boarding behaviour of bus passengers. *Sustainable Cities and Society*. doi.org/10.1016/j.scs.2021.103111

Tapia R, **de Jong G**, Larranaga A, Bettella Cybis H. 2021. Exploring Multiple-discreteness in Freight Transport. A Multiple Discrete Extreme Value Model Application for Grain Consolidators in Argentina. *Networks and Spatial Economics*. doi.org/10.1007/s11067-021-09531-y

Tengilimoglu O, Wadud Z. 2021. Evaluating the mileage and time efficiency of ridesourcing services: Austin, Texas case. *Transportation Letters*. doi.org/10.1080/19427867.2021.1892936

Tran C, Keyvan-Ekbatani M, Ngoduy D, **Watling D**. 2021. Stochasticity and environmental cost inclusion for electric vehicles fast-charging facility deployment. Transportation Research Part E: Logistics and Transportation Review. doi.org/10.1016/j.tre.2021.102460

Tu R, Li T, … **Chen H, Li Y, Gao J, Liu Y.** 2021. Real-world Emissions of Construction Mobile Machines and Comparison to a Non-road Emission Model. *Science of The Total Environment*. doi.org/10.1016/j.scitotenv.2021.145365

van den Broek-Altenburg E, Atherly A, **Hess S**, Benson J. 2021. The effect of unobserved preferences and race on vaccination hesitancy for COVID-19 vaccines: implications or health disparities. *Journal of Managed Care & Specialty Pharmacy.* doi.org/10.18553/jmcp.2021.27.9-a.s2

Vidal Tortosa E, Lovelace R, Heinen E, Mann R. 2021. Cycling behaviour and socioeconomic disadvantage: an investigation based on the English National Travel Survey. *Transportation Research Part A: Policy and Practice*. doi.org/10.1016/j.tra.2021.08.004

Vidal Tortosa E, Lovelace R, Heinen, Mann R. 2021. Infrastructure is not enough: Interactions between the environment, socioeconomic disadvantage, and cycling participation in England. *Journal of Transport and Land Use*. doi.org/10.5198/jtlu.2021.1781

Vidal Tortosa E, Lovelace R, Heinen, Mann R. 2021. Socioeconomic inequalities in cycling safety: An analysis of cycling injury risk by residential deprivation level in England. *Journal of Transport and Health*. doi.org/10.1016/j.jth.2021.101291

Vitello P, Fiandrino C, Capponi A, Klopp P, **Connors R**, Viti F. 2021. The Impact of SARS-COVID-19 Outbreak on European Cities Urban Mobility. *Frontiers in Future Transportation*. doi.org/10.3389/ffutr.2021.666212

Wadud Z, Chintakayala P. 2021. To own or not to own – That is the question: The value of owning a (fully automated) vehicle. *Transportation Research Part C: Emerging Technologies*. doi.org/10.1016/j.trc.2021.102978

Wadud Z, Huda F. 2021. Fully automated vehicles: The use of travel time and its association with intention to use. *Proceedings of the Institution of Civil Engineers: Transport*. doi.org/10.1680/jtran.18.00134

Wadud Z, Mattioli G. 2021. Fully automated vehicles: A cost-based analysis of the share of ownership and mobility services, and its socio-economic determinants. *Transportation Research Part A: Policy and Practice*. doi.org/10.1016/j.tra.2021.06.024

Wang Y, Zhou H, **Choudhury C**. 2021. Editorial: Special TRF issue on Sustainable Transport. *Transportation Research Part F: Traffic Psychology and Behaviour*. doi.org/10.1016/j.trf.2021.08.012

Wardman M, Batley R. 2021. The demand impacts of train punctuality in great britain: systematic review, meta-analysis and some new econometric insights. *Transportation*. doi.org/10.1007/s11116-021-10186-4

Webb E, **Hess S**. 2021. Joint modelling of choice and rating data: Theory and examples. *Journal of Choice Modelling*. doi.org/10.1016/j.jocm.2021.100304

Webb E, … **Hess S**, Murray J. 2021. Attribute selection for a discrete choice experiment incorporating a best-worst scaling survey. *Value in Health*. doi.org/10.1016/j.jval.2020.10.025

Wei C, **Paschalidis E, Merat N, Solernou A, Hajiseyedjavadi F, Romano R**. 2021. Human-like Decision Making and Motion Control for Smooth and Natural Car Following. *IEEE Transactions on Intelligent Vehicles.* doi.org/10.1109/TIV.2021.3098184

Weintrob A, Hansell L, Zebracki M, **Barnard Y,** Lucas K. 2021. Queer Mobilities: Critical LGBTQ Perspectives of Public Transport Spaces. *Mobilities*. doi.org/10.1080/17450101.2021.1958249

Woodcock J, Aldred R, **Lovelace R**, Strain T, Goodman A. 2021. Health, environmental and distributional impacts of cycling uptake: The model underlying the Propensity to Cycle tool for England and Wales. *Journal of Transport and Health*. doi.org/10.1016/j.jth.2021.101066

Wu W, Lin Y, **Liu R**, Jin W. 2021. The multi-depot electric vehicle scheduling problem with power grid characteristics. *Transportation Research Part B: Methodological.* doi.org/10.1016/j.trb.2021.11.007

Wu W, Lin Y, **Liu R**, Li Y, Zhang Y, Ma C. 2021. Online EV Charge Scheduling Based on Time-of-Use Pricing and Peak Load Minimization: Properties and Efficient Algorithms. *IEEE Transactions on Intelligent Transportation Systems*. doi.org/10.1109/TITS.2020.3014088

Xiao L-L, Liu T-L, Huang H-J, **Liu R**. 2021. Temporal-spatial allocation of bottleneck capacity for managing morning commute with carpool. *Transportation Research Part B: Methodological*. doi.org/10.1016/j.trb.2020.11.007

Yitong M, **Johnson D, Wang J**, Shi X. 2021. Competition for rail transport services in duopoly market: Case study of China Railway (CR) Express in Chengdu and Chongqinq. *Research in Transportation Business and Management*. doi.org/10.1016/j.rtbm.2020.100529

Zannat K, Choudhury C, Hess S. 2021. Modelling departure time choice of car commuters in Dhaka, Bangladesh. *Transportation Research Record*. doi.org/10.1177/03611981211039840

Zannat K, Bhaduri E, Goswami A, **Choudhury C**. 2021. The tale of two countries: Modelling the effects of COVID-19 on shopping behaviour in Bangladesh and India. *Transportation Letters*. doi.org/10.1080/19427867.2021.1892939

Zhang A, Li T, Tu R, Dong C, **Chen H, Gao J, Liu Y**. 2021. The Effect of Nonlinear Charging Function and Line Change Constraints on Electric Bus Scheduling. *Promet - Traffic&Transportation*. doi.org/10.7307/ptt.v33i4.3730

Zhang Y, Chen Z, Li G, Liu Y, **Chen H**, Cunningham G, Early J. 2021. Machine Leaning Based Vehicle Model Construction and Validation -Towards Optimal Control Strategy Development for Plug-in Hybrid Electric Vehicles. *IEEE Transactions on Transportation Electrification.* doi.org/10.1109/tte.2021.3111966

Zhang Y, Huang Y, **Chen H**, Na X, Chen Z, Liu Y. 2021. Driving behavior oriented torque demand regulation for electric vehicles with single pedal driving. *Energy*. doi.org/10.1016/j.energy.2021.120568

Zhou Z, Wang Y, **Liu R**, Wei C, Du H, Yin C. 2021. Short-Term Lateral Behavior Reasoning for Target Vehicles Considering Driver Preview Characteristic. IEEE Transactions on Intelligent Transportation Systems. doi.org/10.1109/TITS.2021.3107310

Conference papers

Khatibi S, Teimouri M, **Rezaei M**. 2021. Real-time Active Vision for a Humanoid Soccer Robot Using Deep Reinforcement Learning. *International Conference on Agents and Artificial Intelligence*. doi.org/10.5220/0010237307420751

Liu Y, Chen H, Gao J, Dave K, Chen J. 2021. Gap analysis and future needs of tire wear particles. SAE Technical Papers, *SAE WCX Digital Summit*. doi.org/10.4271/2021-01-0621

Louw T, Madigan R, Lee YM, De Marco C, Mallada J, **Merat N**. 2021. Don't Worry, I'm in Control! Is Users' Trust in Automated Driving Different When Using a Continuous Ambient Light HMI Compared to an Auditory HMI? *13th International Conference on Automotive User Interfaces and Interactive Vehicular Applications*. doi.org/10.1145/3473682.3481875

Mirnig A, Marcano M, … **Madigan R**. 2021. Workshop on Exploring Interfaces for Enhanced Automation Assistance for Improving Manual Driving Abilities. *13th International Conference on Automotive User Interfaces and Interactive Vehicular Applications*. doi.org/10.1145/3473682.3477441

Solernou A, Paschalidis E, Hasan M, Wang H, **Markkula G, Romano R**. 2021. Performance comparison of lane-changing models for merging scenarios in traffic simulation for driving simulators. Proceedings

of the Driving Simulation Conference 2021 Europe VR.

Tabone W, **Lee YM, Merat N**, Happee R, de Winter J. 2021. Towards future pedestrian-vehicle interactions: Introducing theoretically-supported AR prototypes. *AutomotiveUI '21*. doi.org/10.1145/3409118.3475149

Books and Book Chapters

Buehler R, **Heinen E**, Nakamura K. 2021. Bicycle Parking. In: Pucher J, Buehler R (eds.) Cycling for Sustainable Cities. MIT Press, 103-118.

De Jong G, Sharma M, et. al. 2021. Analysis of route and mode transport choice in Eastern South Asia following integration agreements. In: Herrera Dappe M, Kunaka C (eds.) *Connecting to Thrive Challenges and Opportunities of Transport Integration in Eastern South Asia*. World Bank Publications, 49-82. doi.org/10.1596/978-1-4648-1635-2_ch2

De Jong G, Tavasszy L. 2021. Modelling mode choice in freight transport. In: Vickerman R (ed.) *International Encyclopedia of Transportation. Elsevier* 57-62. doi.org/10.1016/B978-0-08-102671-7.10407-5

Grant-Muller S, … Crawford F, **Choudhury C**, Cunningham T, **Harrison G, Hodgson F, … Tsoleridis P**. 2021. Technology enabled data for sustainable transport policy. In: Vickerman R (ed.) *International Encyclopedia of Transportation*, 135-141. DOI: 10.1016/B978-0-08-102671-7.10627-X

Heinen E, Handy S. 2021. Programs and Policies Promoting Cycling. In: Pucher J, Buehler R (eds.) Cycling for Sustainable Cities. MIT Press, 119-136.

Mariel P, Hoyos D, Meyerhoff J, Czajkowski M, **Dekker T**, et.al. 2021. *Environmental Valuation with Discrete Choice Experiments. Springer International Publishing*. DOI: 10.1007/978-3-030-62669-3

Odolinski K, Wheat P. 2021. Rail cost functions. In: Vickerman R (eds.) *International Encyclopedia of Transportation. Elsevier*, pp. 425-430. DOI: 10.1016/B978-0-08-102671-7.10080-6

Pangbourne K, Attard M. 2021. Transitions and disruptive technologies in transport planning. In: Vickerman R (eds.) *International Encyclopedia of Transportation. Elsevier.* 309-313. DOI: 10.1016/B978-0-08-102671-7.10700-6

Wheat P, Odolinski O, Smith A. 2021. Applications of Production Theory in Transportation. In: Ray S, Chambers R, Kumbhakar S (eds.) Handbook of Production Economics. Springer 1-34.

Reports

Anable J, Marsden G. 2021. Covid-19 Transport, Travel and Social Adaptation Study: Understanding behaviour change with neighbourhood characteristics. Centre for Research into Energy Demand Solutions. Oxford, UK. ISBN: 978-1-913299-12-5

Marsden G, Anable J, Docherty I, Brown L. 2021. At a crossroads: Travel adaptations during Covid-19 restrictions and where next? Centre for Research into Energy Demand Solutions: Oxford. ISBN 978-1-913299-08-8

Marsden G, Anable J, Brown L, Docherty I. 2021. House of Lords Covid Committee: inquiry into the long-term impact of the pandemic on the UK's towns and cities. CREDS consultation response.

Ojeda-Cabral M, Batley R, Johnson D. 2021. Rail Openings Appraisal: Review and development of appraisal practice for new railway lines, stations and services. Project page (with non-technical-summary): www.sparkrail.org/Lists/Records/DispForm.aspx?ID=27517
Full technical report: www.sparkrail.org/Lists/Records/DispForm.aspx?ID=27518
published by RSSB

Rahman SM, Enam A, Sohel Mahmud S, **Wadud Z**. 2021. Links between Transport, Air Quality and COVID-19 Spread in Bangladesh

Wadud Z, Rahman S, Enam A. 2021. Modelling the links between transport, air quality and COVID-19 spread using naturalistic data from Dhaka and Bangladesh

Weber H, Hiller J, Eckstein L, Metz B, Landau A, **Lee YM, Louw T, Madigan R, Merat N** et.al. 2021. L3Pilot Deliverable D7.3: Pilot evaluation results.

Metric	Publication share	Citations per Publication	Field-Weighted Citation Impact
International collaboration	58.8%	18.9	2.15
Only national collaboration	15.4%	15.8	1.74
Only institutional collaboration	19.8%	14.7	1.37
Single authorship	6.0%	7.9	0.95
Academic - corporate collaboration	6%		

ITS Journal metrics

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Barnard, Yvonne	ARCADE, PAsCAL
Batley, Richard	Rail Openings Appraisal, RSSB Partnership
Batool, Zahara	Covid Exposure Risk, HITRANS MaaS, VITALISE
Boussad, Yanis	TRACK
Brown, Llinos	TRANSAS
Calastri, Chiara	RSSB Partnership, Shift2MaaS, TOZCA
Campbell, Morgan	E-DRONE, Serious Games, Sustaining Active Travel Neighbourhoods
Cass, Noel	STEP, UK-CREDS
Chen, Haibo	HETMAR, MODALES, PAsCAL, nPETS
Choudhury, Charisma	NEXUS, SPARC-IIT Kharagpur, TOZCA
Cirino- Goncalves, Rafael	Seeing Machines Fellowship
Daly, Michael	L3PILOT, Trustonomy
Dave, Kaushali	PAsCAL
Dekker, Thijs	RSSB Partnership
Gao, Jianbing	HETMAR, MODALES
Garcia de Pedro, Jorge	COMMOTIONS, HAROLD, HIKER, HumanDrive Extension, L3PILOT, NOVA VIDA
Grant-Muller, Susan	COVID-19 Leeds Lifeband, KARMA, Micromobility Behavior, RAIM, TRACK
Haines-Doran, Thomas	UK-CREDS
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Hancock, Thomas	NEXUS
Harrison, Gillian	COVID-19 Leeds Lifeband, InExiTI, KARMA, U-PASS
Heinen, Eva	COCOMO, ELEVATE
Hess, Stephane	APOLLO, PT Electrification
Hodgson, Frances	COVID-19 Leeds Lifeband, KARMA, RAIM, TRACK
Horrobin, Anthony	HAROLD, L3PILOT, Trustonomy
Jamson, Samantha	uCARe, Trustonomy
Jiang, Li-Ke	Land Value and Transport, PAsCAL, West Coast Main Line Property Impacts
Johnson, Daniel	Land Value and Transport, Rail Openings Appraisal, RSSB Partnership , Shift2MaaS, West Coast Main Line Property Impacts
Kalantari, Amir	SHAPE IT
Kalatian, Arash	NEXUS
Lee, Yee-Mun	L3PILOT
Lin, Han and Transport	Bus Demand, CQC Efficiency Network, Land Value
Lin, Yi-Shin	COMMOTIONS
Lin, Zhiyuan	aVSTP, MODALES, RAILSa
Liu, Ronghui	AI – ATO, aVSTP, PT Electrification, RAILSa
Liu, Ye	HETMAR, MODALES, nPETS
Lokesh, Kadambari	Decarbon8, Shared Digital Carbon
Louw, Tyron	L3PILOT
Lovelace, Robin	Active travel in new developments, AFRIMAPR, CYCLEMON, Data Science Fellowship, Evaluate Local NO2 plans, GIGWORK, PCT, Safer Roads Map, Sustaining Active Travel Neighbourhoods, TIICYCLING, UNCCUT
Ma, Xiaoxiao	ASSETS4RAIL, Shift2MaaS, TIES
Madigan, Ruth	First Bus, L3PILOT
Markkula, Gustav	COMMOTIONS, SHAPE IT
Marsden, Greg	Cut Carbon Network, DecarboN8, E-DRONE, TRANSAS, UK-CREDS
Matthews, Bryan	PAsCAL, SUITCEYES
Merat, Natasha	ARCADE, First Bus, HAROLD, HIKER, HumanDrive Extension, L3PILOT, Seeing Machines Fellowship, SHAPE IT
Morgan, Malcolm	OPTIC, Safer Roads Map, Shared Digital Carbon, UK-CREDS, UNCCUT
Mullen, Caroline	COCOMO, U-PASS
Munir, Said	HETMAR, MODALES, nPETS
Nash, Chris	RSSB Partnership
Nellthorp, John	Land Value and Transport , nPETS, West Coast Main Line Property Impacts
Odolinski, Kristofer	GEARBODIES, IN2ZONE, NEXTGEAR
Ojeda-Cabral, Manuel	ASSETS4RAIL, Land Value and Transport, Rail Openings Appraisal, RSSB Partnership , West Coast Main Line Property Impacts
Ozturk, Ibrahim	HAROLD
Palma, David	APOLLO, PT Electrification
Pangbourne, Kate	ADAPT, HITRANS MaaS
Paschalidis, Evangelos	PAsCAL, nPETS
Pattinson, Jo-Ann	ARCADE, RAILSb, RoAD, U-PASS
Peng, Chen	SHAPE IT
Philips, Ian	Evaluate Local NO2 plans, Shared Digital Carbon
Pierce, David	RSSB Partnership, TIES
Rezaei, Mahdi	L3PILOT, Inclusive Public Space

Romano, Richard	HIKER, L3PILOT, NOVA VIDA
Ropkins, Karl Clean Air Network	CARES, Evaluate Local NO2 plans, TRANSITION
Rushton, Chris	CARES, Evaluate Local NO2 plans
Sadraei, Ehsan	HIKER, Inclusive Public Space, L3PILOT
Shepherd, Simon	TRACK, U-PASS
Smith, Andrew	ASSETS4RAIL, GEARBODIES, HYPERNEX, IN2ZONE, NEXTGEAR, RSSB Partnership, Shift2MaaS, TIES, TransEnergy
Solernou-Crusat, Alberto	HAROLD, HIKER, Interoperable Simulator, L3PILOT
Song, Fangqing	TOZCA
Srinavasan, Aravinda	COMMOTIONS
Stead, Alexander	Bus Demand, CQC Efficiency Network, RSSB Partnership, TIES
Suchak, Keiran	KARMA
Talbot, Joseph	Active travel in new developments, PCT, Safer Roads Map, TIICycling
Tate, James	CARES, Evaluate Local NO2 plans, uCARe
Tomlinson, Andrew	HumanDrive Extension, L3PILOT, TRACK
Tran, Vo-Huyen	TIES
Wadud, Zia	Covid Exposure Risk Tradeoffs in Transport, SPARC-IIT Kharagpur, Transport-Air Quality & Covid19, UK-CREDS
Watling, David	MODALES, PAsCAL, TRACK
Wheat, Phillip	Bus Demand, CQC Efficiency Network, NEXTGEAR, TIES
Whiteing, Anthony	RSSB Partnership , Shift2MaaS
Yang, Yuanxuan	TRACK
Yang, Yue	SHAPE IT

Having just handed in their dissertations, these students are relaxing at the one of the outdoor bars set up on Campus whilst Covid restrictions applied in indoor spaces. Two of the girls are staying on at Leeds for further study. One is going into employment. May 2021 Photo courtesy Joanna Carder.

Notes

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