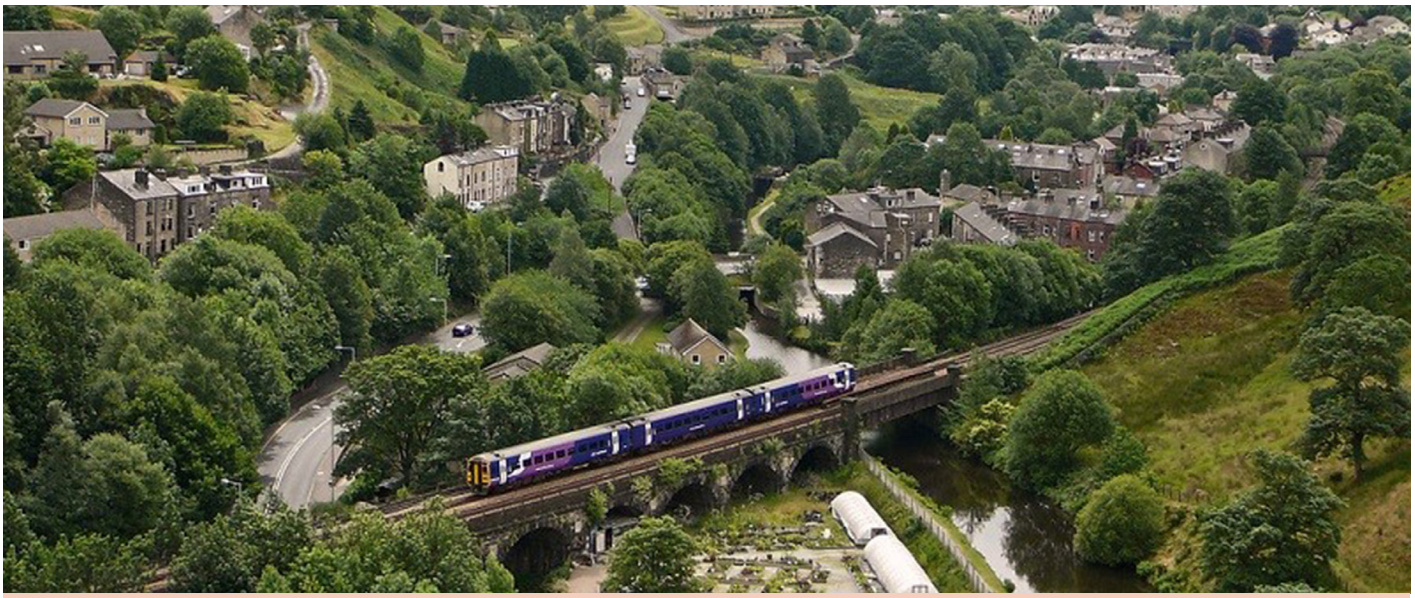
Institute for
Transport Studies (ITS)

UNIVERSITY OF LEEDS

ITS RESEARCH REPORT 2019



Land Value and Transport: Modelling and Appraisal – research led by Dr John Nellthorp is described on page 22

Athena SWAN Silver Award

GENDER CHARTER

ITS, together with schools in the Faculty of Environment, won the prestigious Athena SWAN Silver award. Our strong commitment to support women at all levels, and our broader inclusion strategy, was awarded by the Equality Challenge Unit, the national body that promotes equality in the higher education sector. ITS has a higher than national average ratio of female students and has seen a steady increase in female researchers and a more gender equal representation of female professors.

Vice Chancellor Sir Alan Langlands and Leeds City Councillor Judith Blake unveiled the new Highly Immersive Kinematic Experimental Research lab (HIKER) – the largest 4K resolution pedestrian simulator in the world.

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University of Leeds bathed in winter lights

Highlights of 2019

Sir Peter Hendy CBE, alumnus and honorary graduate of the University of Leeds, Chair of Network Rail and the London Legacy Development Corporation visited ITS to deliver a seminar that focused upon the delivery of major rail projects.

Student feedback included the comment:

> *The key message for me from this very insightful talk by Sir Peter Hendy was how important it is to develop long-term strategic plans for transport that directly support economic growth. Without it, transport planning theory quickly falls foul of ever-changing politics.*

Sir Peter Hendy CBE, alumnus and honorary graduate of the University of Leeds, Chair of Network Rail and the London Legacy Development Corporation

Leeds City Council gave the green light to support an application by the University to develop a site on the outskirts of Leeds that will host large-scale research and experimental facilities, including the **new Institute for High Speed Rail and Systems Integration.**

Professor Oliver Carsten has for many years championed **Intelligent Speed Assistance** and his research has come to fruition with the approval by the EU of vehicle standards for 2021/22 which include compulsory fitment of Intelligent Speed Assistance.

2019 saw the launch of **Virtuocity** https://uolds.leeds.ac.uk/facility/virtuocity/, a world-leading technical platform for innovation in the design of urban transport and city systems. Under the Virtuocity umbrella, **HIKER** the new pedestrian simulator joins the University of Leeds Driving Simulator and Truck Sim. HIKER allows participants to interact with virtual urban environments and vehicles without the need to wear any Virtual Reality equipment.

With the rise of automated transport, such as driverless cars, it is vital that we have the means to safety test how people will interact with new technology. The combined simulation capacity in Virtuocity is a safe and controllable environment where we can investigate the interactions of road users with new and current transport systems, ensuring we design future cities that are more enjoyable, sustainable and pleasant to live in.

The simulators in Virtuocity are already integral to a number of projects exploring human factors in transport systems including interACT; HumanDrive; Programme for Simulation Innovation and XCYCLE (the latter two projects were reported in Research Report 2018 and the former two projects are described on pages 17-18). For more information on Virtuocity and exploring human factors in transport systems please contact Professor Richard Romano R.Romano@leeds.ac.uk or Professor Natasha Merat n.merat@its.leeds.ac.uk

In the media

Professor Jillian Anable has commented to the BBC on how sport utility vehicles (SUVs) are contributing to a rise in overall exhaust emissions from new cars despite increasing sales of electric vehicles in the UK. See further analysis at https://www.bbc.co.uk/news/business-50713616

Dr James Tate comments in a Guardian item on electric vehicle (EV) costs - https://www.theguardian.com/environment/2019/feb/12/electric-cars-already-cheaper-own-run-study

Dr Charisma Choudhury was interviewed by BBC Radio 4's You and Yours about Driving Behaviour on Smart Motorways. Charisma emphasized the need to consider the driver stress levels in the design of smart motorways and highway design in general. Clip on smart motorways starts at 8:42 and Charisma at 9:30 - https://www.bbc.co.uk/sounds/play/m0006tz7

Bryan Matthews was interviewed by CNN on how technology contributes to improving mobility and access to transport for disabled people https://edition.cnn.com/2019/05/29/business/disability-technology-transport/index.html

Professor Richard Romano explained how virtual reality can be used to drive local engagement in city planning. Hear Prof Romano (from 26.05) in the Born in Bradford podcast: https://www.bbc.co.uk/sounds/play/m0001kbc

Streetsblog USA cited **Dr James Tate's** study confirming that cyclists are exposed to less air pollution than drivers while travelling through traffic: https://usa.streetsblog.org/2019/10/08/report-drivers-arent-safe-from-air-pollution/. Reaching out to the community Dr Tate also gave a talk to a year 8 class at Mount St Mary's School to support their #breatheLeeds initiative.

Launch of Virtuocity and HIKER

UK Government Chief Scientific Adviser Sir David King added: "It's been shown that the health benefits of walking and cycling far outweigh the costs of breathing in pollution, if more drivers knew the damage they could be doing to their children, they'd think twice about getting in the car."

Professor Natasha Merat and her team exhibited the Driving Simulator and Automotive Vehicle projects at the **Science Museum:** https://uolds.leeds.ac.uk/news/automation-research-on-showcase-at-science-museum-lates/

Dr Caroline Mullen received feedback from Sustrans that her paper entitled 'Freedom of movement and fairness: Transforming transport planning for social and environmental justice' has been influential in developing Sustrans' inclusive cities plans.

Professor Andrew Smith and **Dr Manuel Ojeda Cabral** commenced work on rail economics in partnership with the Rail Safety and Standards Board.

Professor Stephane Hess and **Dr David Palma** announced the release of **Apollo**, their free software for advanced choice modelling. This unique package covers a wide set of existing models, allows users to code their own models, and incorporates facilities for both classical and Bayesian estimation, as well as numerous pre and post-estimation functions. The software is distributed as an R package, and full details are available at www.ApolloChoiceModelling.com

The latest version of the stats19 R package https://docs.ropensci.org/stats19/ developed by **Dr Robin Lovelace** and colleagues is being used in policy making contexts. Staff at the House of Commons are using it as the basis for a web tool through which MPs can explore road safety in their constituencies. The software has also been used by Essex Highways to create a new map estimating crashes per km on the road network that will be used to inform the deployment of proactive front-line police enforcement in Essex.

Professor Karen Lucas leads the Sustainable Transport Equity Partnerships to which UN Environment, UN Habitat, Flone and 2 new city partners – Dhaka and Nairobi – have registered. This partnership is a continuation of Prof Lucas's ESRC GCRF funded International Network for Transport and Accessibility in Low Income Communities (INTALInC) www.intalinc.leed.ac.uk

Awards

Dr Chandra Balijepalli was acknowledged at the National Institute of Technology, Warangal, India for 'Excellence and contribution made to the transport field over three decades'. An alumnus of the Warangal Institute, Dr Balijepalli led a team of engineers, planners and economists and paved the way for successfully implementing the first ever East-West rail corridor in Mumbai.

Dr Zahara Batool won the best paper award in the category 'Roads and Intermodality' at the XXVI World Road Congress. UK Minister of Transport presented the award at the Houses of Parliament for the paper: Starkey P, Batool Z, and M.Younis W. 2019. The expansion of three-wheeler transport services: the case of qingqis in Pakistan. *XXVI World Road Congress. Abu Dhabi*

Thomas Hancock won the Andrew Daly award for the most innovative application of choice modelling in his paper: Hancock T, Hess S, Choudhury C. 2019. Quantum rotation: a new method for capturing a change of perspective. *Presented at ICMC 2019, the 6th International Choice Modelling Conference.*

Dr Chongfeng Wei won best poster prize of the 26th IAVSD Symposium on Dynamics of Vehicles on Roads and Tracks

Dr Kate Pangbourne won the best paper award presented at the 15th Scottish Transport Applications and Research conference for her paper: 'Collaborative practices across organisational boundaries in Scottish transport governance: fit for the future?' http://www.starconference.org.uk/star/2019/Pangbourne.pdf

Rafael Gonçalves was awarded the 2019 Honda Outstanding Student Paper Award at the 10th International Driving Symposium on Human Factors in Driver Assessment, Training and Vehicle Design for his paper 'Using Markov Chains to Understand the Sequence of Drivers' Gaze Transitions During Lane-Changes in Automated Driving'. https://drivingassessment.uiowa.edu/sites/drivingassessment.uiowa.edu/files/da2019_34_concalves_final.pdf

Dr Charisma Choudhury received an outstanding paper award at the 7th International Conference on Transportation and Space-Time Economics (TSTE) for her paper 'Evaluating Passengers' Heterogenous Behavioural Response to Beijing Peak

Avoidance Policy Using Smart Card Data'. Charisma is an Honorary Guest Professor at Beijing Jiaotong University and a Board Member of two committees of the Transportation Research Board (TRB).

Dr John Nellthorp, Dr Manuel Ojeda Cabral, Daniel Johnson, Dr Chris Leahy and Dr Like Jiang also won an outstanding paper award at TSTE for their paper 'Land Value and Transport: Understanding the Property Market Impact on Major Rail Investments and Other Policies using Cross-sectional and Time Series Data'.

In addition, **Dr Nellthorp's** report 'Land Value and Transport (Phase 2): Modelling and Appraisal' https://transportforthenorth.com/wp-content/uploads/LVT-Phase-2-Final-Report-ITS-2019.pdf provides new insight into links between transport and land value. The report was funded by Transport for the North (TfN), West Yorkshire Combined Authority (WYCA) and the Engineering and Physical Sciences Research Council (EPSRC) and is the first of its kind. The results have been presented at six international conferences.

Dr Robin Lovelace and colleagues won the Open Data Award in the Impact category in the national Transport Technology awards for their Propensity to Cycle Tool (PCT - see page 13). The award will support a REF Impact Case Study based on the employment of PCT by more than 50 local and regional transport planning authorities influencing over £500m of sustainable transport investment. The PCT's impact is also growing internationally. Dr Lovelace also met with the Committee on Climate Change and with Transport for Greater Manchester (TfGM) on their cycling strategy.

Dr Gustav Markkula has become an associate member of the EPSRC Peer Review College

Professor Greg Marsden was elected Fellow of CIHT

Professor Susan Grant-Muller was appointed 'distinguished international expert' by the German Ministry of Science, Universities of Excellence

Dan Johnson, Dr John Nellthorp and Dr Charisma Choudhury receive their outstanding paper awards at the 7th International Conference on Transportation and Space-Time Economics (TSTE) in Beijing.

programme and visited KIT Germany to assess their research programmes.

Professor Chris Nash received a silver medal for services to Masaryk University in the Czech Republic, where he has been a Visiting Professor for 4 years, providing short courses in European rail policy and transport project appraisal and collaborating on research issues. "I have helped them develop a major programme of research on the implications of high speed rail for the Czech Republic, and I chair the advisory board for this project. We have organised a series of workshops on rail economics issues and I have brought in both Andrew Smith and Phill Wheat in visiting positions to boost the collaboration."

Influencing Transport Policy

Research led by **Professor Susan Grant-Muller**, has been included as a policy recommendation to world governments following the meeting of the UN-Habitat Assembly, the world's foremost deliberative and policy making forum on city life. The EU funded EMPOWER project, led by Professor Grant-Muller has been used as an exemplar in a recent Finnish road traffic act and as an example of best practice in Department of Transport guidance notes in the USA. Other countries interested in these schemes include Singapore, Malta and Greece. The research developed smartphone incentive schemes encouraging city dwellers to make greener transport choices. The scheme helps local transport authorities to launch an innovative software app in their region. Citizens are encouraged to choose sustainable transport options by collecting reward points, taking part in games, competitions, challenges and sharing modes. The incentive schemes have helped to make carbon savings of between 15-30%. Professor Grant-Muller says:

Prior to the research, there may have been a perception that incentives based behavioural measures were impractical and unlikely to be impactful. However a key element was that the research led to real-life implementations by city leaders and the novel micro-mobility location data generated allowed us to capture the impact. To have these measures included in such high level policy guidance will be awareness raising and lead to further impact.

Professor Jillian Anable is a member of the Northern Powergrid External Stakeholder Panel and a member of the Committee on Climate Change Transport team.

'Let's not forget the WHY of driverless cars'. Watch Dr Louw's talk: https://www.youtube.com/watch?v=0ixUnrfjbaU

Professor Karen Lucas currently holds 5 long term influential posts: Executive Board K2 Sweden; Steering Committee Travel Survey Methods conference; Academic advisor to Highways England's Lower Thames Crossing project; Cluster Leader NECTAR conference; Special Interest Group Leader and Scientific Committee World Conference on Transport Research (WCTR).

Dr Caroline Mullen is on the Advisory Board of a project funded by the Swedish Energy Agency.

Professor Andrew Smith continues his role as Econometric Advisor to Ofgem; he continues to develop work for the Italian Transport Regulation Authority and he is on SNCF's scientific committee for marginal cost estimation and track access charges.

Dr Phill Wheat was appointed expert adviser by the DfT to update its time series econometric models of aviation passenger demand.

Dr James Tate gave a talk in Brussels at the Workshop on Remote Sensing of Vehicle Emissions which aims to set-up an EU initiative to gather and share vehicle emissions data with a view to support the EU market surveillance and in-service conformity testing plus potentially other obligations such as periodic technical inspection monitoring of low emission zones.

Research by **Dr Ian Philips,** and **Dr Robin Lovelace's** Propensity to Cycle Tool, were cited a number of times in the report for Gina Dowding MEP (Green Party) 'A Sustainable Transport System for the North West'. https://ginadowding.org.uk/wp-content/uploads/2020/01/Sustainable-Transport-North-West-FINAL2.pdf. The report includes ebikes and segregated cycleways as important modes that would contribute to the reduction of carbon emissions.

Dr Tyron Louw gave a talk entitled 'Let's not forget the WHY of driverless cars', at SHIFT Automotive 2019 in Berlin. Research conducted by members of the Human Factors and Safety group using the University of Leeds Driving Simulator was presented to make a case for considering the human element in the design of automated vehicles. Dr Louw called on journalists, researchers, manufacturers, and legislators to play their part in delivering on the potential of driverless cars to improve road safety. Watch Dr Louw's talk: https://www.youtube.com/watch?v=0ixUnrfjbaU

Visitors

To help develop strategic partnerships for education and research ITS hosted visits from three high-level delegations: (i) With the support of the UK government Department for International Trade, ITS welcomed a **South Korean ministerial delegation** from the Presidential Committee for Fourth Industrial Revolution – Smart City Strategy Committee; (ii) **College of Economics and Management of Tianjin University**, China. Tianjin presented research seminars on low-carbon transportation in China, and in behavioural management of urban traffic and (iii) **CEPT University of India**.

Our international visitors included: **Professor Harun Al-Rasyid** from Bandung Institute of Technology, Indonesia hosted by Dr Chandra Balijepalli; **Muhammad Farda** and **Tryas Praesha** from Bandung Institute of Technology hosted by Dr Balijepalli and Professor Simon Shepherd; **Dr Toshiya Hirose** from Shibaura Institute of Technology, Japan hosted by Professor Richard Romano; **Dr Peng Liao** from Southern University of Science and Technology, China hosted by Professor Ronghui Liu; **Dr Koki Satsukawa** from Institute of Industrial Science, University of Tokyo, Japan hosted by Professor David Watling; **Dr Hazvinei Tsitsi Tamuka Moyo** from University of Cape Town, Africa and **Dr Rodrigo Tapia** from Federal University of Rio de Janeiro, Brazil, both hosted by Professor Stephane Hess.

ITS hosted a one day workshop on 'Advanced traffic management for smart mobility' with presentations given by **seven visiting Japanese researchers, led by Prof Yoshii of Ehime University.**

Visiting postgraduate researchers included: **Andrea Vanesa Papu Carrone** from Technical University of Denmark hosted by Professor David Watling; **Zhenni Chen** from Tianjing University, China hosted by Dr Chiara Calastri; **Andrea Gilardi** from University of Milan, Italy hosted by Dr Robin Lovelace; **Ning Huan** from Beijing Jiaotong University, China hosted by Professor Stephane Hess; **Zhaoxia Kang** from Bandung Institute of Technology, Indonesia hosted by Professor Andrew Smith; **Samuel Elias Lingdren** from VTI, Sweden hosted by Dr John Nellthorp; **Fan Liu** and **Yafei Liu** from Beijing Jiaotong University, China hosted by Professor Ronghui Liu; **Wei Lyu** and **Chengliang Xu** from Tsinghua University, China hosted by Professor Natasha Merat; **Talita Santos** from Federal University of Rio de Janeiro, Brazil

hosted by Professor Greg Marsden. The Universities Transport Studies Group (UTSG2019) conference was hosted by ITS in Leeds and received positive feedback. **Supertram**, the Institute's own music band led by **Bryan Matthews** played transport themed popular songs to entertain the 100+ delegates.

Staff changes

In 2019 we celebrated the promotions of **Dr Eva Heinen, Dr Tyron Louw** and **Dr Robin Lovelace**.

Director of ITS **Professor Richard Batley** will step down in 2020. We warmly thank Richard for his leadership over the past 4 years which saw further growth in both student numbers and research activity.

New staff and leavers

Reflecting the growth in both education and research activity, the Institute has 37 academics, 43 researchers and 16 managerial and support staff. We welcomed **Dr Muhammad Adeel, Dr Zahara Batool, Dr Jan Broekaert, Dr Sally Cairns, Dr Noel Cass, Junyan Chen, Hannah Devine Wright, Dr Jianbing Gao, Dr Thomas Hancock, Dr Zhiyuan Lin, Dr Ye Liu, Dr Xiaoxiao Ma, Shona McCulloch, Dr Jo-Ann Pattinson, Jami Pekkanen, Tina Shield and Dr Joey Talbot. We saw the return of Dr Ruth Madigan** and **Jo Moran** from maternity leave.

We said farewell to Dr Alex Baker-Graham, Sam Bennet, Dr Romain Crastes dit Sourd, Oscar Giles, Dr Charlotte Kelly, Dr Chris Leahy, Peter Morrow, Emma Tsoneva and Dr Jim Uttley.

Postgraduate Research Students

During 2019 we had 77 research students at ITS: Khaled Abdullah, Mohammad Abu-Bakar, Emmanuel Acheampong, Samuel Adjei-Appiah, Ilyas Alhassan, Mahmoud Al-Khazaleh, Shaima Almansoori, Zihao An, Peter Atkinson, Jeroen Bastiaanssen, Jawaher Binsuwadan, Isam Bitar, Martyna Bogacz, Jake Bruce, Davide Bruscoli, Fanta Camara, Mauro Capurso, Juan Castellanos-Vanegas, David Chikwendu, Rafael Cirino-Goncalves, Christopher Cook, Anna Correa-Pereira, Edmond Daramy-Williams, Louise de-Tremerie, Patrick Dichabeng, Stephen Dixon, Rafael Dos-Reis, Lawrence Duncan, Umoh Edemeka, Anthony Ezenwa, Cristhian Figueroa-Martinez, Thiago Guimaraes-Rodrigues, Thomas Hancock, Md Bashirul Haque, Probo Hardini, Thalia Hernandez-Amezcua, Lydia Hidayati, Rashed Ishmaeel, Rizal Kamaruddin, Naphat Ketphat, Alexandros Kontotasios, Edward Lambert, Gengze Li, Qiyang Liu, Henry Lo, Davide Maggi, Tahera Mayat, Ioanna Moscholidou, Tamas Nadudvari, Haruko Nakao, Taufiq Nugroho, Lamprini Papafoti, Evangelos Paschalidis, Mickael Perrier, David Pierce, Vishnu Radhakrishnan, Kacper Rossa, Teekanya Rujinarong, Ehsan Sadraei, Rosie Samuel, Mohammad Sarker, Fangqing Song, Panagiotis Spyridakos, Sidi Sun, Tianli Tang, Yvonne Taylor, Jack Thompson, Kai Tian, Lap Kwan Tjiong, Panagiotis Tsoleridis, Nur Ubaidillah, Chinebuli Uzondu, Ying Wang, Zhuoqian Yang, Jingyan Yu, Khatun Zannat and Weiming Zhao.

In addition, ITS staff co-supervised eight students based in other University of Leeds schools: Sakarias Bank (Psychology), Gyeonghwa Lee (Design), Daisy Thomas, Weiyi Yao and Nura Kabuga (Engineering), Colin Caine, Caroline Tait and Eugeni Vidal-Tortosa (Geography), plus Zhenni Chen and Manu Mahan (visiting students).

Anderson Etika (reported in ITS Research Report 2018), Chinebuli Uzondu, Ehsan Sadraei and Panos Spyridakos celebrate their graduation and PhD awards.

PhD Awards

Seventeen of our students were awarded postgraduate research degrees.

Peter Atkinson 'Fitting the Bike to The Chain: An analysis of transitions towards households integration of multi-modal cycling'; **Mauro Capurso** 'Consideration of alternatives: Development of hybrid modelling approaches and applications to transport mode choice'; **Louise de Tremerie** 'An application of quantitative and qualitative methods in freight mode choice modelling'; **John Dixon** 'Developing a methodology for ex post evaluation of the wider impact of the restoration of rail services to previously disconnected or isolated regions on employment and property prices and accessibility to jobs and essential services'; **Rafael dos Reis** 'Acceptability and impacts of positive incentives for sustainable mobility behaviour: A segmentation approach in Curitiba, Brazil'; **Joanna Elvy** 'Towards socially inclusive sustainable mobility: The role of social capital in participatory transport planning processes'; **Thomas Hancock** 'Travel behaviour modelling at the interface between econometrics and mathematical psychology'; **Qiyang Liu** 'Analysing public acceptability of sustainable transport policy in the Chinese context. The case of congestion charging in Beijing'; **Taufiq Nugroho** 'Optimal urban goods

Alumni networking event at WCTR Mumbai. Standing centre back : General Secretary of WCTR Professor Greg Marsden and previous General Secretary, Emeritus Professor Tony May.

movement planning taking independent retailer restocking activities into consideration'; **Evangelos Paschalidis** 'Developing driving behaviour models incorporating the effects of stress' **Ehsan Sadraei** 'Driving simulator motion cueing assessment: A platform design perspective'; **Spyridakos Panagiotis** 'Virtual techniques for prototype HMI evaluation'; **Nur Ubaidillah** 'Determinants of car and motorcycle ownership and use in Sarawak'; **Chinebuli Uzondu** 'The influence of road safety culture on driver behaviour: a study of Nigerian drivers'; **Ying Wang** 'Incorporating weather impact in railway traffic control'; **Jingyan Yu** 'Modelling and simulation of urban road network evolution using generative network models'; **Weiming Zhao** 'Traffic control with connected and automated vehicles on urban roads'.

Alumni

The 'Big Get Together' is a collection of social events that take place across the globe, where Leeds alumni can meet new people, share their pride in the University of Leeds and celebrate their lifelong connection with the University. Four of the year's events were hosted by ITS alumni in their home countries:

Alumni **Robert Quaye**, MSC Transport Planning & Engineering 2009 and **Shafiq-Ur Rahman** PhD 2014 hosted events in Ghana and Bangladesh respectively. **Diego Silva Lopez**, MSc Transport Planning 2017, hosted his first 'Big Get Together' event at an English Pub in Santiago de Chile, combining the love for his own city with his fond memories of Leeds. **Chris Byaruhanga**, MSc Transport Planning and Engineering 2012, has been hosting 'BGT' events in Uganda since the initiative began. Chris stated that:

> *My career has progressed very well after graduating from Leeds, which makes me a very proud alumnus and I'm interested in getting to know new and old alumni so that we can all expand our networks and share work opportunities and experiences.*

The ITS annual alumni networking events are attended by a diverse range of industry professionals from both the public and private sectors. In 2019 the ITS networking event was attended by over 40 alumni and kindly hosted by AECOM at their offices in Aldgate Tower, London. A keynote speech was delivered by alumnus Luis Pilo Willumsen, PhD Transport Demand Modelling and Forecasting 1980. At the WCTR, General Secretary Professor Greg Marsden, ITS also hosted an alumni networking event in Mumbai.

Alumna, Dr Clare Linton, was named among the '40 under 40 Transport Leaders for the 2020s' by *Passenger Transport Magazine* that identifies top young professionals who it believes are the future of the industry. It is a great accolade for Dr Linton, who graduated from ITS in 2017 with a PhD in Low Carbon Technologies. During her studies, Clare worked part-time as a Policy Researcher for the Urban Transport Group and since graduation has continued this role on a full-time basis. Her work ranges across different transport policy areas such as urban freight, transport and health, social inclusion and smart transport futures. Dr Linton has stayed in touch with the University as one of the Leeds Alumni Ambassadors.

RESEARCH PROJECTS

The last three years have seen particular growth and success in seven cognate areas of global importance: Transport & Energy; Transport & Cities; Simulation; Automation; Rail; Connected Mobility; Transport & Health.

This year we have won research contracts worth over £5M in these areas. 53 of our current projects are described in the following pages under themed headings.

TRANSPORT AND ENERGY

AdVANce: Light Goods Vehicles Carbon Reduction

Grant holder: **Dr Anthony Whiteing**
Investigators: **Dr Eleonora Morganti, Professor Jillian Anable, Dr Like Jiang**
Funded by: **UK ERC**
Collaborative partner: **Oxford University**
Dates: **October 2016 to March 2019**

Abstract: Light goods vehicle (van) traffic has been the fastest-growing segment of road traffic in recent years, yet little research has been conducted into the causes of this. The adVANce project has investigated trends in van use, the energy implications of such use and the opportunities for carbon and pollution

reduction from the van sector particularly in urban areas, through case study work and analysis of vehicle MoT data.

Impact: Typologies of van use in sectors such as retail and food have been created, allowing the potential effects of various policies to reduce emissions in this key transport sector to be analysed through carbon modelling.

DecarboN8

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

Abstract: The DecarboN8 network brings together researchers, industry and government to design solutions which can be deployed rapidly and at scale. We are developing answers to questions such as: How can different places be rapidly switched to electromobility for personal travel? How do decisions on the private fleet interact with the quite different decarbonisation strategies for heavy vehicles? What is the right balance between infrastructure expansion, intelligent system management and demand management? Will the embodied carbon emissions of major new infrastructure offset gains from improved flows and could these be delivered in other ways?

The answer to these questions is unlikely to the same everywhere in the UK and DecarboN8 pays attention to where the answers might be different and why, to develop an innovative place-based approach to decarbonisation. We pay attention to the major societal implications of any of the changes proposed and we work with diverse sectors and communities to deliver solutions which share the decarbonisation challenge fairly. DecarboN8 is part of the Cut Carbon Network.

Decarbon8 – delivering solutions which share the decarbonisation challenge fairly.

Cut Carbon Network

Grant holder: **Professor Greg Marsden**
Funded by: **EPSRC**
Coordinating partner: **University of Leeds**
Dates: **September 2019 to August 2023**
Website: https://cutcarbon.org.uk/
Abstract: Cut Carbon is a £5m investment in decarbonising transport. Five Decarbonising Transport Networks have been funded to bring together expertise from across academia and industry to lay the groundwork for the use of low carbon technologies across road, rail, marine and air networks. Each network has its own specialist focus area such as examining commercial flights using electric airplanes, smart vehicle to grid connectivity challenges and decarbonising freight transport. The Cut Carbon initiative acts as a one stop shop for finding out about events, funding calls and key network deliverables across all of the networks, recognising the need for a whole system approach to rapid decarbonisation. It will share syntheses of the latest decarbonisation solutions. The network will help connect industry, government and academia to the in-depth studies being conducted within in each of the networks.

ADAPT

Grant holder: **Dr Kate Pangbourne**
Investigators: **Samuel Bennett, Dr Alexander Baker-Graham**
Funded by: **EPSRC**
Dates: **June 2016 to May 2021**
Collaborative partners: **See project website**
Website: adapt.leeds.ac.uk

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

Impact: Norfolk County Council and Oxford City Council have been guided by Dr Pangbourne's presentations to follow new approaches in influencing sustainable travel mode shift.

STEPS project - helping Global South cities deliver safer pedestrian environments.

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

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

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

Impact: There has been huge media interest. We are saying that the shift to electric vehicles is not enough to decarbonise the transport sector.

UK Energy Research Centre Phase 3 (UK ERC 3)

Grant holder: **Professor Jillian Anable**
Funded by: **UK Energy Research Centre (UK ERC)**
Dates: **January 2016 to April 2019**
Coordinating partner: **Imperial College London**
Collaborative partner: **University of Oxford**
Website: www.ukerc.ac.uk

Abstract: UK-ERC is a 'virtual' research centre comprising a focal point for UK research on sustainable energy. It takes an independent, whole systems approach, drawing on engineering, economics and the physical, environmental and social sciences. The primary objective is to explore the UK energy transition in an uncertain world, and the synergies and trade-offs between the key drivers for this transition. Professor Anable works primarily on 'Key challenges in energy system decision-making' centering on the analysis of policy scenarios for carbon mitigation of the UK transport sector using the UK Transport Carbon Model (UKTCM).

Electricity SATNAV

Grant holder: **Professor Jillian Anable**
Investigators: **Maria-Jose Ambrosio-Albala, Dr Noel Cass**
Funded by: **EPSRC**
Dates: **September 2017 to August 2019**
Coordinating partner: **Aston University**
Collaborative partners: **University of Southampton**

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

TRANSPORT AND CITIES

Sustainable Transport Equity Partnerships (STEPS)

Grant holder: **Professor Karen Lucas**
Funded by: **Global Challenges Research Fund - HEFCE**
Dates: **December 2018 - July 2019**
Website: www.intalinc.leeds.ac.uk

Abstract: This is follow on work from the INTALINC project (see project website). One of the gaps identified through INTALInC's research is the severe inadequacies of walking environments in transport policy in the Global South. Walking can constitute up to 75% of all journeys in Low Income Countries, as the only available and affordable mode to access work, markets, healthcare and education. But, fundamentally many of the environments in which people are walking are unsafe and unpleasant. Ongoing construction of auto-dependent travel environments is creating soaring traffic deaths, chronic congestion and poor air quality. The poorest populations, and especially women, children and older and disabled people suffer more restrictions on their travel and are more vulnerable to violence and harassment in the public sphere. This

means that Global South cities urgently need to promote pedestrian environments that are inclusive, safe and connected to achieve a number of their related Sustainable Development Goals, such as reduced inequalities, gender equality and improved access to services.

Impact: Focusing on work in Nairobi and Dhaka we have brought together engineers, social scientists, public health officials, transport planners and urban planners with the aim of delivering policies on the ground.

Uptake of E-Motorcycles in Indonesia

Grant holder: **Dr Chandra Balijepalli**
Investigator: **Professor Simon Shepherd**
Funded by: **Royal Academy of Engineering**
Dates: **March 2018 to January 2020**
Coordinating partner: I**nstitute of Technology Bandung, Indonesia**
Collaborative partners: Center of Excellence, Automotive Control & System, Institute of Teknologi, Sepuluh Nopember Surabaya and Department of Transport Bandung City.

Abstract: Motorcycle is a dominant mode of transport in Indonesia. Nearly three-quarters of vehicles are motorcycles in cities such as Jakarta, Bandung, and Surabaya. The road networks are highly congested with average speeds dropping below 10kph during peak hours and emissions from two-stroke engines are a real problem in terms of air quality. Despite major policy initiatives for alternative modes of transport such as Bus Rapid Transit and Mass Rapid Transit in Jakarta, motorcycles continue to grow in numbers due to the ease of purchase and lack of license checks. If motorcycles were electric powered the pollution problem could be reduced. The objective of this research is to develop a system dynamic model of the uptake of e-motorcycles in Bandung.

The project will investigate the impact of subsidies, battery range and availability of charging points on the reduction of CO_2 and other emissions. We will adapt the system dynamic model developed for UK passenger cars, and a simpler model of Taiwan which looked at e-motorcycles, to the Indonesian context by calibrating the diffusion model to the uptake of e-motorcycles. The adaptation will consider similar experiences as revealed in Kunming, China where a panel of surveys was conducted over six years through a series of interviews. In order to build the local context, we will conduct sample-based interviews in Bandung to understand local preferences. A novelty of this work will be to link the outcomes of system dynamic model with a SATURN traffic simulation model of Bandung to reveal the impact on both emissions and congestion. This combined modelling approach will facilitate testing of policy sensitivity to various scenarios involving subsidies, availability of charging points and battery range.

Papers: The following four papers were *presented at the 6th International Conference on Electric Vehicular Technology, Bali, Indonesia:*

Balijepalli NC. 2019. Electric scooter use: Lessons from Asian cities, prospects and challenges for Indonesia.

Farda M, Shepherd S, Balijepalli NC, Crastes dit Sourd R, Praesha T and Lubis HA. 2019. Estimating the uptake of electric motorcycles in Bandung city using discrete choice modelling methods.

Shepherd S, Praesha T, Balijepalli NC and Farda M. 2019. Investigating factors to support electric scooter uptake: The case of Bandung city.

Students enjoy a world of flavours during International Night at ITS

Shepherd S. 2019. System Dynamics and the take up of alternative fuel vehicles.

Impact: The research on uptake of e-motorcycles attracted four presentations including a key-note and an invited talk at an international conference. In addition the project team conducted a workshop with policy makers drawn from the Ministries of Energy, Environment, Transport, Local Authorities, NGOs and academics in Indonesia. The Government of Indonesia is exploring methods to promote electric vehicle technology which will potentially impact on the local environment in the future.

Under Reform

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

Abstract: Under Reform aims to develop cutting edge insights into how reforming transport governance works, and how best to generate more sustainable transport systems in Indian cities. In 2015 the Indian national government

Shafiq-Ur Rahman hosting the Alumni Big Get Together in Bangladesh (see page 12).

launched the *Smart Cities Mission*, aiming to reform transport governance more effectively than had been managed at individual city level. The project research will analyse previous and planned reforms in four of India's designated smart cities, considering their impact on the prosperity and the quality of life of citizens. The aim is to move beyond simply identifying problems, rather developing an understanding of how to overcome them.

Papers: Marsden G, Reardon L, Singh M and Vishwanath S. A Special Session hosted by the project at the 15th WCTR in Mumbai https://underreform.org/world-conference-on-transport-research-society/

Reardon L et. al. 2019. Assessing the Applicability of Multilevel Governance in the India Context: An Analysis of the Smart Cities Mission Programme *presented at the 4th International Conference on Public Policy 2019*. https://underreform.org/project-paper-at-international-public-policy-conference/

Marsden G, Campbell M, Reardon L, Gupta S, Singh M, Verma A and Bhat P. 2019. What are the Indian Smart City Reforms? A cross-comparative relational analysis *presented at the Royal Geographical Society (with IBG) Annual International Conference 2019*. https://underreform.org/representation-at-rgs-ibg-london-conference/

Impact: The project hosted eight international visitors on a study tour of Smart City transport in four UK cities. The activity enhanced UK-Indo collaboration and one regional government went on to organise a knowledge-sharing session: https://underreform.org/study-tour-sparks-uk-indian-collaboration-activity-in-case-study-city-of-bangalore/

U-PASS

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

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

Paper: Mullen C, Shepherd S, Xu M, Xue Q. 2019. Governance and regulation of autonomous mobility for sustainable mobility? *7th International Conference on Transportation and Space-time Economics*

ELVITEN

Grant holder: **Dr Haibo Chen**
Funded by: **EU H2020**
Dates: **November 2017 to October 2020**
Collaborative partners: **21 partners in industry and academia (see website for details)**
Website: www.elviten-project.eu

Abstract: Electrified L-category Vehicles Integrated into Transport and Electricity Networks (ELVITEN) aims to boost the usage of electrified bicycles, scooters, tricycles and quadricycles (EL-Vs) in the urban environment and ultimately to achieve a mind-shift among users by providing them with a better EL-V experience. This will be achieved by designing and offering replicable usage schemes, consisting of support services, ICT tools and policies. EL-Vs are being tested in Genoa, Rome, Bari, Malaga, Berlin and Trikala. The project has three principal objectives: First, to make users more familiar and facilitate them to use EL-Vs instead of conventional vehicles for their private transport and for light urban deliveries.

Second, to collect rich information sets made of real usage data, traces from dedicated ICT tools, and users' opinions after real trips. Third it will generate detailed guidelines and business models for service providers, planning authorities and manufacturers in order to make EL-Vs more attractive and integrated in the transport and electricity networks.

Impact: Speed up the market penetration of EL-Vs; supply the manufacturer with crucial information for the development and the engineering work of the next generation of EL-Vs; give the vehicle manufacturers and mobility service providers the necessary information to develop successful business models; contribute to quality of life in urban environments; provide recommendations for effective policy measures supporting the deployment of EVs; and contribute to climate action and sustainable development objectives.

Propensity to Cycle Tool (PCT)

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

Abstract: PCT is a planning support system to improve cycling provision at many levels from regions to specific points on the road network. For further information on the thinking underlying the tool's design, and the methodology used to create it, please follow links in the PCT website to Lovelace et al. (2017) (commute layer) and Goodman et al. (2019) (school layer).

Impact: Won the TRansTech award and has transformed strategic planning for cycling across England and Wales, influencing central government policy as a key part of the Cycling and Walking Investment Strategy. Has attracted further research funding - see ACTON.

Dr Robin Lovelace and Dr Rachel Aldred with the TRansTech award for PCT

ACTON

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

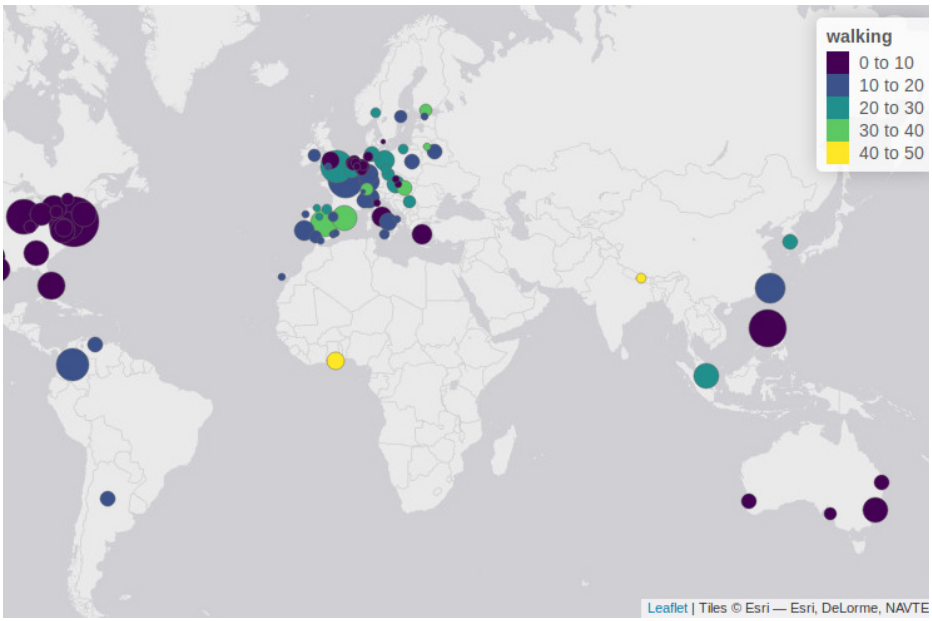
Abstract: ACTON is a research project to provide evidence for local authorities, developers and civil society groups to support planning and investment in sustainable transport infrastructure in and around new developments. The award-winning Propensity to Cycle Tool is influencing strategic cycle network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

Impact: Improved decision-making around new infrastructure developments.

PRETTI: Public Realm Economic appraisal Toolkit for Transforming Investments.

Grant holder: **Dr Manuel Ojeda-Cabral**
Investigators: D**r John Nellthorp; Dr Thijs Dekker**
Funded by: **Transport Research Innovation Fund (TRIF)**
Coordinating partner: **WYCA**
Dates: **January 2019 to May 2020**

Abstract: The public realm (or urban realm) has significant impacts on cities and society's welfare, ranging from citizens' well-being and satisfaction with life to economic activity and productivity. Well-informed policy decisions are needed since the majority of investments in public realm are funded with tax-payers money. However, the current capabilities to appraise public realm schemes are very limited and Regional and Local Authorities struggle to justify expenditure on improving the public realm. Similarly, impacts on public realm from other projects (e.g. transport) are difficult to quantify and monetize, potentially leading to suboptimal choices. The apparent lack of evidence on what constitutes good value-for-money in urban realm improvements highlights the need for research and better tools for appraisal. Through the PRETTI project we are helping to address these challenges by exploring current practices, existing evidence and,



ACTON project – supporting planning and investment in sustainable transport infrastructure.

ultimately, by providing a fundamental rethink of valuation and appraisal in the context of urban realm.

Impact: A workshop with key stakeholders was hosted at ITS during 2019, with a total of 23 representatives from local and regional authorities, national government (transport and housing sectors), consultants and academics.

Green & Blue Infrastructure

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

Abstract: It's difficult for practitioners to prove value for money for Green (parks and green spaces) and Blue (drainage/run off) infrastructure. With the aim of providing better tools for appraisal we are investigating business cases in the Calderdale/ Don catchment area. Stakeholders include WYCA, Leeds City Council and Kirklees Council. This research connects with another project, PRETTI (described above).

Impact: The work will contribute to an update of the Green Book (guidance on how government should appraise their investments).

City Infrastructure Engineering

Grant Holder: **Professor Philip Purnell, School of Civil Engineering**
Co-Investigator: **Professor Natasha Merat**
Funded by: **EPSRC**
Dates: **January 2016 to July 2021**
Coordinating partner: **University of Leeds**
Collaborative partners: **UCL, University of Birmingham, University of Southampton**
Website: http://selfrepairingcities.com/

Abstract: This project aims to tackle the Grand Challenge of Zero Disruption from Infrastructure Engineering in UK cities by 2050. The project is developing technologies that will identify, diagnose and repair street-works through minimally invasive techniques including: Drones that can repair street lights and potholes; Hybrid robots to operate indefinitely within live utility pipes performing inspection, repair, metering and reporting tasks.

Impact: It is anticipated that this project will lead to a wide range of benefits for citizens' health, wellbeing, happiness and economic prosperity by reducing the impact of infrastructure engineering.

Spatial Public Satisfaction

Grant holder: **Dr Phill Wheat**
Investigators: **Dr Chris Leahy**
Funded by: **WYCA**
Dates: **January to December 2019**

Abstract: What factors influence public satisfaction with road maintenance? Combining the disciplines of choice modelling, economics and asset management, the aim of this project was to provide Local Authorities with information on how better to maintain the public roads.

Impact: Pilot studies in Leeds and Wakefield provided evidence that LAs can affect how people perceive road works. At a workshop with WYCA opportunities to roll out to all other LAs were explored. Our findings have led to the installation of more 20 mph speed limits in residential areas.

CQC Efficiency Network

Grant holder: **Dr Phill Wheat**
Investigators: **Dr Alex Stead, Dr Chris Leahy**
Funded by: **Local Authorities**
Dates: **April 215 to March 2022**
Coordinating partner: **measure2improve**
Website: www.nhtnetwork.org

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

Papers: Wheat P, Stead AD, Greene WH. 2019. Robust stochastic frontier analysis: a Student's t-half normal model with application to highway maintenance costs in England. *Journal of Productivity Analysis*. DOI:10.1007/s11123-018-0541-y.

Stead AD, Wheat P. 2019. The case for the use of multiple imputation missing data methods in stochastic frontier analysis with illustration using English local highway data. *European Journal of Operational Research*.

Impact: This project was awarded an EPSRC Impact Acceleration Account which supports knowledge exchange and the delivery of impact from EPSRC funded research. CQC is referenced in

the DfT's Incentive Fund Self-Assessment Process and contributes to the case for local authorities receiving enhanced incentive funding. Collaboration with the network was funded for a further three years.

SIMULATION

Pedestrian-in-the-Loop Simulator (HIKER)

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

Abstract: Pedestrians represented roughly 24% of road fatalities and 22% of the seriously injured in the UK in 2015 (DfT, Reported Road Casualties Great Britain: 2015, Annual Report). 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. 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. What makes the simulator unique in the world is its very high resolution displays combined with its large walkable environment (9 metres by 4 metres) and its integration with driving simulators to test interactions between pedestrians and drivers.

Impact: The simulator was used extensively last year to support the interACT project. In the coming year it will be used by multiple new projects studying the interaction of pedestrians with vehicles including AVs. This includes the VeriCAV project.

HIKER – the largest 4K resolution pedestrian simulator in the world.

VeriCAV

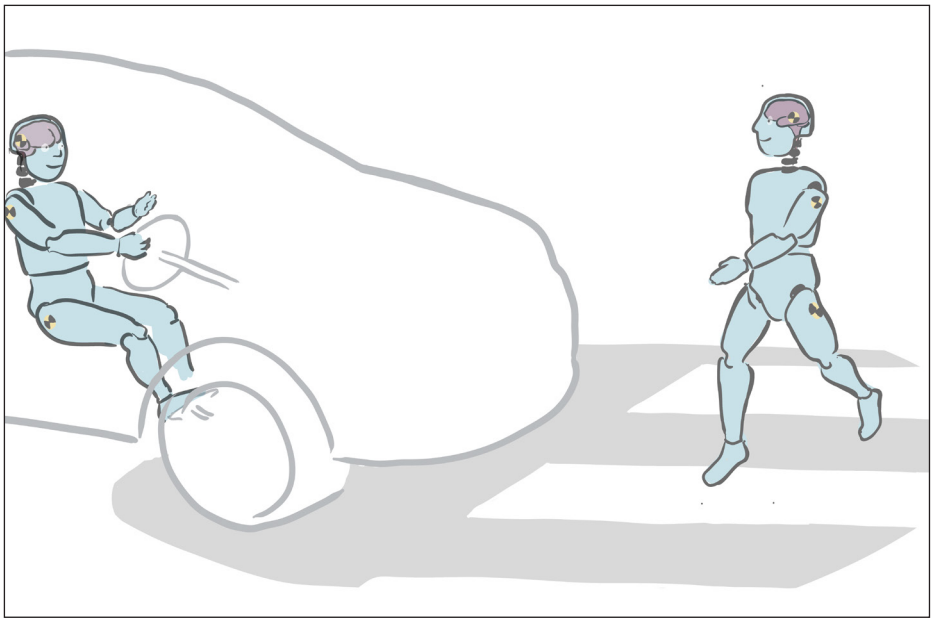
Grant holder: **Professor Richard Romano**
Investigators: **Dr Albert Solernou-Crusat, Dr Gustav Markkula, Professor Natasha Merat**
Funded by: **Innovate UK**
Coordinating partner: **HORIBA MIRA**
Collaborative partners: **Aimsun, CPC**
Dates: **September 2019 to December 2020**
Website: https://vericav-project.co.uk/

Abstract: The VeriCAV project is developing an integrated test framework to allow Automated Driving Systems (ADSs) to be validated in simulation, exposing them to large numbers of complex driving situations such that developers and regulators can have real confidence in their reliability and safety when deployed on the roads. The project will go beyond scenario based testing to a paradigm where optimal test cases are generated from the space of all possible situations. VeriCAV is looking to improve the efficiency of testing by minimising human effort in supervising the huge number of tests. As part of this approach, a test oracle will automate the evaluation of an ADS's performance during a test run and also aggregate information on the simulation setup in order to automatically create test coverage statistics. The research team at Leeds will focus on validation of the test framework by applying methodologies developed to validate operator in the loop driving simulators as well as increase the technology readiness level of realistic smart agents that are based on cognitive road user behaviour/ interaction models. Smart actors are key to allowing a breath of ADS test scenarios in simulation. The validation approach compares the ADS's response between simulated and real environments and evaluates the ADS's performance on a number of metrics to ensure that the simulation performance is similar to that in the real world. The smart agents have been developed in prior research and their responses to the scenarios will be used to tune the simulation setup in the test oracle to find the most critical events for the testing of the ADS. In addition, the cognitive models will be compared to machine learning based approaches developed by project partners to understand the value of both approaches and applicability to a range of scenarios

HAROLD: HAzards, ROad Lighting and Driving

Grant holder: **Professor Natasha Merat**
Investigators: **Anthony Horrobin**
Funded by: **EPSRC**
Coordinating partner: **Professor Steve Fotios, University of Sheffield**
Dates: **January 2019 to June 2022**

Abstract: Road collisions can be avoided if drivers are able to detect and recognize potential hazards in sufficient time. After dark, reaction time are



Computational Models of Traffic Interactions for Testing of Automated Vehicles (COMMOTIONS).

significantly reduced. Road lighting is of particular importance for revealing hazards beyond the reach of vehicle headlights such as pedestrians emerging from the side. 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. For pedestrians on main roads a flashing LED band, worn on the wrist or ankle could provide a low-cost counter-measure to reduce the risk of accident. We will use the University of Leeds Driving Simulator to find out how the detection of hazards is affected by changes in lighting intensity and colour. We will also investigate how driver distraction affects the perception of hazards and whether optimal lighting can mitigate this. The driving simulator places the test participant in a realistic setting while maintaining control of road situation and participant safety.

Impact: Our aim is to ensure the guidance and standards documents used by lighting designers are revised to include the criteria proposed as a result of this research.

AUTOMATION

COMMOTIONS (Computational Models of Traffic Interactions for Testing of Automated Vehicles)

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

Abstract: If automated vehicles (AVs) cannot interact well with human road users, they risk causing frustration or even casualties. This EPSRC fellowship project is researching mathematical models of how humans interact in road traffic, with the objective of using these models to test and optimise the interactive behaviour of AVs. The interaction models are being developed based on knowledge and methods from cognitive neuroscience, using behavioural data from naturalistic and controlled environments (e.g., the new ITS HIKER lab), as well as neurophysiological data collected in collaboration with Leeds School of Psychology. The project will also investigate how the developed cognitive models compare to and can be complemented with purely data-driven, machine-learned models of interactive behaviour, in a collaboration with the School of Computing. The project partners FiveAI and Aimsun provide direct links to intended industrial applications of the models, in AV software and traffic modelling tools, respectively.

SEARUB

Grant holder: **Professor Samantha Jamson**
Investigators: **Professor Oliver Carsten**
Funded by: **EU**
Coordinating partner: **TNO**
Collaborative partners: **VVA, DLR, Transport & Mobility Leuven**
Dates: **March 2019 – March 2020**

Abstract: Driver assistance, partial and full automation will have a strong impact on the behaviour and performance of all road users in traffic. This project will assess the consequences of this deployment for EU policy and relevant legislations in terms of: Traffic Rules; Driver Licensing; Training of Professional Drivers; Interaction of Road Users with Automation.

Impact: Identification of the challenges and gaps between the current and future policy as a result of the introduction of automated vehicles.

TRUSTONOMY

Grant holder: **Professor Samantha Jamson**
Investigators: **to be recruited**
Funded by: **EU H2020**
Coordinating partner: **Softeco**
Collaborative partners: **16 partners - see project website**
Dates: **May 2019 – April 2022**
Website: https://h2020-trustonomy.eu/

Abstract: Autonomous vehicles are becoming a reality and most of the major manufacturers have plans to commercially release an autonomous vehicle by 2020-2024. Despite these technological breakthroughs, current market analysis indicates that broad adoption of fully autonomous vehicles might be decades away. This in turn suggests that the human factor will remain essential for the safety and performance of road transport in the

forthcoming decades. Trustonomy is investigating and assessing the performance, ethics and acceptability of technologies and approaches in a variety of autonomous driving scenarios, covering different types of users (age, gender, driving experience), road transport modes (private cars, trucks, buses), levels of automation (L3 – L5) and driving conditions.

L3PILOT

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

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

Impact: With the comprehensive piloting of automated driving functions in test vehicles, L3Pilot will pave the way for large-scale field tests of series cars on public roads.

L3PILOT: Testing a fully automated car

Papers: Goncalves RC, Louw T, Markkula G, Merat N. (in press). Applicability of risky decision-making theory to understand drivers' behaviour during transitions of control in vehicle automation. *Proceedings of the International Congress on Ergonomics and Usability of Human Interfaces: Product Information, Built Environments and Transport 2019.*

Gonçalves RC, Louw T, Madigan R, Merat N. 2019. Using Markov chains to understand the sequence of drivers' gaze transitions during lane-changes in automated driving. *Proceedings of the international driving symposium on human factors in driver assessment, training and vehicle design. 217-223*

Innamaa S, Merat N, Louw T, Metz B, Streubel T & Rösener C. 2019. Methodological challenges related to real-world automated driving pilots. *Proceedings of the 26th World Congress on Intelligent Transport Systems.*

Metz B, Rösener C, Louw T, Aittoniemi E, Björvatn A, Wörle J, Weber H, Torrao G, Silla A & Innamaa S. 2019. Evaluation methods: *Deliverable D3. 3 of L3Pilot.*

InterACT

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

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

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

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

Impact: The project has prompted a new collaboration between ITS and a group from Keio University in Japan.

Papers: Camara F, Bellotto N, Cosar S, Weber F, Nathanael D, Althoff M, Wu J, Ruenz J, Dietrich A, Markkula G, Schebien A, Tango F, Merat N & Fox C. 2019. Pedestrian Models for Autonomous Driving Part II: high level models of human behaviour. *IEEE Transactions on Intelligent Transportation Systems.*

Camara F, Dickinson P, Merat N & Fox C. 2019. Towards game theoretic AV controllers: measuring pedestrian behaviour in Virtual Reality. *IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS).*

Camara F, Merat N & Fox C. 2019. A heuristic model for pedestrian intention estimation. *IEEE Intelligent Transportation Systems Conference (ITSC), 3708-3713.*

Giles O, Markkula G, Pekkanen J, Yokota N, Matsunaga N, Merat N & Tatsuru D. 2019. At the Zebra Crossing: Modelling Complex Decision Processes with Variable-Drift Diffusion Models. *PsyArXiv.*

Lee YM, Madigan R, Garcia de Pedro J, Tomlinson A, Solernou-Crusat A, Romano R, Markkula G, Merat N & Uttley J. 2019. Understanding the messages conveyed by automated vehicles. *Proceedings of the 11th International Conference on Automotive User Interfaces and Interactive Vehicular Applications, 134-143.*

Lee YM, Uttley J, Solernou-Crusat A, Giles O, Romano R, Markkula G & Merat N. 2019. Investigating pedestrians' crossing behaviour during car deceleration using wireless head mounted display: an application towards the evaluation of eHMI of automated vehicles. *Proceedings of the 10th International Driving Symposium on Human Factors in Driving Assessment, Training and Vehicle Design, 252-258.*

Madigan R, Nordhoff S, Fox C, Amini RE, Louw T, Wilbrink M, Schieben A & Merat N. 2019. Understanding interactions between Automated Road Transport Systems and other road users: A video analysis. *Transportation research part F: traffic psychology and behaviour, 66, 196-213*

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Portouli E, Nathanae D, Amditis A, Lee YM, Merat N, Uttley J, Giles O, Markkula G, Dietrich A & Schieben A. 2019. Methodologies to Understand the Road User Needs When Interacting with Automated Vehicles. *International Conference on Human-Computer Interaction, 35-45.*

Schieben A, Wilbrink M, Kettwich C, Dodiya J, Weber F, Sorokin L, Lee YM, Madigan R, Markkula G & Merat N. 2019. Testing external HMI designs for automated vehicles–An overview on user study results from the EU project interACT, 9. *Tagung Automatisiertes Fahren*

Schieben A, Wilbrink M, Kettwich C, Madigan R, Louw T & Merat N. 2019. Designing the interaction of automated vehicles with other traffic participants: design considerations based on human needs and expectations. *Cognition, Technology & Work, 21, 1, 69-85.*

Human Drive

Grant holder: **Professor Natasha Merat**
Investigators: **Professor Rich Romano, Dr Gustav Markkula, Dr Albert Solernou-Crusat, Dr Yee Mun Lee, Dr Chongfeng Wei, Dr Foroogh Hajiseyedjavadi, Dr Evangelos Paschalidis, Michael Daly, Anthony Horrobin, Dr Zahara Batool, Dr Andrew Tomlinson, Dr Charisma Choudhury**
Funded by: **Innovate UK**
Dates: **July 2017 to March 2020**
Collaborative partners: **Nissan, TSC, Hitachi, Horiba Mira, Highways England, Aimsun, Cranfield University, Atkins**
Website: humandrive.co.uk

Abstract: The HumanDrive project has developed a prototype autonomous vehicle and demonstrated an automated journey in live traffic and under different environmental conditions. The Grand Drive from Nissan Cranfield to Sunderland was achieved as part of an investigation into how autonomous driving can emulate a natural, human-like driving style. On its journey, the Nissan LEAF test vehicle experienced a range of driving scenarios from country lanes with no or minimal road markings, to junctions, roundabouts and

motorways. Autonomous technology was activated along the route to change lanes, merge and stop and start when necessary. The system has undergone a robust testing process including simulation, hardware in the loop, private test track and small sections of public roads. The Leeds team developed and tested a series of vehicle control models. Can more human-like behaviour from an automated vehicle affect user behaviour and acceptance? In our state of the art motion-based driving simulator, the experiences of drivers were monitored to ensure the vehicle control models are acceptable to a wide range of users.

Impact: watch the video https://uolds.leeds.ac.uk/news/humandrive-cenex-lcv2019-low-carbon-vehicle-event/

Papers: Louw T, Hajiseyedjavadi F, Jamson H, Romano R, Boer E & Merat N. 2019. The relationship between sensation seeking and speed choice in road environments with different levels of risk. *Proceedings of the 10th International Driving Symposium on Human Factors in Driver Assessment, Training and Vehicle Design.*

Paschalidis E, Hajiseyedjavadi F, Wei C, Solernou-Crusat A, Merat N, Romano R & Boer E. 2019. Deriving metrics of driving comfort for autonomous vehicles. A time-series latent variable approach of speed choice. *International Choice Modelling Conference 2019*

Wei C, Romano R, Hajiseyedjavadi F, Merat N & Boer. 2019. Driver-centred Autonomous Vehicle Motion Control within A Blended Corridor. *IFAC-PapersOnLine, 52, 5, 212-217.*

Wei C, Romano R, Merat N, Hajiseyedjavadi F, Solernou-Crusat A, Paschalidis E & Boer E. 2019. Achieving Driving Comfort of AVs by Combined Longitudinal and Lateral Motion Control. *The IAVSD International Symposium on Dynamics of Vehicles on Roads and Tracks, 1107-1113*

Wei C, Romano R, Merat N, Wang Y, Hu C, Taghavifar H, Hajiseyedjavadi F & Boer E. 2019. Risk-based autonomous vehicle motion control with considering human driver's behaviour. *Transportation Research Part C: Emerging Technologies, 107.*

TRANSITION - the adoption of driverless vehicles is not possible in some regions.

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

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

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

TRANSITION

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

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

Shift2Maas: Mobility-as-a-Service platforms enable a seamless passenger experience

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

Papers: Mole C, Giles O, Merat N, Romano R, Markkula G & Wilkie R. 2019. Where you look during automation influences where you steer after take-over. *Proceedings of the 10th International Driving Symposium on Human Factors in Driver Assessment, Training and Vehicle Design.*

Mole C, Markkula G, Giles O, Okafuji Y, Romano R, Merat N & Wilkie R. 2019. Drivers fail to calibrate to optic flow speed changes during automated driving. *Proceedings of the 10th International Driving Symposium on Human Factors in Driver Assessment, Training and Vehicle Design.*

Wilkie R, Mole C, Giles O, Merat N, Romano R & Markkula G. 2019. Cognitive load during automation affects gaze behaviours and transitions to manual steering control. *Proceedings of the 10th International Driving Symposium on Human Factors in Driver Assessment, Training and Vehicle Design.*

RAIL

Shift2MaaS

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

Abstract: The main goal of Shift2Maas is to support the uptake of new and integrated Mobility-a-as-Service platforms (MaaS) to enable seamless passenger experience. In collaboration with other Shift2Rail projects, Shift2Maas seeks to remove the barriers which hinder the uptake of MaaS platforms. The developed solutions will be tested in three different European sites. Shift2Maas will demonstrate the benefits of IP4 through pilots focussed on shared mobility.

ASSETS4RAIL

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

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

RSSB Secondment

Grant holder: **Dr Manuel Ojeda-Cabral**
Funded by: **University of Leeds Impact Acceleration Account**
Dates: **September 2018 to June 2020**

Abstract: Railways are complex systems with multiple interfaces delivered by many different organisations. Through research, risk modelling and analysis RSSB helps the rail industry in the areas of safety, standards, knowledge, and innovation. RSSB have formed a strategic partnership with the University of Leeds. 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.

OPTIYARD – Optimised Real-time Yard and Network Management

Grant holder: **Professor Ronghui Liu**
Investigators: **Dr Zhiyuan Lin, Dr Xiaoxiao Ma, Professor Andrew Smith, Dr Anthony Whiteing**
Funded by: **EU H2020**
Dates: **October 2017 to September 2019**
Coordinating partner: **UIC**
Website: optiyard.eu

Abstract: The European Commission's 2011 White Paper stated that, by 2050, rail should substantially expand its modal share over medium and long distances. This planned surge in rail capacity (within a range of 70-90%), will contribute to rail being the preferred modal choice. As rail yards are the first and last points of customer experience for the physical journey, they must be easily accessible and efficient. OptiYard defines an improved information and communications process and simulates intelligent real-time yard operations. To do so, it provides automated optimisation algorithms for yard management and uses a technical demonstrator in the form of a fully functional software module.

Impact: The OptiYard decision support tool will help to enhance competitiveness whilst increasing service reliability and customer satisfaction by providing accurate and updated information.

RAILS: Roadmaps for AI Integration in the Rail Sector

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

OPTIYARD – developing optimisation algorithms for efficient rail yard operations.

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

Smart Maintenance and the Rail Traveller Experience (SMaRTE)

Grant holder: **Dan Johnson**
Investigators: **Dr Kate Pangbourne, Professor Andrew Smith, Jeremy Shires, Dr Thijs Dekker**
Funded by: **EU H2020/ S2R**
Coordinating partner: **ITS**
Collaborative partners: **University of Huddersfield, FIT Consulting, IST Lisbon, Fertagus, UNIFE, Luleå University of Technology, Ergoproject, UITP, London Underground Limited, Luleå Flygteknik**
Dates: **September 2017 to August 2019**

Abstract: The project brought together two related but distinct areas of research. Smart maintenance and human factors are concerned with digitisation and the use of information to enhance decision making, either by industry players in respect of maintenance decisions, or by rail users in employing smart applications to navigate the rail system and its interaction with other modes.

Reducing Energy Demand (TransEnergy)

Grant holder: **Professor Andrew Smith**
Investigators: **Dr Jean-Christophe Thiebaud, Dr Romain Crastes dit Sourd, Alex Stead, Jeremy Shires**
Funded by: **EPSRC**
Dates: **July 2017 to July 2019**
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 was a socio-economic study providing financial models and frameworks to support adoption and implementation of the technology.

Land Value and Transport – modelling the relationship between rail accessibility and property values.

Land Value and Transport – Modelling and Appraisal

Grant holder: **Dr John Nellthorp**
Investigators: **Dr Chris Leahy, Dr Like Jiang**
Funded by: **West Yorkshire Combined Authority (WYCA), Transport for London and an EPSRC Impact Acceleration Account**
Dates: **January 2018 to August 2019**

Abstract: This project is contributing new spatial econometric models focusing on the relationship between rail accessibility and property values and exploring the potential for land value change (or uplift). These models take advantage of increasingly available data, and address various limitations of previous models in this field. The aim was to provide authorities at national & regional level with quantitative evidence which will help inform Business Cases for rail improvement, and the Business Case for Northern Powerhouse Rail (NPR) is one specific application. The model results for NPR were delivered to Transport for the North in November. The concept for the research was developed through an earlier scoping study which identified significant gaps in the understanding of property value changes due to transport infrastructure investment. The models therefore include: A new theoretical framework; A more complete and detailed representation of accessibility to economic opportunities, as a driver of property values – by multiple modes including rail, walk and car; Recognition of a wide range of environmental factors.

Outputs: The models as a set include both cross-sectional, sectional and time series models, and address the residential and commercial property markets The outputs include quantification and mapping of various scenarios, and economic appraisal/ business case analysis using the results. Formal reports to the Advisory Panel and to sponsors have been delivered at milestones during the project. The Advisory Panel includes DfT, the National Infrastructure Commission, leading academics and others.

Papers: Nellthorp et al. 2019. Land Value and Transport (Phase 2): Modelling and Appraisal. Final Report. https://transportforthenorth.com/wp-content/uploads/LVT-Phase-2-Final-Report-ITS-2019.pdf

Impact: The North of England served as the location for the study area – a much wider area than is typically included in hedonic property price studies of transport investment. The modelling results reveal the sensitivity of property values to changes in the region's rail network. Further work in this research area has been funded by HS2.

CONNECTED MOBILITY

ARCADE

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

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

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

KARMA

Grant holder: **Professor Susan Grant-Muller**
Investigators: **Dr Gillian Harrison, Frances Hodgson**
Funded by: **Alan Turing Institute Fellowship**
Dates: **October 2018 – May 2022**
Website: https://www.turing.ac.uk/research/research-projects/new-data-forms-transport-policies

Abstract: KARMA aims to create a step change in understanding the cross-sectoral impacts of transport schemes by

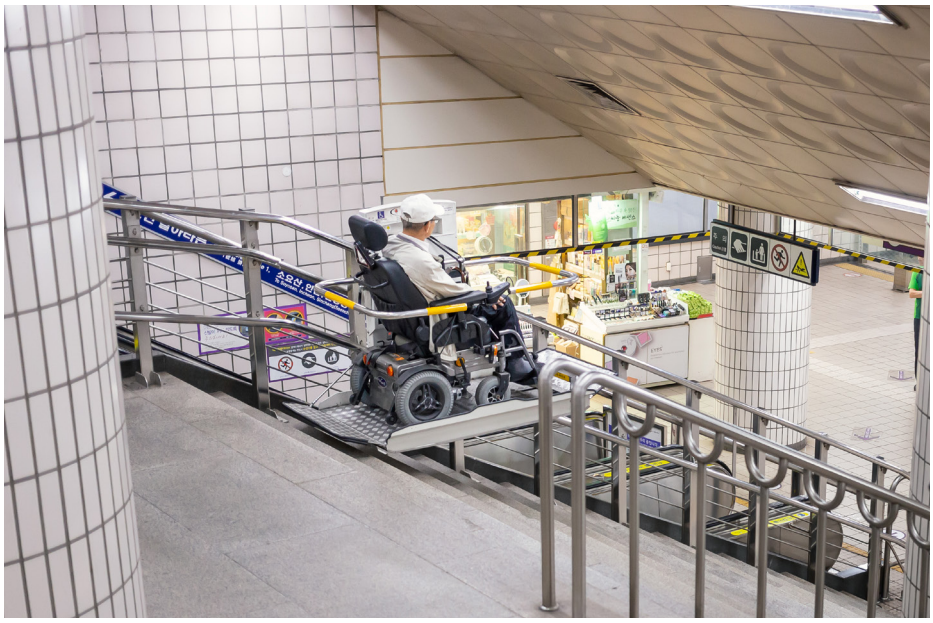
advanced analytics of next generation transport and other urban data (e.g. phone location signals, sensor data and more). The project objectives are to: Create new databases and model interfaces, with interoperability between 'next-generation' data, traditional data and mathematical models; Enhance existing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

Impact: Early findings will be presented in January and February 2020 by Prof. Grant-Muller at the Maurice Bloch seminar (University of Glasgow) and to the joint UITP/European Committee of the Regions annual event. The KARMA team have been awarded a new research project (in collaboration with QMUL) concerned with the use of dynamic graph theory, which will draw on KARMA data and insights. This follow-on project is called RAPHTORY.

SUITCEYES (Smart, User-friendly, Interactive, Tactual, Cognition-Enhancer, Yielding Extended Sensosphere)

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

Abstract: 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,



Valuing Accessibility in Transport

face and object recognition, machine learning, and gamification. Perception of the environment is one of the challenges this project will address. This, among other wider benefits, will help to enhance a deafblind person's ability to travel safely in their community.

Mapping Accessible Transport for Persons with Reduced Mobility

Grant holder: **Bryan Matthews**
Investigators: **Dr Like Jiang**
Funded by: **EU DG-MOVE**
Dates: **August 2018 to September 2019**
Coordinating partner: **Panteia (NL)**
Collaborative partners: **TIS (PT) and AARMIS (PT)**

Abstract: There is a growing awareness (and accompanying political and commercial will) to provide information services that cater for disabled and older people, but there is much confusion as to how and what to include. This project aimed to develop technical solutions and recommendations to provide travel information through digital means. The objectives were to increase the understanding of what is required by persons of reduced mobility, learn from existing practices, propose and test a solution. In pursuing these objectives, the consortium took into account the transport and information access requirements of a wide range of characteristics, including but not limited to mobility difficulties, visual or hearing impairment, and cognitive or learning disabilities.

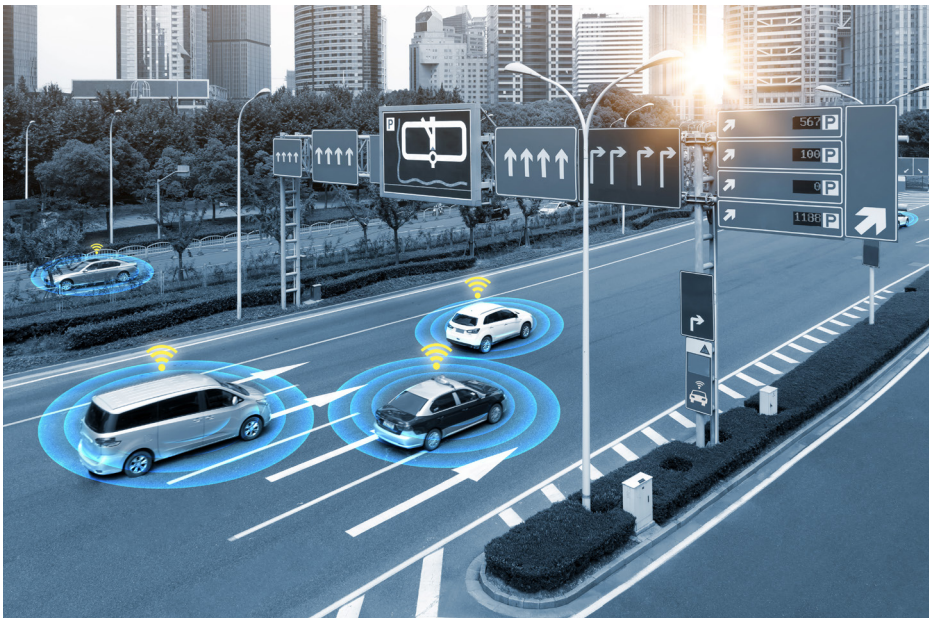
Papers: Teoha T, Matthews B & Carvalho D. An assessment of digital travel information services serving persons with reduced mobility in Europe *to be presented at the 8th Transport Research Arena*

Valuing Accessibility in Transport

Grant holder: **Dr Manuel Ojeda-Cabral**
Investigators: **Dr Thijs Dekker, Professor Richard Batley, Dr Chiara Calastri, Jeremy Shires, Bryan Matthews, Dr Phill Wheat, Dr Chris Leahy**
Funded by: **DfT**
Coordinating partner: **ARUP**
Dates: **June 2019 to October 2020**

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

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



Automated driving progressed by the internet of things (AUTOPILOT).

AUTOPILOT

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

Abstract: 'Automated driving **P**rogressed by **I**nternet **O**f **T**hings' (AUTOPILOT) brings the Internet of Things (IoT) into the automotive world. IoT enables connections between objects or 'Things'. The IoT connects anything, anytime, anyplace, using any service over any network. The project aims to transform connected vehicles (i.e. moving 'Things' within the IoT ecosystem) into highly and fully automated vehicles. While using the IoT potential for automated driving, AUTOPILOT also returns data from autonomous cars to the IoT.

AUTOPILOT will involve vehicles, road infrastructure and surrounding objects in the IoT ecosystem, with particular attention to the safety-critical aspects of automated driving. The IoT-enabled AUTOPILOT cars are being tested in real conditions at six permanent large-scale pilot sites in Finland, France, Italy, the Netherlands, South Korea and Spain. The project aims to bring automated driving towards a new dimension.

Papers: Harrison G, Shepherd S, Chen H, Barnard Y. 2019. Benefits and Uptake Sensitivities of Connect and Automated Vehicles. *Presented at the 2019 European Transport Conference.*

Pattinson J & Chen H. 2019. A barrier to innovation: Europe's ad-hoc cross-border framework for testing prototype autonomous vehicles. *International Review of Law, Computers & Technology*

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

PAsCAL

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

Abstract: PAsCAL proposes an awareness-driven and large-scale penetration approach to address issues raised by the majority of the general public - issues that hinder the wide market uptake of Connected and Autonomous Vehicles (CAV). Using an interdisciplinary mix of innovative tools from both human science and technology to capture public acceptance and attitude we will analyse and assess the concerns raised by people, model and simulate realistic scenarios for hands-on practice, and validate the research innovation in several real-world trials.

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

TRANSPORT AND HEALTH

Global Mobility Options for Sustainable Transitions (GMOSTIII)

Investigators: **Dr Robin Lovelace**
Funded by: **World Health Organisation (WHO)**
Dates: **August to November 2019**
Website: https://github.com/ATFutures/who3/

Abstract: This project builds on previous research funded by WHO and contributed to the Urban Health Initiative with the ongoing development of a web application to explore health benefits of sustainable transport policies. The aim of this project was to create a flexible framework for analyzing, visualizing and testing a range of scenarios based

on different input datasets and parameters, and to ensure the framework can be updated and modified at any stage within or beyond the project timetable. We have delivered that in the form of open source software, the R package 'Upthat', which users can install and adapt for their own use cases.

Output: The main output is a stable prototype, called 'The Urban Planning and Transport Health Assessment Tool' (Upthat; R Lovelace et al. 2018), previously named the Active Transport Toolkit (ATT). Upthat can be used for many purposes related to the interface between transport and human health, including assessment of exposure to air pollution, changes in the distribution of physical activity, and the spatial distribution of cycling and walking.

Impact: Influenced thinking in the World Health Organisation about public-facing tools based on open data and open source software for city planning.

uCARe

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

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

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

Targeting the Bad Emitting Vehicles

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

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

Impact: First patent has been published in full: Miller DW, Hynd JW, Sandhu GS, Burnett AD, Ropkins K. Particulate Matter/Number Synchronization Measurement Device. Formally recognised 29 January 2019 as US10,190,945. Second patent pending.

City Air Remote Emission Sensing (CARES)

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

Abstract: CARES aims to investigate contactless measurement of vehicle exhaust emissions such that it becomes a widespread means for the monitoring and enforcement of real-world vehicle emissions. We develop plume chasing instruments to detect high-emitters in free flowing traffic. We turn fast-response air quality sensors into roadside point samplers, adding particle mass, number and size to the remote sensing capabilities. Furthermore, we speed up the data handling towards a real-time analysis of vehicle emission data; merging the emissions data with technical data from national vehicle registers and relevant data from traffic and air quality management systems. Third, we eliminate today's often very time consuming data analysis by providing a suite of open-source functions. All our innovations will

ELVITEN project – supporting the shift from conventional vehicles to EL-Vs (see page 12).

improve the user friendliness, bring down costs by automated operations and achieve a broader deployment potential of remote emission sensing. CARES aims to demonstrate these developments in three major, heavily air polluted cities in Europe.

Impact: CARES will bring together researchers, remote emission sensing technology providers, local, regional and national authorities and many other stakeholders from Europe, China and the rest of the world, to maximize the project's exploitation potential.

Evaluate Local NO2 plans

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

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

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

OptiTruck

Grant holder: **Dr Haibo Chen**
Investigators: **Dr Richard Connors, Professor David Watling, Dr Yue Huang, Dr Jianbing Gao, Dr Kaushali Dave,**
Funded by: **EU H2020**
Dates: **September 2016 to August 2019**
Coordinating partner: **ERTICO**
Collaborative partners: T**en partners in industry and academia (see website for details)**
Website: optitruck.eu

Abstract: The automotive industry has developed powertrain technologies to improve the fuel efficiency of Heavy-Duty Vehicles (HDVs). However, due to increasing road freight, total HDV energy use and CO2 emissions are expected to remain undiminished if no policy action is taken. OptiTruck aimed to combine the most advanced technologies from powertrain control with intelligent transport systems in order to achieve a 20% global reduction of energy consumption, while achieving Euro VI emission standards, for heavy duty road haulage.

Papers: Gao J, Chen H, Ma C, Tian G, Zhu F. 2019. An analysis of energy flow in a turbocharged diesel engine of a heavy truck and potentials of improving fuel economy and reducing exhaust emissions. *Energy conversion and management, 184, pp.456-465.*

Gao J, Chen H, Chen J, Ma C, Tian G, Li Y. 2019. Explorations on the continuous oxidation kinetics of diesel PM from heavy-duty vehicles using a single ramp rate method. *Fuel, 248, pp.254-257.*

Gao J, Chen H, Li Y, Chen J, Zhang Y, Dave K, Huang Y. 2019. Fuel consumption and exhaust emissions of diesel vehicles in worldwide harmonized light vehicles test cycles and their sensitivities to eco-driving factors. *Energy conversion and management, 196, pp.605-613.*

Watling D, Connors R & Chen H. 2019. Sensitivity analysis of optimal routes, departure times and speeds for fuel-efficient truck journeys. *6th International Conference on Models and Technologies for Intelligent Transportation Systems.*

Huang Y & Chen H. 2019. Review of rolling resistance influence on fuel consumption of trucks. *13th ITS European Congress.*

Gao J, Chen H, Tian G, Ma C, Zhu F. 2019. Oxidation kinetic analysis of diesel particulate matter using single- and multi-stage methods. *Energy & Fuels, 33(7), pp.6809-6816.*

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

MODALES

Grant holder: **Dr Haibo Chen**
Investigators: **Dr Yue Huang**
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Collaborative partners: **16 European partners in industry and academia and 3 Chinese Partners (see website for details)**
Dates: **September 2019 to August 2022**
Website: http://modales-project.eu/
Abstract: MODALES is aimed at

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

DECISIONS

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

Abstract: Mathematical models of choice are used to understand and forecast behaviour, or valuate intangibles such as time. These outputs are key in many decision-making contexts. While current modelling techniques are faithful to economic theory, their behavioural and psychological soundness have been questioned. The Decisions project is developing choice models that more accurately represent the human decision-making process and the context of real-life choices.

This requires introducing behavioural and psychological elements in mathematical choice models and implies moving away from the 'homo economicus' framework to a more complex representation, where 'soft' factors such as social influence affect decisions.

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

The DECISIONS project considers soft factors in mathematical models of choice to help evaluate intangibles such as time.

Papers: Webb EJD, Meads D, Lynch Y, Randall N, Judge S, Goldbart J, Meredith S, Moulam L, Hess S & Murray J. 2019. What's Important in AAC Decision Making for Children? Evidence from a Best-worst Scaling Survey, *Augmentative and Alternative Communication.*

Daly AJ & Hess S. (in press) VTT or VTTS: a note on terminology for value of travel time work. *Transportation.*

Dada M, Zuidgeest M & Hess S. (in press) Modelling pedestrian crossing choice behaviour on Cape Town freeways: caught between a stone rock and a hard place? *Transportation Research Part F.*

Calastri C, Crastes dit Sourd R. (in press) We want it all: experiences from a survey seeking to capture social network structures, lifetime events and short-term travel and activity planning. *Transportation.*

Calastri C, Hess S, Choudhury CF, Daly AJ & Gabrielli L. (in press) Mode choice with latent availability and consideration: theory and a case study. *Transportation Research Part B*

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